A REVISION OF THE GENUS *EPOPHTHALMIA* BURM. (ODON., CORDULIINAE),

with notes on habits and larvae.

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With 29 text-figures and one coloured plate.

INTRODUCTION.

Some time ago whilst occupied with a revision of the Indo-Australian members of the genus *Macromia* I had occasion to consult publications dealing with the closely allied genus *Epophthalmia*. At that time the material available to me for study was very poor; and discrepancies in literature as well as early difficulties over the determination of specimens I was obliged to borrow material from other collections, and make a careful study of all the already known species.

Thanks to the generosity of Odonatists, who had already become aware of the many problems in connection with defining the species of this most striking genus, important material gradually came under my notice: as a result of which I now contemplate making a revision of this genus.

Although I now have before me a comparatively large number of specimens, yet some of the known species of *Epophthalmia* are very poorly represented. This can be attributed partly to the very restricted occurrence of such species even in countries where the genus is well represented, and partly to the difficulty in capturing them owing to their swift flight. At the same time the number of species at present known to us is very small, and in more than one case our knowledge about their distribution is based only upon a single almost valueless label-record with inconcise indication of habitat.

With regard to synonymy; it must be admitted, that since the publication of MARTIN'S monograph 'Cordulines' in the Cat. Coll. DE SELYS LONGCHAMPS, considerable confusion has arisen, very largely due to the misinterpretation of the correct views of last century Odonatists. And for a knowledge of the habitat of certain species later authors had to depend entirely on the very fragmentary and doubtful statements of their predecessors: as a result of which unreliable views when once accepted often become accepted.

In the following descriptions I have sometimes had to rely on the characters used by several authors many of which are ordinarily considered to be of

problematical value, as for example the colour pattern of the head and abdomen, and more especially the shape of the male anal appendages. But I have found that these features are sufficiently constant; and after taking into account other factors, it has been found possible to apply them with satisfactory results. They will perhaps aid in the recognition of at least most of the males, as far as available material allows.

To facilitate the recognition of the several species a comparative study of the neuration has been made: but, in contrast with so many other genera, including certain "groups" of the closely related genus *Macromia*, this study has led to disappointment, as no valuable neural characters could be found.

It is especially to be regretted that no more females could be obtained, this fact contributing in no small measure to the incompleteness of the present paper. For this reason I have refrained from making any generalizations regarding geographical influence; although in one widely distributed species, *E. vittata*, the tendency to develop well marked geographical subspecies seems to have reached an advanced phase — so much so in fact that I do not hesitate to regard this phenomenon as significant and possibly to be regarded as a natural result of prolonged isolation. In other cases of perhaps more slowly migrating species, e.g. *E. vittigera*, the development of subspecies within the eastern limit of its range is less striking and perhaps still in an initial stage; although the tendency to differ from the typical form in certain characters of minor importance can already be seen — these characters sometimes paralleling others of similar value in a very striking manner.

In the following historical review I have tried to fix the position of the genus in the subfam. Corduliinae. A brief key to the species is given, followed by a more amplified one: and finally each of the species is discussed separately. Contrary to my original plan, namely to give a very detailed description for each species, it has been found advisable to adopt the method of treatment just described. Firstly, because excellent descriptions already exist for at least three species; secondly, because it is my opinion that such detailed descriptions are liable to lead to confusion rather than to the ready identification of species; and thirdly, because many of the species have so much in common that undesirable repetition would be necessary.

In order to facilitate consultation of the best of existing descriptions references are given in heavy print under the heading of each species — including cases where the original description was copied or extracted.

At the end of this paper descriptions and figures of the full grown and young larvae of three species are given. Much attention was devoted to these larvae, although a full account of that of one of them has already been published by CABOT in his well known paper.

The figures appended are original camera lucida drawings; except for figures 20, and 28 which have been worked up by a native artist.

My thanks are due to Col. F. C. FRASER (Coimbatore), Dr. F. F. LAIDLAW (Uffculme), Mr. K. J. MORTON (Edinburgh), Dr. F. RIS (Rheinau) for their

generosity in loaning me all the specimens in their collections. Through the kindness of M. A. BALL I have been able to study all the *Epophthalmia* specimens in the Brussels Museum, formerly DE SELYS' collection. Mr. R. VAN EECKE has lent me the type of *E. australis* HAGEN from the Leiden Museum, and Dr. E. TITSCHACK (Museum Hamburg) has done me similar service as regards a lot of unidentified larvae and imagoes which proved to be of great interest.

It is my hope that the arrangement adopted, though it may hereafter be subject to revision, will fulfill the primary object to which this paper is directed, namely that of overcoming hesitation about devoting study to these beautiful Dragonflies.

November, 1930.

HISTORICAL.

The name *Epophthalmia* [1]) was first proposed by BURMEISTER in the second volume of his well known "Handbuch der Entomologie", 1839, p. 844 for a rather large number of Corduliine genera, including *Epophthalmia, Didymops, Synthemis, Tetragoneuria, Somatochlora, Cordulia* and *Syncordulia.* It is very unfortunate that the european *Cordulia aenea* also took part of the genus as this gave rise to the opinion of many authors that, according to the rules of nomenclature, the name *Epophthalmia* had to be considered as a pure synonym of *Cordulia* LEACH 1815. Strictly spoken they are right but nevertheless the author has retained BURMEISTER's name *Epophthalmia,* for the following reasons:—

1. The first species described by BURMEISTER under *Epophthalmia* was *vittata,* of the same author.
2. According to HAGEN (Verh. zool. bot. Ges. Wien, 17, 1867) BURMEISTER has personally given to understand that he should like to consider *vittata* as the genotype of *Epophthalmia.* HAGEN (loc. cit., p. 62) writes „Der Gattungsname *Epophthalmia* ist auf den persönlich ausgesprochenen Wunsch Prof. BURMEISTER's seiner *E. vittata* belassen".
3. BRAUER and HAGEN as well as the two monographers of later time i.c. DE SELYS LONGCHAMPS and RÉNE MARTIN have respected BURMEISTER's desire and even at present days the name is in use by several students in *Odonata.*

Thus I think that the only commonsense line to take under this circumstance, is to assume *vittata* to be the real type of *Epophthalmia* and to refer

[1]) From *ἐπί* upon, and *ὀφθαλμός* eye. — „Der einzig sichere, beiden Geschlechtern gleichmässig eigene Unterscheidungscharakter dieser in manchen Beziehungen von den ächten Libellen abweichenden Gruppe liegt in der Bildung der Augen, und zwar darin, dass jedes Netzauge an seinem Hinterrande vor den Schläfen einen kleinen Fortsatz aussendet, welcher in die Wange hineintritt, und offenbar die Andeutung eines 2ten Auges ist." (BURMEISTER, l.c., p. 844).

Azuma NEEDHAM (vide postea), a name which had to make its appearance as substitute, to synonymy. This course has been followed in the present paper.

The first more restricted diagnosis of *Epophthalmia* was offered by DE SELYS in the "Synopsis des Cordulines" (1871). In that work it still figured as a subgenus of *Macromia* RAMBUR, and contained two groups, the nearctic *E. taeniolata* RAMB., being the only representative of the first group, and the oriental *vittata,* the type of the second group, including also the other true members of the genus known at that time. In the 2nd Additions to the Synopsis (1878) a second North American species was added to the first group, viz. *georgina* SELYS. On a later place in the same work DE SELYS altered his views to a certain extent in placing *E. elegans* BRAUER with *georgina* in the *taeniolata*-group, leaving all other true *Epophthalmia*'s in the first group of *vittata.* Not to mention other more fundamental marks of identification both groups were characterized in having cross-veins in the triangles of all wings, whereas *amphigena* — also considered to be a *Epophthalmia* with some doubt — appeared in a special paragraph and was defined in having the triangles of the front wings traversed, those of the hind pair being free.

This new arrangement did not give much satisfaction, even not to DE SELYS himself, as is obvious from his remarks on the subject.

Then mention should be made of an interesting report on Corduliine larvae, I mean the third part of LOUIS CABOT's fine work "The Immature State of the Odonata", subfam. Cordulina, published in the Memoirs of the Museum of Comparative Zoology at Cambridge, U.S.A., 1890. This paper is of special interest as it deals with the larva of one of our species, undoubtedly to be referred to *elegans* though CABOT only placed it in the genus *Epophthalmia* with some doubt, according to the fact that these nymphs shew conspicuously spotted wings which rather let him suppose they might belong to *Chlorogomphus.* Yet CABOT was quite right in placing these larvae close to *Macromia.* (NEEDHAM and other authors have shown that spotted wings may occur in many Libellulid genera during larval life, whereas in the adult stage of such genera the wings are hyaline). It may be remembered that CABOT was the first who saw that all nearctic species previously referred to the genus *Epophthalmia* are true *Macromia*'s; this consideration was based upon characters found in a rather large number of larvae from different habitat. MARTIN, in his monograph of the Corduliinae, Cat. Coll. SELYS (1906), however, gave nothing more than a true reflection of his great informant's ideas. Some fifteen years went over before NEEDHAM published his interesting paper on "New Dragon-fly Nymphs in the United States National Museum", in the Proc. U.S.Nat.Mus., vol. 27, 1904. On page 698 of that paper the larva of *E. elegans* was again discussed, but of more interest are NEEDHAM's remarks on the adult insect. Here a new genus was created to contain the large chino-japanese species. The author's arguments in doing so may be quoted *verbatim:*—

"This species differs from the more typical species of *Epophthalmia* by characters which I believe will be regarded as justifying its generic

separation. Aside from its huge stature, its singular color pattern, its unusual proportions in length of male abdominal appendages, and its smaller number of cubito- anal cross veins, it has three other characters in contradistinction to the more typical species of *Epophthalmia* that I regard of generic importance: (1) Its cubital vein where it borders the subtriangle is straight and strong; in the others it is weak and angulate. (2) Its radial sector is gently and regularly curved; in the others it is broken and distinctly ajog opposite the distal end of the radial supplement. (3) Its ninth abdominal segment in the male bears above a truncated cone; in the others it bears two basal denticles.— Since this is the largest and one of the most peculiar members of the fauna of the Land of the Dragonfly, I would suggest as an appropriate name for a new genus to contain it the classical Japanese name *Azuma*".

In a next to mention paper of WILLIAMSON, the wing-photographs of *elegans* and ? *vittata vittata*, reproduced on page 370 and 371 of it, show at a glance that the above enumerated neural differences as given by NEEDHAM are rather imaginary, and after consulting the material itself the characters proved to be greatly liable to vary. When comparing figs. 1 and 2, I note the following:—

sub (1) In both species the cubital vein where it borders the subtriangle in front wing is angulate and as can be observed in set specimens, there is but very slight difference in the strength of this vein [In my specimens of *E. vittigera* the last named difference is not perceivable at all and in a male and female of *elegans* from Formosa the cubital vein where it borders the subtriangle in front wing is even more angulate than in other species of the genus].

sub (2) The radial sector is almost exactly similar [In my examples of *vittigera* however, I must admit that this vein appears slightly broken towards its apex, but, so far as I am aware, its course is not different].

The third mark of distinction between *Azuma* and *Epophthalmia* (mentioned *sub* (3), *antea*) is, I think, of even less importance than the other ones. Moreover it was found to be variable within the limits of each species, especially in *vittata* and *vittigera*. Hence I propose to withdraw the name *Azuma*.

As already hinted at above, WILLIAMSON's splendid paper "The North American Dragonflies (Odonata) of the genus Macromia" (Proc.U.S.Nat.Mus., 37, 1909) deals also with *Epophthalmia*. In defining the genus *versus Macromia* he writes:—

"They are separated at once from *Macromia*, among other characters, by the greatly developed genital hamules in the male and by several venational characters, among which may be mentioned the abrupt apical curving of *M3* and *M4* in both front and hind wings, and the posterior widening of the hind wing from the anal angle to the termination of *M4*. (See figs. 1, 2.) Venational differences between *Azuma* and *Epophthalmia* are slight and are mainly to be found in the relations of *Cu* and *A* in the front wing proximal to the triangle. The crossed or uncrossed condition of triangles

and subtriangles, which has been used in the past in distinguishing *Macromia* and *Epophthalmia* has no value here as a generic character." [1])

WILLIAMSON's note on the genital hamule in the males seems especially worth attention as the structure of this organ offers a valuable point of distinction between the two genera.

In MARTIN's "Clé pour la détermination des Genres de *Macromini*" (recte *Macromiini*) in his work on the Corduliinae in WYTSMAN's Genera Insectorum (Gen. Ins., Subfam. Cordulinae, Bruxelles, 1914, p. 23), the previous abandoned system in defining the genera was again followed, even in separating *Macromia* from *Azuma-Epophthalmia*, thus neglecting the better characters suggested by WILLIAMSON some five years earlier. In the same key North America is given as a habitat for NEEDHAM's genus *Azuma*. This, of course, is a mistake.

In 1916 RIS (Supplementa Entomologica, 5, p. 71) already stated that the differential characters on which *Azuma* was based are insufficient but at the same time, according to the rules of nomenclature, he applies that name to all the species previously united under *Epophthalmia* sensu WILLIAMSONi 1909.

In the present paper the name *Epophthalmia* is adopted for reasons quoted above.

The last summarizing treatise to be mentioned on the subject is that of FRASER in the tenth part of his "Indian Dragonflies" (Journ. Bombay N. H. Soc., 1921, pp. 673—691), dealing with the Indian representatives of the subfamily. Here again *Macromia* and *Epophthalmia* are separated from each other by the neural characters as given by NEEDHAM and MARTIN, but the diagnosis of the genus is very full, giving a good idea of its appearance though many of the characters given are, of course, also applicable to *Macromia*.

Since the date of WILLIAMSON's work no further changes have been made in the composition of the genus. [2])

Genus **EPOPHTHALMIA** BURMEISTER.

1839 BURMEISTER Handb.Entom., 2, p. 844 (pars).
1867 HAGEN Zool.Bot.Ges.Wien, 17, p. 59, 62.
1871 SELYS Synopsis d.Cordulines, p. 89 sep. (pars).
1878 SELYS 2me Add.Syn.Cord., pp. 31-32 sep. (pars).
1890 CABOT Mem.Mus.Comp.Zool., 17, 1, pp. 9-11, Pl. 1 fig. 1 (larva *elegans*).
1904 NEEDHAM Proc.U.S.Nat.Mus., 27, p. 698 (imago et larva *elegans*, sub *Azuma*).
1906 MARTIN Cat.Coll. SELYS, 17, Cordulines, p. 57 (key; pars).
1908 NEEDHAM Ann.Ent.Soc.Amer., 1, 4, p. 278 (key; *Azuma* versus *E.*).

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[1]) In NEEDHAM's 'Key to the genera of the Corduliinae of the World, based on venational characters', in his paper "Critical Notes on the Classification of the Corduliinae" (Ann.Ent.Soc. Amer., I, 4, 1908, p. 278), the two genera where separated from each other by the last mentioned character only. The distinction between *Azuma* and *Epophthalmia*, as given in this paper was based on the different shape of the vein *Cu* where it bounds the subtriangle in the forewing.

[2]) Just as this paper was going to the press to be printed off, Mr. E. B. WILLIAMSON of the University of Michigan, Ann Arbor, in a recent letter dated 23th March, kindly informs me that NEEDHAM's generic name *Azuma* is preoccupied by *Azuma* JORDAN & SNYDER, for a Japanese fish genus.

1908 WILLIAMSON Ent.News, Philad., pp. 429-430 (key; *Macromiini*).
1909 WILLIAMSON Proc.U.S.Nat.Mus., 37, p. 369, fig. 1-2 (wings *elegans*, ?*vittata*).
1914 MARTIN Gen.Ins., Cordul., p. 23 (key; *Azuma* versus *E.*), pp. 25-26.
1916 RIS Supplem.Entom., 5, p. 71 (*Azuma* versus *E.*).
1921 FRASER Journ. Bombay N. H. Soc., p. 674 (key), pp. 677-678.

Corduliine dragonflies of very large size with an alternated colour-design of reddish to dark brown with metallic green or blue reflex and bright yellow or more quiet stripes and spots. Head large and globular with eyes very bulky, more tranversely placed than in the long axis of the body, not especially contiguous. Eyes in fully mature insects brilliant green above, olivish to grayish blue beneath. Mouth parts and face reddish or dark brown to almost black, usually spotted with yellow but sometimes unicolorous. Frons without sharply indicated anterior border, its upper portion divided into two at least slightly flattened parts, suture rather deep; coloration usually metallic green or blue, whether or not spotted with yellow. Epicranium small with two rather pointed elevations. Occipital triangle rather long, much protruding in front, glossy black. Occiput glossy black with an indistinct large brownish spot on each side against the sinuous projection at posterior margin of the eye.

Synthorax very bulky and of robust size, reddish or dark brown with slight to very brilliant metallic lustre. Antehumeral band of yellow always present, at least occupying the lower half of mesepisternum. Sides at least with complete yellow fascia running to level of coxae and covering the stigma. Thorax brown underneath, whether or not spotted with yellow. Legs long and robust, for the most part black; fore tibia of male with a yellow keel on the flexor surface, occupying the distal half to $^5/_8$; middle tibia with keel occupying the distal $^4/_5$-$^5/_6$; hind tibia with keel extending from near the base to the apex (from $^7/_8$-$^9/_{10}$ of the total length) [1]). Tarsal claws with strong hooks, of about the same size as the claws but slightly enlarged at base, claws thus appearing bifid at end.

Wings long and tapering rapidly towards the apex which is much pointed. Basal portion of hind wing from the anal angle to the termination of *M4* very considerably widened posteriorly, especially in the male; tornus produced and strongly angulated in male but never acute. Wings hyaline, in young females the tips of front wings to proximal side of pterostigma pale yellow (*vittigera*), or all tips indistinctly yellowish; in mature females the whole surface of all four frequently more or less golden yellow and in old specimens very often heavily clouded with brownish. In the male the anal field of hind wing very regularly tinted with pale yellow. Extreme base of hind wings in both sexes often heavily spotted with yellow or dark brown. Pterostigma short and narrow, black. Membranula long and rather broad, usually dark grayish in colour, its distal end darkened, extending from base to end of anal triangle or slightly before or beyond, its distal end, after a slight widening, rather abruptly narrowed towards the wing border. Anal triangle very long and narrow, two-celled.

[1]) In this respect no specific differences could be traced.

Number of antenodal and postnodal cross-veins variable, at least 14 antenodals in front wing, 9 in hind wing.

Anal loop well-developed, rather rounded in general outline, always wider than long, never reaching distal end of triangle and containing at least six cells (usually more), *M4* and *Cu1* in front wing widely divergent in their distal course. Two or rarely three rows of cells in the discoidal field before the forking of *M1-3*. *Cu1* and *Cu2* strongly curved towards the wing border; *M3* and *M4* likewise but with a still more abrupt apical curving towards the margin, these veins running closely parallel to each other in all wings. Arculus between first and second antenodal nervure, its sectors distinctly stalked. Veins *M2* and *Rs* slightly undulated or nearly straight as also the radial supplement. Median supplement absent. — Proximal angle of subtriangle in front wings distal to the level of arculus by at least the length of the interior side of subtriangle. Triangle of hind wing distal to the level of arculus for about the same length as its proximal side. Triangles long and narrow, costal side in front wing at most half as long as distal side, usually shorter, all of them traversed by at least one cross-vein. Subtriangles in front wing generally of about equal width as triangles, proximal side very irregular (in *elegans* usually more regular, but it was never found to be perfectly straight), always traversed by at least one cross-vein. Supratriangles traversed once or more.

Abdomen long, subcylindrical, of about the same length as the wings or longer (incl. anal appendages).

First two segments of male much inflated in dorso-ventral, moderately in lateral dimension; tumidity of distal end of abdomen usually less striking, variable. Segment 3 of male more or less constricted before the middle, thence gradually widening or nearly parallel-sided to segment 8, 9 or 10, the intervening segments either slim and cylindrical, or (*elegans*) rather flattened and widened. Abdomen of female long and cylindrical but rather compressed laterally and — with the exception of the basal segments — usually parallel-sided throughout. Colour usually dark brown or velvet-black, with proximal segments often polished but sometimes more or less ferruginous, generally with bright yellow or orangish bands or spots. Auriculae on second segment of male very small, knob-like, simple.

Genital lobe large, of very characteristic shape: projecting markedly from the ventral surface, almost quadrate and broadly truncated, each bent inwards to meet its fellow on the opposite side so as to enclose like a purse the distal portion of the posterior hamuli, which in their distal ends are closely approximated. Posterior hamuli foliate and much depressed, rather thick at base, each strongly ridged laterally and with a rather deep triangular furrow; distal portion rapidly tapering, its ventral margin strongly arcuate, directed ventrad, ending in a fine more or less circularly curved hook [1]).

[1]) Specific differences in the shape of the posterior hamuli as well as in that of the penis could not be traced, both organs being of very uniform build in all the species examined, and thus appear without value in separating the species.

Basal joint of penis with a pair of very blunt lateral protuberances near the distal end; second joint about three times as long as thick, very slightly curved at base, hardly enlarging towards its end, with a conspicuous dorsal hook followed by a transverse depression which is covered with a very regular mass of transversely arranged striae, radiating on the sides. Third joint about half as long as second, sharply bent at base, subtriangular in profile with a moderate concavity on extensor, a triangular convexity on flexor surface; glans small, membranous, almost hyaline except for a thickly pigmented median crest; distal lobes three in number, the two lateral lobes small and rounded, not sharply separated from the median lobe; this large, bearing a very long and slender cornua which at end divides into two or three very stiff and exceedingly long thread-like processes, which appear spirally twisted in natural position (fig. 1).

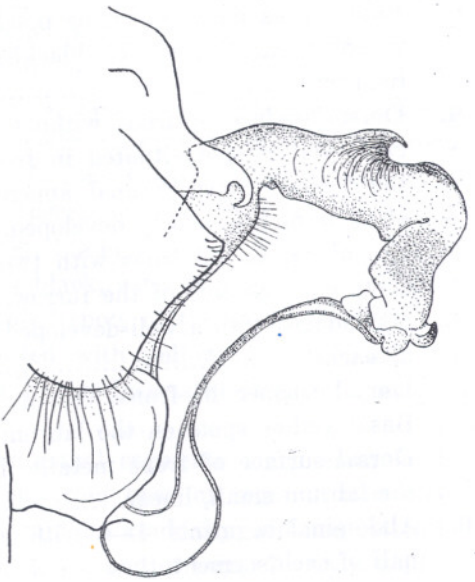

Fig. 1. *E.vittata sundana* LIEFTINCK, ♂. Right lateral view of penis, drawn from freshly captured specimen.

Superior anal appendages of male small, about as long as or slightly longer than tenth abdominal segment, robust and more or less angulated, usually with an extero-lateral protuberance beyond the middle, then rather tapering and more or less inwardly curved with rounded or pointed apex. Inferior appendage triangular, curving upwards more or less to meet the superiors, its apex slightly notched.

Vulvar lamina bilobed, of variable length but never more than half as long as ninth tergite. Ninth sternite extraordinary enlarged, plate-like, flattened or with a sharp median crest at base, about as long as or slightly longer than the tenth tergite, with or without small knobs. Appendages very short, conical.

Genotype: *E. vittata* BURM.

Key to male species.

1. Labium and metepimerum of synthorax partly yellow. ..... 2.
—. Labium and metepimerum of synthorax reddish- to dark brown, unicolorous. ..... 3.
2. Abdominal segment 6 with two mid-dorsal spots of yellow. Superior anal appendages rather rounded at tip. ..... **elegans** (BRAU.).
—. Abdominal segment 6 without yellow spots on dorsum. Superior anal appendages acutely pointed at their tips. ..... **elegans,** subspec.?

3. Labrum with clear or pale yellow markings. Frons at least with a yellow point on either side on its anterior surface. Abdominal segment 8 with yellow markings at its base. Insects with rich yellow or orangish coloration ... 4.
—. Labrum uniform dark brown or black, without yellow or whitish spots or lines. Frons dark brown or black, unmarked. Abdominal segment 8 unicolorous dark brown or blackish. Insects with yellow coloration much reduced. ..... 7.
4. Dorsal surface of frons without any yellow markings, or with only one clear yellow spot situated in front of the median ocellus and filling up the furrow. Superior anal appendages of male with extero-lateral tooth at their middle poorly developed. ..... 5.
—. Dorsal surface of frons with two large widely separated squarish yellow spots on each side of the furrow, which itself is unmarked. Superior anal appendages with a well-developed extero-lateral tooth at about the middle of each. ..... **frontalis** SELYS [1]).
5. Dorsal surface of frons with a large, unpaired median spot of yellow. Basal yellow spots on the labrum well-marked, rather rounded. ..... 6.
—. Dorsal surface of frons metallic blue, unicolorous. Basal yellow spots on the labrum small, linear. ..... **vittata cyanocephala** HAGEN.
6. Abdominal segments 4—6 with clear yellow rings, occupying the basal half of each segment, these bands not sharply defined behind. Superior anal appendages, viewed from side, with their upper margin very slightly convex. Insect of large size: abd. + app. 57, hw. 51-52 mm. ..... **vittata vittata** BURM.
—. Abdominal segments 4—6 with much narrower yellow rings, not extending to the base of each segment, occupying from $^1/_5$-$^1/_6$ of the length of these segments. Superior anal appendages, viewed from side, with their upper margin slightly but decidedly concave. Insect of smaller size: abd. + app. 52-54, hw. 47-49 mm. ..... **vittata sundana,** ssp.n.
7. Postclypeus uniform dark brown. Antehumeral band of yellow incomplete above, occupying the lower half of mesepisternum. Wing-bases entirely hyaline. Abdominal segment 7 with a yellow marking occupying one-third of the dorsum. Distal third of superior anal apps. not abruptly inwardly bent. Insect of smaller size, abdomen incl. apps. at most 55 mm long. ..... **australis** HAGEN.
—. Postclypeus with pale yellow or whitish lines. Antehumeral band of yellow almost complete, extending at least beyond half the length of mesepisternum. Extreme base of hind wings marked with dark spots at least in costal field. At most a narrow ring of yellow on abdominal segment 7. Distal third of superior anal apps. abruptly inwardly bent. Insect of large size, abdomen incl. apps. 56-59½ mm long. .... **vittigera** (RAMB.).

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[1]) References to other members of the group of *E. frontalis* SEL. are made in the tabular description or under the heading of that species furtheron in the text.

TABULAR DESCRIPTION OF SPECIES.

Males.

1. Metepimerum with a sharply defined clear yellow band running parallel to the second lateral suture and occupying about its posterior third. Labium black, median lobe almost entirely yellow, lateral lobes each with a large rounded or subtriangular yellow spot aside. Labrum with complete broad yellow band at base. Dorsal surface of frons without yellow spots. Synthorax with very broad yellow bands. Insects of very large size. ..... 2.

—. Metepimerum without yellow markings. Labium reddish brown to black, without yellow spots. Labrum brown or black, without yellow band at base but sometimes with two widely separated spots of the said colour. Dorsal surface of frons whether or not spotted with yellow. Yellow bands on synthorax narrower, sometimes almost linear. Insects of large or moderate size. ..... 3.

2. Abdomen very robust, with basal abdominal segments much enlarged in dorso-ventral, less in lateral dimension, from base of segm. 3 narrowed, this segment rather constricted in the middle, gradually widened laterally towards its end. Abdomen from segm. 4 to the end of segm. 7 very considerably widened (width of segm. 4 at base 2.5, of segm. 7 at end 5.8 mm), from middle of segm. 6 to end of 9 flattened and rather high, then segm. 8 only very slightly, 9—10 very considerably narrowed to the end. Segm. 6 with two mid-dorsal squarish or somewhat rounded, bright yellow spots, separated from each other by the longitudinal carina; these spots not extending onto the sides of the segment. Segm. 7 with a bright yellow ring, occupying slightly less than its basal half on the dorsum, this band with its posterior transverse limit trilobed, the middle lobe triangularly projecting behind. Segm. 8 black with narrow yellow transverse band at base widening along the median line and pointed behind. Anal appendages small, the superiors comparatively thick and robust, each of them distinctly bent inward after the middle, distal half tapering. Extero-lateral tubercle well-developed.

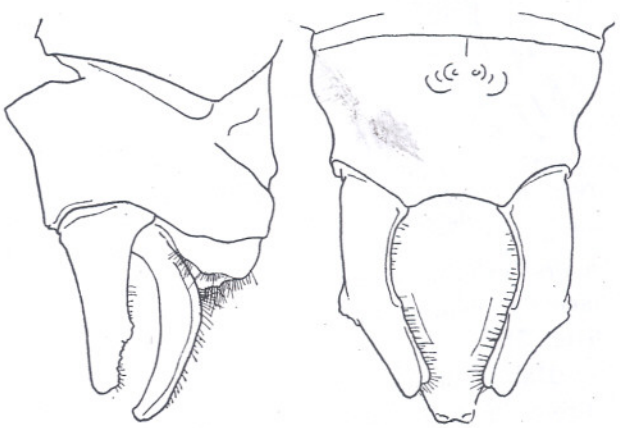


Fig. 2. *E. elegans* BRAUER, ♂ Japan (Mus. Brussels). Anal appendages, right side and dorsal view.

Apex blunt, obliquely truncated interiorly, and, when viewed from above very slightly notched by a longitudinal furrow dividing it into two portions, the intero-ventral portion being rounded and closely beset with strong black hairs, the somewhat larger extero-dorsal portion slightly angulated and almost bare at tip. Inferior anal appendage as long as upper pair, but sometimes either very slightly shorter or distinctly longer (fig. 2). — Hab.: Japan, China, Formosa. ..... **elegans** (BRAUER).

—. Abdomen less robust, with basal abdominal segments much enlarged in dorso-ventral, less in lateral dimension, from base of segm. 3 narrowed, this segment only very slightly constricted in the middle, hardly widening laterally towards its end. Abdomen from segm. 4 to the middle of segm. 6 with parallel sides, almost cylindrical, from the middle of segm. 6 to the end of 7 distinctly widened (width of segm. 4 at base 2.4, of segm. 7 at end 4.4 mm). Terminal segments slightly and gradually narrowed, 7—9 higher and less flattened than in the preceding species. Segm. 6 entirely black above and aside; on the ventral portion of the tergites two reddish brown spots at base; 7 with a bright yellow ring occupying slightly less than its basal half on dorsum and with its posterior transverse limit straight, not projecting in the middle. Segm. 8 black with very narrow transverse yellow line at base scarcely protruding behind. Anal appendages small, the superiors slender, more flattened and less inwardly curved after their middle; distal half tapering. Extero-lateral tubercle well-developed. Apex, when seen from above, obliquely truncated interiorly, scarcely notched by a very short longitudinal furrow; intero-ventral margin rounded and beset with strong black hairs, exterior margin straight with very small irregular tubercles, tips acutely pointed. Inferior anal appendage slightly longer than upper pair (fig. 3).

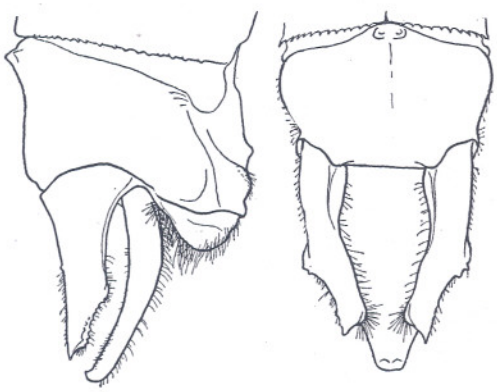


Fig. 3. *E. elegans subsp.*? ♂ Formosa (coll. MORTON). Anal appendages, right side and dorsal view.

— Hab.: Formosa. ..... **elegans**, subspec. ?

3. Frons light to dark brown. Labrum with clear yellow or pale yellow markings. Vertical and dorsal surfaces of frons either marked with clear yellow spots or (*vittata cyanocephala*) with a yellow point only on either side on its anterior surface. Postclypeus with broad basal band of yellow, often interrupted in the middle line. Antehumeral and lateral thoracic bands rather broad, clear yellow. Transverse yellow rings on dorsum of abdominal segments 2—6 conspicuous, at least part of them complete, sometimes almost occupying the basal half of the segments. Terminal segments 8—10

and anal appendages either almost entirely ferruginous or reddish- to dark brown with yellow markings at least on base of segm. 8 ..... 4.

—. Face black or very dark brown. Labrum uniform dark brown or black without yellow or whitish spots. Frons dark brown or black with bright metallic reflex, but without any yellow markings. Postclypeus unmarked or with only small pale aqueous-yellow spots or lines. Antehumeral band either reduced and only occupying the ventral portion of mesepisternum, or complete; in both cases narrow and usually of a dull yellow colour. Transverse marks on dorsum of abdominal segments 2—6 narrow, incomplete (paired), less intensively coloured, sometimes reduced to mere traces. Terminal segments 8—10 and anal appendages very dark brown or black, unicolorous. ..... 8.

4. Frons with bright metallic green or bluish green lustre, especially above; upper margins of tubercles rather irregularly rounded in front and towards the sides. Dorsal surface either entirely unmarked, or with conspicuous subtriangular yellow spot situated just in front of the median ocellus and filling up the deep furrow. Oblong lateral yellow spot on postclypeus in front of the compound eye separated from the main fascia covering the postclypeus. Sides of synthorax in fully adult specimens reddish- to dark russet-brown, with bright metallic green lustre, this reflex deepened along the lateral yellow fascia covering the stigma. Antehumeral band long, almost reaching antealar sinus. Superior anal appendages with extero-lateral tooth at about their middle obsolete, or only poorly developed (figs. 6—8). ..... 6.

—. Frons with bright metallic bluish green lustre, especially above; upper margins of tubercles more markedly pronounced, their dorsal surfaces rather more flattened, slightly framed, each with a large squarish yellow spot in the centre; these spots widely separated from each other. No yellow spot filling up the furrow. Oblong lateral yellow spot on postclypeus in front of the compound eye wider and confluent, or nearly so, with the main fascia to form a very broad arched band almost filling up the whole postclypeus; this band not undulated: basal depressions on either side of the median line not brown. Remaining yellow spots on face much as in *vittata*. Antehumeral band slightly curved, not narrowed in the middle, shorter than in *vittata*, ceasing at about 1.5 mm before antealar ridge. Lateral yellow band covering the stigma broad. Superior anal appendages ferruginous with their upper margins distinctly concave when viewed in profile, slightly turned upwards towards the apex, each with a well-developed extero-lateral tooth at about the middle. ..... 5.

5. Ground-colour of synthorax chestnut-brown with slight metallic reflex on the dorsum and on each side along the lateral yellow fascia only, the intervening spaces thus being without metallic lustre. Wings long, basal portion of the hinder pair from the anal angle to a level of about end of anal loop considerably widened, after this widening both hind wings regaining

their usual width more abruptly than in the other species. Three rows of cells between the lower boundary-nerve of anal loop (A_2) and the posterior border of hind wing. Anal loop containing 9—10 cells with distinct central cell. A minute brown point in *c* at extreme base of hind wings. Nodal index $\frac{6.14}{9.10.}\left|\frac{15.7}{10\,9}\right.(\frac{42}{38})$. Abdomen long, as in *vittata vittata* but up till the end of segm. 7 less cylindrical, more rapidly enlarged, segm. 7 distinctly widened towards its apex and from the base of 8 again much narrowed. Dorso-ventral enlargement of last three abdominal segments more pronounced than in *vittata* and its races. Ground-colour of basal abdominal segments reddish brown, from segm. 3 to 6 gradually changing into almost deep black, 7—10 and anal appendages lighter. Complete broad citron-yellow ring on segm. 2, as in *vittata*, 1—1.5 mm wide on mid-dorsum, more than 2 mm across the auricles. Very broad transverse orange yellow band on segm. 3 sharply defined and occupying $^2/_5$ of the segment at dorsum, very broadly joining a latero-ventral fascia running to the antero-basal margin of the segment where it is broadly connected with the lower posterior border of the preceding segment (these markings thus longer than in *vittata vittata*). Similar rather sharply limited yellow rings on segm. 4—6 occupying the basal half of each segment. 7 brownish on dorsum, its basal half ferruginous, this colour badly defined; remaining segments ferruginous, above unsharply limited yellowish. Appendages likewise, unmarked, slightly darker. Superior ones comparatively thick and robust. Inferior appendage slightly longer than upper pair (fig. 4). Length: abd. + app. 54, hw. 48: 16.5, pt. $\frac{>3}{3}$ mm. — Hab.: "Malaisie ?" (possibly India). **frontalis** SELYS.

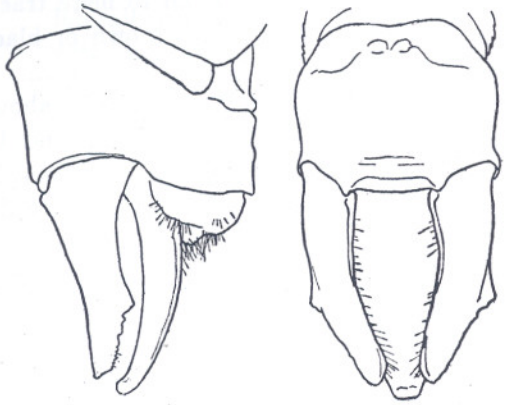


Fig. 4. *E. frontalis* SELYS, ♂ „Malaisie?" (Mus. Brussels), Type. Anal appendages, right side and dorsal view.

—. (Immature male). Ground-colour of synthorax slightly darker with metallic green reflex especially vivid on dorsum and on each side along the lateral yellow fascia, the intervening spaces only having a faint metallic hue. Wings very short, basal portion of hinder pair more evenly widened and no rather abrupt transition between this and the apical part of the wing. Only two rows of cells between A_2 and the posterior border of hind wing. Anal loop narrower, consisting of only very few, 6—7 cells without central cell in left hind wing. A minute brown point in *c* and *sc* at extreme base of hind wings. Nodal index $\frac{6.14.}{8.12.}\left|\frac{14.6}{10\,8}\right.(\frac{40}{38})$. Pterostigma brown. Abdomen deformed by pressure, with its light markings almost similar to the pre-

ceding species. Ground-colour of segm. 1—6 deep black, of 7 brown, spotted and banded as in *frontalis*, of 8—10 cloudy, somewhat patchy ferruginous, and on dorsum of 8 a subtriangular yellowish streak at base. Appendages yellow, the superiors finely tipped with brown, more slenderly built and slightly more bent inwards after their middle. Inferior appendage distinctly longer than upper pair (fig. 5). Length: abd. + app. 53.5, hw. 54:15, pt. $\frac{>3}{3}$ mm. — Hab.: Assam (Khasia Hills). ..... cf. **frontalis** SELYS.

6. Mouth-parts and face reddish- or dark brown with two large basal yellow spots on the labrum; with a rounded spot at base of mandibles; with a sinuous transverse band on postclypeus (sometimes broken into four pieces), and besides, with a lateral oblong yellow spot on postclypeus, close before the eyes. Conspicuous rather rounded clear yellow spots on either side on the vertical portion of frons and a large unpaired median spot of the same colour on the dorsal surface of frons; this mark rounded aside, slightly pointed in front. ..... **7.**

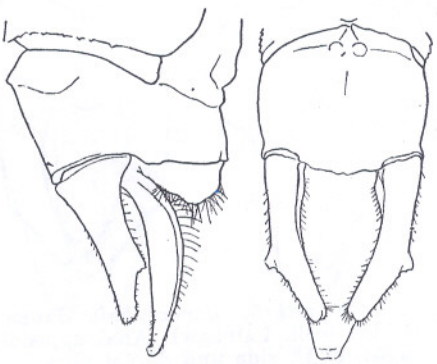


Fig. 5. *E.* cf. *frontalis* SELYS, ♂ Khasia Hills, Assam (Mus. Brussels). Anal appendages, right side and dorsal view.

—. Mouth-parts and face reddish- or dark brown with two small linear basal yellowish spots on the labrum; with a narrow sinuous transverse band on postclypeus, slightly interrupted in the middle line and broadly sinuous on either side of it (caused by two brown basal impressions), and with a lateral oblong spot on postclypeus before the eyes. A almost obsolete yellow point only on each side on the vertical portion of frons. Dorsal surface of same metallic blue without any light markings. Ground-colour of synthorax very dark reddish brown, this colour almost everywhere suffused with brilliant blue metallic lustre. Antehumeral band narrow, almost straight, not interrupted in the middle, gradually tapering to a point above. Lateral yellow band covering the stigma narrow, considerably narrowed below and rather pointed. Abdomen shaped as in the typical race, but decidedly shorter. Ground-colour of abdominal segments black. Complete narrow citron-yellow ring on segm. 2, width of this band at most 1 mm mid-dorsally, at most 2 mm across the auricles. Narrow transverse citron-yellow ring on segm. 3, sharply defined and occupying ¼ of the segment aside, distinctly and triangularly constricted by the dorsal carina; proximal half of latero-ventral margin of same segment narrowly bordered with pale yellow. Yellow rings on segm. 4—5 in front of transverse carina very narrow, not extending to the base of each segment, slightly diffuse in front, occupying about $^1/_6$ on segm. 4, $^1/_4$-$^1/_5$ on segm. 5. These spots

diffusely interrupted in the middle line by the dorsal carina. Segm. 6—7 with complete basal orange yellow rings, occupying about ⅓ or slightly more of these segments respectively.

Segm. 8 with a sharply defined transverse band at base, widest in the middle and not overlapping the sides. Segm. 9 very dark brown, unmarked, passing on the sides into dark ferruginous. Segm. 10 reddish brown on dorsum, on the sides at base partially suffused with yellow and on mid-dorsum again fading to brownish. Anal appendages reddish brown. Inferior appendage rather longer than the superiors (only one specimen examined). Shape of superior appendages almost alike those in the typical race (fig. 6). Insect of large size. Length: abd. + app. 55, hw. 53 : 16, pt. 3.4 mm. — Hab.: Ceylon. .....

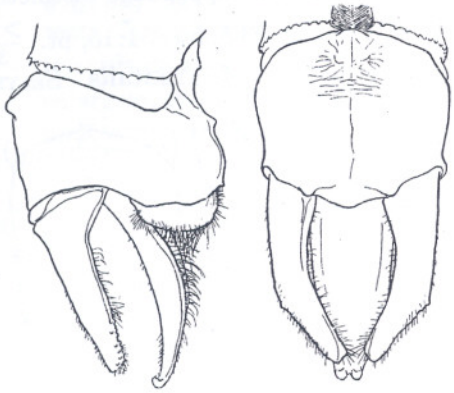


Fig. 6. *E. vittata cyanocephala* HAGEN, ♂ Ceylon (coll. LAIDLAW). Anal appendages, right side and dorsal view.

vittata cyanocephala HAGEN.

7. Postclypeus with a complete straight or sinuous transverse light yellow band: on either side of the median line this band sometimes encloses two brown points filling up the depressions. Light markings on anterior part of head bright citron-yellow. Ground-colour of synthorax reddish- to dark brown with bright bluish green metallic reflex. Antehumeral band straight or slightly curved, not narrowed in the middle, at least 1 mm broad above. Lateral yellow band covering the stigma broad, rather rounded below. Abdomen long (i.e. segm. 7 about two times as long as broad), up till the end of segm. 7 very gradually enlarged, from the base of segm. 8 again very evenly narrowed. Ground-colour of basal abdominal segments dark brown to reddish brown, as far as segm. 6 inclusive gradually passing into bright ferruginous; segm. 7—10 and appendages bright ochreous, without dark markings (sometimes terminal segments slightly darkened aside). Complete broad citron-yellow ring on segm. 2; width of this band on mid-dorsum 1—1.5 mm, more than 2 mm across the auricles. Broad transverse orange yellow ring on segm. 3, rather sharply defined and occupying ⅓ of the segment at dorsum, not interrupted by the median line, joining a longitudinal fascia of the same colour running along latero-ventral margin to the lower antero-basal margin of the preceding segment, where it is narrowest. Similar but much broader yellow rings on segm. 4—6, occupying the basal half of each segment, these bands not sharply pronounced behind, passing into the ferruginous ground-colour (sometimes the extreme base of segm. 4 diffusely brownish black). Superior anal appendages, viewed from side, with their upper margin very slightly convex and bent downwards towards

the apex, distal half of the appendages thus appearing as lengthening of the proximal part, comparatively more robust than in *vittata sundana*. Inferior appendage as long as or slightly longer than upper pair (fig. 7). Insect of large size. Length: abd. + app. 57, hw. 51-52 : 16, pt. 3.6-4 mm. — Hab. Peninsular India (excl. Ceylon), Thibet, Bengal ..... **vittata vittata** BURM.

—. Postclypeus with two oblong pale yellow spots on each side at base; middle piece of same brown with two extremely fine arched lines in front of it, pale yellow in colour. Arrangement and number of light markings on anterior part of head the same as in the typical race, but more reduced, those on the face pale yellow. Ground-colour of synthorax very dark reddish brown with rather dark green metallic reflex. Antehumeral band evenly curved, slightly constricted in the middle, rather rounded and at most 0.6 mm broad above. Lateral yellow band covering the stigma narrow, considerably narrowed below and rather pointed. Ground-colour of abdominal segments velvety black, from segm. 9 gradually fading to dark brown; segm. 10 and appendages very dark reddish brown. Abdomen comparatively shorter (e.g. segm. 7 less than two times longer than broad), shaped as in the typical race. Complete, narrow, citron-yellow ring on segm. 2, width of this band on mid-dorsum at most 1 mm, across the auricles at most 2 mm. Narrow transverse citron-yellow ring on segm. 3 sharply defined and occupying ¼ of the segment aside, distinctly and triangularly constricted by the dorsal carina or narrowly separated into two semicircular spots; proximal half of latero-ventral margin of same segment narrowly bordered with pale yellow. Yellow rings on segm. 4—6 in front of transverse carina very narrow, not extending to the base of each segment, slightly diffuse in front, occupying less than $^1/_5$ of segm. 4, almost $^1/_6$ of segm. 5—6. These spots diffusely interrupted in the median line by the dorsal carina. Segm. 7 with a complete basal orange yellow ring, occupying slightly less than ⅓ of the segment, protruding a little behind; this ring often diffusely darkened towards the extreme base of the segment. Segm. 8 with a sharply defined narrow transverse dorsal line at base not extending onto the sides, and often divided into two pieces by the longitudinal carina forming two somewhat diamond-shaped yellow spots. Segm. 9 very dark brown, unmarked. Segm. 10 and appendages reddish brown, slightly darkened above and at base. Superior anal appendages, viewed from side, with their upper margins slightly but distinctly

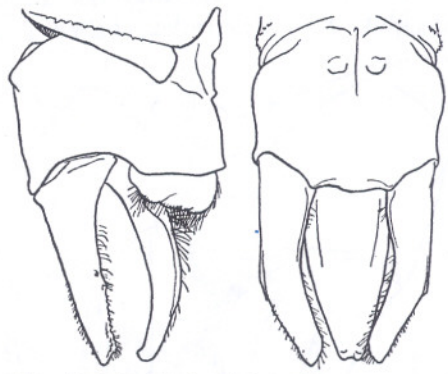


Fig. 7. *E. vittata vittata* BURMEISTER, ♂ Poona, W. India (coll. LAIDLAW). Anal appendages, right side and dorsal view.

concave, this margin very little bent upwards towards the apex, thus distal half of the appendages evenly and slightly curved, rather slender and more pointed than in the typical race. Inferior anal appendage a trace shorter than upper pair (fig. 8). Insect of smaller size. Length: abd. + app. 52-54, hw. 47-49 : 16, pt. 3.4-3.5 mm. — Hab.: Java... **vittata sundana** ssp.n.

8. Mouth-parts and face reddish- to dark brown without any trace of pale yellow lines or spots. Dorsal surface of frons black with brilliant metallic blue or violet reflex, below gradually fading to dark reddish brown. Thorax jet-black with very brilliant metallic green or blue shine, marked with light as follows: — A short *incomplete* straight cuneiform antehumeral band, pale orangish in colour and running obliquely over the mesepisternum extending upwards for half of its height, tapering to a point; below this stripe covers the antero-dorsal half of the mesinfraepisternum, which on its postero-ventral part is reddish brown in colour. Sides with a complete straight, narrow, pale orangish stripe covering the stigma (width at most 1 mm) running along first lateral suture, below almost touching coxae of second pair of legs, above slightly narrowed, not reaching dorsal margin of metepisternum. Dorsal surface of thorax, especially on mesepisternum, covered with long, soft, silvery or golden-yellow hair. Venter reddish brown, rather buff; coxae reddish brown. Legs black, basal ⅔-¾ of exterior sides of fore and middle femora, basal ⅓-½ of hind femora reddish brown. Wings hyaline without brownish spots at extreme base of posterior pair. Pterostigma dark brown, almost black. Nodal index varying between $\frac{47}{41}$ and $\frac{54}{44}$. Abdomen short and of rather compact building, with comparatively short segments, from middle of segm. 3 to the end of 8 gradually enlarged and slightly depressed, then distinctly narrowed towards the end with posterior margin of segm. 10 much narrower than the same margin of segm. 8. Dorso-ventral enlargement of terminal four segments less marked than in *vittigera*. Dorsal surface jet-black, sparsely decorated with dull yellow. Segm. 1 black. Segm. 2 with a very narrow transverse line on dorsum at base, this line slightly widened and rounded behind, not overlapping the sides; these with a thick, comma-shaped dull yellow band running obliquely from the auricles to the base of second sternite, which is reddish brown in colour. Dorsum

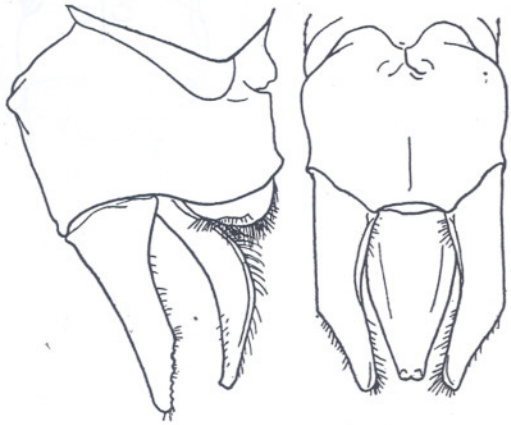


Fig. 8. *E. vittata sundana* LIEFTINCK, ♂ Buitenzorg, Java (Mus. Buitenzorg), Type. Anal appendages, right side and dorsal view.

of segm. 3—4 with small, paired, strongly diamond-shaped orangish spots in front of the transverse carina, occupying about ⅛ of their length. Laterally, after a slight constriction, these spots are confluent with the dull orangish colour on the ventral portion, covering the anterior ⅔ or half of these segments, respectively. Segm. 5—6 with only barely visible orangish lines on dorsum, similarly placed as those on the preceding segments, that on segm. 6 usually absent. Segm. 7 with a very broad dull orangish ring roundabout the segment, occupying its basal third; its posterior margin straight but on mid-dorsum this marking bears a squarish protuberance behind. Dorsum of segm. 8—10 and superior anal appendages unicolorous, velvet-black. There are, besides, extremely narrow yellowish lines behind the articulations of abdominal segments 3—5. Anal appendages, when viewed from above, roughly subtriangular in general outline. Superior ones thick, slightly bent inwards after their middle but apices widely distant, never meeting one another, with a well-developed extero-lateral tubercle slightly behind the middle of each; when seen in profile they appear almost straight, thick at base, gradually narrowed to the end with perfectly rounded apices. Inferior appendage strongly curved, always longer than superior pair, dark reddish brown in colour (fig. 9). Insect of moderate size. Length: abd. + app. 53—55, hw. 49-52 : 14-14.5; pt. $\frac{2.8\text{-}3}{2.6\text{-}2.8}$ mm.

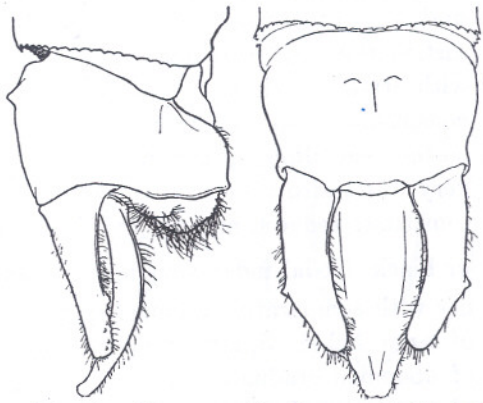


Fig. 9. *E. australis* HAGEN, ♂ Limbotto, Celebes (Mus. Leiden), Type. Anal appendages, right side and dorsal view.

Hab.: Celebes and "Moluques". ..... **australis** HAGEN.

—. Mouth-parts and face reddish- to very dark brown, unmarked excepted postclypeus which is always decorated with pale aquaish-yellow lines as follows:— A mere point on its lateral lobes, at inferior antero-lateral margin, close before margin of the compound eye (present in most of Java and Borneo males but very often absent altogether); a narrow transverse stripe at base, at least interrupted in the middle (Java, Borneo), sometimes broken up into four pieces (Timor, Borneo, Palawan):— the lateral spots largest, slightly oblique, abruptly leaving off before reaching margin of compound eye, the median ones on each side of the middle line arcuate, comma-shaped or linear, edging or filling up the depressions (in the two males from Palawan the four spots much reduced, the median ones vestigial). Dorsal surface of frons black with brilliant green or bluish green reflex, below gradually fading to dark brown. Thorax very dark reddish brown to almost black with brilliant but less intensive metallic shine, marked

with yellow as follows: — A narrow (0.7—0.3 mm), almost complete, slightly curved antehumeral stripe situated as in *australis,* but always extending upwards markedly beyond half the length of mesepisternum, in typical specimens of equal width and ceasing at 1.3 mm before antealar sinus, rounded above — in specimens of eastern habitat reduced and gradually narrowed above, almost linear and ceasing at about 2 mm before antealar sinus. Sides with a complete straight yellow or orangish stripe covering the stigma (1.2—0.6 mm) situated as in *australis,* almost reaching dorsal margin of mesepisternum. Dorsal surface of thorax covered with grayish- or dark brown hair. Metepimerum only moderately metallic, even in very old specimens, the dark brown ground-colour generally visible. Thorax and legs otherwise very similar to *australis;* in specimens of eastern distribution the coxae and legs are almost entirely black. Wings hyaline or with irregular clouds of yellow. Extreme base of posterior pair always conspicuously spotted with dark rusty brown; these spots at least present in costal field filling up the space between base and first antenodal cross-vein, very often also present, though vestigial, in subcostal and median spaces, sometimes reduced and only visible in costal field. Pterostigma dark brown or black. Nodal index varying between $\frac{51}{43}$ and $\frac{56}{48}$ Abdomen lengthy and slender with comparatively longer segments, from middle of segm. 3 to the end of 5 parallel-sided, almost cylindrical, not depressed, from base of 6 to end of abdomen gradually widened with posterior margins of segm. 8 and 10 of almost equal width. Last four abdominal segments more markedly and more abruptly enlarged in dorso-ventral dimension. Dorsal surface either dark brown with a reddish shade (Malacca, Sumatra, Java), or jet-black (Borneo, Palawan, Timor), segm. 2—7 or 2—5 narrowly decorated with more or less sharply defined spots of a dull yellow or orange colour. Segm. 1 blackish, 2 with a rather broad transverse subbasal ring in front of the transverse carina; this band straight on dorsum, largely extending onto the sides, just touching the auricles, then running obliquely downwards to meet base of second sternite, which is brown. On dorsum this band does not reach the base of its segment, being 1—1.5 mm distant from it and about 1 mm wide. Dorsum of 3—5 or 3—4 (Palawan) with small paired diamond-shaped orangish spots in front of the transverse carina, these progressively smaller from before backwards, their respective

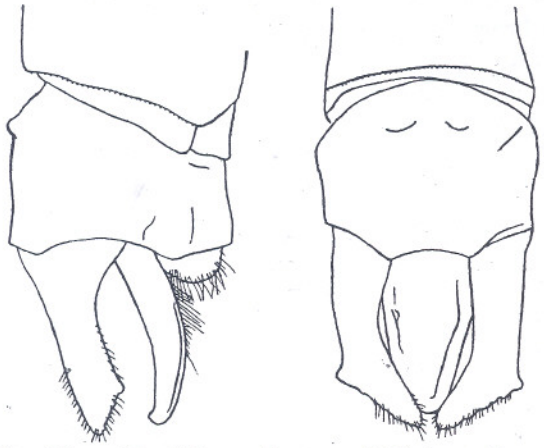


Fig. 10. — *E. vittigera* RAMBUR, ♂ Sintang, Borneo (coll. RIS). Anal appendages, right side and dorsal view (After RIS).

width being about 1—1.2, 0.8, 0.3—0.5 mm (Malacca to Timor), 0.8, 0.4, 0.2 (Borneo), 0.5, 0.3, absent (Palawan). In specimens from Sumatra and Java the spots are confluent with the very dark orange brown colour underneath, as in *australis*, in the other males these segments remain black. Segm. 6 with traces of orangish lines usually absent though still visible in males from Malacca, Sumatra and Java. Segm. 7 in front of the transverse carina either marked with a narrow ring, whether or not interrupted in the middle line (Malacca, Sumatra, Java), or entirely black (Timor, Borneo, Palawan). Dorsum of 8—10 and anal appendages unicolorous, dark reddish brown to velvet-black. Extremely narrow yellowish lines at articulations of basal segments usually absent. Anal appendages, viewed from above, roughly squarish in general outline. Superior ones very thick and robust, at first parallel-sided, their distal one-third very abruptly and strongly bent inwards with a well-developed exterolateral tubercle; apices strongly inclined to one another and nearly meeting. When seen in profile they appear almost straight, very thick at base, then parallel-sided and lastly, after having given off their tooth, rapidly tapering with apices nearly pointed. Inferior appendage slightly curved, of equal length, dark reddish brown or black (figs. 10—11). Insect of large size. Length: abd. + app. 56—59½, hw. 50-53 : 15-16, pt. $\frac{3\text{-}3.2}{2.7\text{-}3}$ mm. — Hab.: ? Burma, ? Assam, ? Tonkin, Malacca, Sumatra, Java, Borneo, Palawan, Timor. ..... **vittigera** (RAMB).

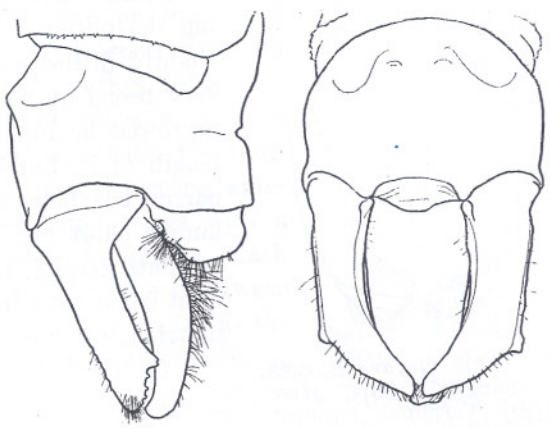


Fig. 11. *E. vittigera* RAMBUR, ♂ Tay Tay, Palawan (coll. MORTON). Anal appendages, right side and dorsal view.

Females [1]).

1. Metepimerum with a sharply defined clear yellow band running parallel to the second lateral suture and occupying its posterior third to fourth. Labium black with its median lobe and a large rounded or subtriangular spot on each side on the lateral lobes bright yellow. Labrum with complete broad yellow band at base. Dorsal surface of frons without yellow spots. Clypeus with a ⌐¬-shaped basal yellow fascia. Synthorax with very broad

[1]) The females are very insufficiently known. Only four species (including one subspecies) could be arranged in a key. Apart from this, the female of *E. vittata cyanocephala* has been very briefly characterized by LAIDLAW (1924), but I am unable to separate it from typical *vittata* from the description only.

yellow bands. Wings hyaline with pale basal yellow spot in costal and subcostal spaces extending to about first antenodal cross-vein and with their apical ⅓-¼ portion also of a pale yellow colour. Nodal index low, varying between $\frac{43}{39}-\frac{49}{44}$. Basal portion of hind wing comparatively narrow. Abdomen stout, subcylindrical, terminal segments much flattened in dorso-ventral dimension. Black, segm. 2—3 with broad orange rings similar to those in the male, 4—7 with very large squarish dorsal marks in front of the transverse carina, partly occupying the sides, touching the posterior margin of preceding segment or slightly diffuse in front, the marking on segm. 7 very broad at base, encircling the whole segment, narrowed behind and occupying almost ¾ of the length of it. Latero-ventral margin of 8—9 and a narrow basal stripe on dorsum of 8 orangish. Vulvar lamina short and small, about one fourth as long as ninth tergite, not projecting downwards, somewhat trapezoidal in general outline, divided into two subtriangular portions by a shallow incision (fig. 12).

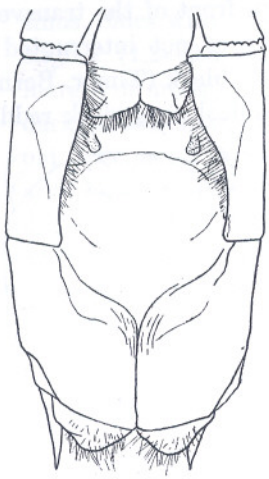


Fig. 12. *E. elegans* BRAUER, ♀ Shanghai (Mus. Hamburg). Terminal segments of abdomen, ventral view.

Length: abd. 57-62, hw. 52½-54 : 14-14½, pt. $\frac{3.2-<4}{3.0-3.8}$ mm. Insect of very large size. ..... **elegans** (BRAUER).

—. Metepimerum without yellow markings. Labium reddish- to dark brown without yellow spots. Labrum light or dark brown without complete yellow fascia at base, sometimes spotted with pale yellow. Clypeus with incomplete narrow yellow lines at base or unmarked. Dorsal surface of frons whether or not spotted with yellow. Yellow bands on synthorax narrower, sometimes almost linear. Vulvar lamina conspicuous, slightly or not projecting, always divided into two leaf-like lobes. Insects of large or moderate size. ..... **2.**

2. Mouth-parts and face reddish to dark brown with at least traces of two subtriangular basal yellowish spots on the labrum; with a narrow sinuous transverse band on postclypeus sometimes reduced and broken into four pieces, or almost entirely absent; lastly, with an oblong bright spot at margin of lateral lobes, before the eyes. Conspicuous rather rounded clear yellow spots on each side on the vertical portion of frons and an unpaired median spot of the same colour, filling up the furrow, on dorsal surface of same. This spot usually rounded aside and slightly pointed in front (*vittata vittata*), though sometimes vestigial or even absent altogether (*vittata sundana*). Wings hyaline with small yellow or brown spots at extreme base and with apices sometimes yellowish enfumed. Yellow markings on abdomen similar to the male but less sharply defined, ... **3.**

—. Mouth-parts and face reddish- to dark brown, unmarked excepted post-clypeus which is always decorated with pale aquaish-yellow lines as in male. Frons unmarked, its dorsal surface with green or bluish green metallic reflex less intensive than in the male, below fading to reddish- or dark brown. Light markings on thorax and abdomen very similar to the male but in most cases rather broader and less sharply defined. Metallic shine on thorax less brilliant, the dark ground-colour generally being predominant. Wings either hyaline or the whole surface with a dirty ochreous tint (In specimens with hyaline wings the tips of the front wings are always clouded with pale yellow). Front wings whether or not spotted with brown at extreme base, the spots extending outwards as far as first or second antenodal nervure, rather diffuse. Hind wings with a very conspicuous dark ochreous to almost black marking at base filling up the entire space between costa and $R + M$, extending outwards as far as the *third cross vein,* this colour being less intensive in median and cubital spaces. Nodal index varying between $\frac{50}{41} - \frac{58}{49}$. Abdominal segments 3—6 with narrow, paired, transverse yellow spots in front of the transverse carina, these spots progressively smaller from before backwards, those on segm. 6 very small. Segm. 7 with similarly placed triangular yellow mark on dorsum which is pointed in front and connected with the posterior margin of preceding segment, its lateral transverse offshoot being also pointed. Remaining segments unmarked excepted sternites, which are brown. In specimens with heavily tinted wings (probably all very adult females) the light markings on thorax and abdomen are much darkened and badly defined. Vulvar lamina not or only slightly projecting, each of the lobes circular or ovate with completely rounded tips (figs. 13—14). Length: abd. 57-60, hw. 53-55 : 14½, pt. $\frac{>3}{3} - \frac{3.2}{3.1}$ mm. Insect of large size

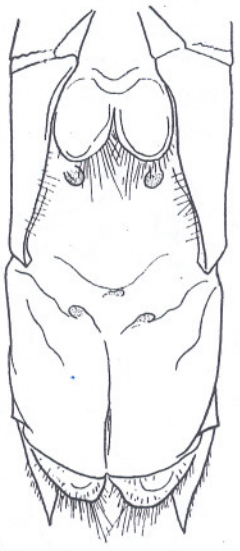


Fig. 13. *E. vittigera* RAMBUR, ♀ Java or. (Mus. Leiden). Terminal segments of abdomen, ventral view.

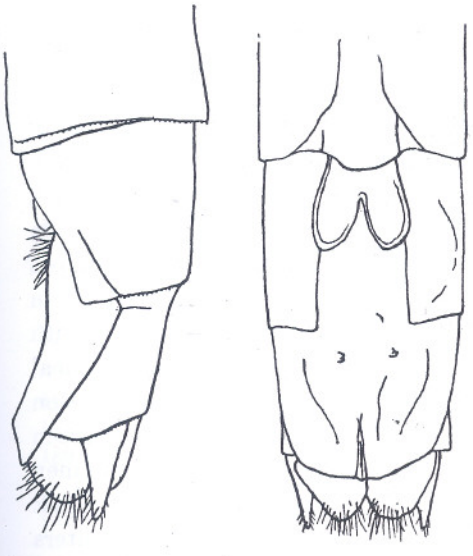


Fig. 14. *E. vittigera* RAMBUR, ♀ Sintang, Borneo (coll. RIS). Terminal segments of abdomen, left side and ventral view (After RIS).

vittigera (RAMB).

3. Head as in the male, dark colours much paler. Yellow ring in front of transverse carina on third abdominal segment continuous along latero-ventral margin of the tergite, meeting posterior border of preceding segment where it is narrowed to almost pointed, occupying ¼-⅓ of the segment, not indented in front by the median line. Light rings on segm. 4—6 in front of transverse carina fairly large, sharply defined posteriorly, their anterior portions indistinct, largely replaced by the brown ground-colour and occupying ⅓-$^1/_4$ of the segments. Basal $^1/_3$-$^2/_5$ of segm. 7 in front of transverse carina with a dull ochreous ring, pointed and extending slightly beyond carina behind. Segm. 8 with two small dorsal spots of the same colour on each side at base. Remaining segments dark russet, unmarked. Vulvar lamina slightly projecting downwards, divided into two oblong somewhat obliquely placed leaf-like lobes, each about half as long as ninth tergite, obtusely pointed (fig. 15).

Fig. 15. *E. vittata vittata* BURMEISTER, ♀ Bengal (Mus. Brussels). Allotype. Terminal segments of abdomen, ventral view. Segm. 9-10 strongly bent downwards; appendages broken.

Wings hyaline, apices of front pair sometimes evenly clouded with pale yellow. Extreme base of hind wings with a small orangish or brown spot between costa and $R + M$ only, extending outwards as far as *first antenodal cross vein*, sometimes median and cubital spaces also yellowish, in one adult specimen (Bengal) the extreme bases of all four wings being diffusely ochreous brown. Nodal index varying between $\frac{43}{38} - \frac{43}{40}$ (only three examples examined). Length: abd. 57-58, hw. 50-51 : 14-14.5, pt. $\frac{3.5}{3.4}$ mm. ..... **vittata vittata** BURM.

—. Head much as in the male but yellow spots more reduced: ground-colour almost uniform dark reddish brown. Light spots at base of labrum vestigial, pale yellowish. Postclypeus with four oblong yellow spots, two on each side, the upper pair situated on either side between the basal impression and the eye-margin, the lower pair at postero-lateral margin, almost touching margin of eye; hence no spur of yellow spots on middle portion of clypeus. Vertex and frons bright metallic green above, the latter with a well-defined subtriangular spot of yellow on each side on its vertical surface, before eye-margin, but, dorsally, there is only a faint indication of a light median spot filling up the furrow. Eyes brilliant emerald-green during life, golden-brown after death. Coloration of thorax and abdomen strikingly similar to that of the male: dark velvet-brown to almost black with metallic green shine on thorax. Legs entirely black, except trochanters which are brown. Abdomen slender, again very similar in shape and size to the male, with its basal segments slightly more swollen, thus giving it a more distinct spindle-shaped appearance. Light markings all narrower

than in the typical race though a trace enlarged when compared with the male, clear citron-yellow on segm. 2—4, thence gradually a little darker, bright ferruginous. Yellow ring around third abdominal segment in front of transverse carina much as in *vittata vittata*, though narrower and distinctly indented to almost separated in front by the longitudinal carina. Well defined rings roundabout segm. 4—6 rather narrow, exactly similar to those in the male, sharply limited posteriorly and below just touching hind margin of preceding segment. Remaining segments as in the typical race. Vulvar lamina slightly projecting, divided into two oblong obliquely placed leaf-like lobes, their distal portion being narrower than in *vittata vittata* and decidedly pointed (fig. 16). Wings entirely hyaline except extreme base of posterior pair which are pale yellowish. A sharply pronounced reddish brown to black spot between costa and $R + M$, in *c* extending outwards as far as *first antenodal cross vein* or a spur beyond, in *sc* to nearly half-way first and second cross-vein. Nodal index varying between $\frac{47}{41} - \frac{49}{42}$ (only two specimens examined). Pterostigma jet-black. Membranula pure white, with its distal portion fading to dark gray along outer margin. Length: abd. 50-56, hw, 49-50 : 13.5-14, pt. $\frac{>3}{3}$ mm.....

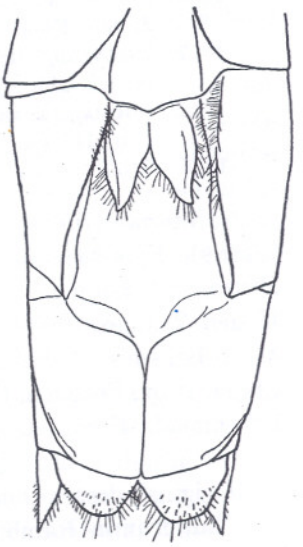


Fig. 16. *E. vittata sundana* LIEFTINCK, ♀ Java (Mus. Leiden). Terminal segments of abdomen, ventral view.

vittata sundana ssp.n.

Epophthalmia elegans BRAUER 1865 (textfigs. 2,12).

1865 ♂♀ **Brauer,** Vierter Ber.Novara Neur., Abh.zool.bot.Ges.Wien, 14, p. 905 (*Macromia*), — Hab.: China, Shanghai.

1866 ♂♀ **Brauer,** Novara-Exp. Zool. I Neuropt., pp. 76-78, Tab. II fig. 4, 4a-c (*Macromia*). — Hab.: idem (same specimens).

1867 HAGEN, Not.b.Stud.BRAUER's Novara-Neur., Verh.zool.bot.Ges.Wien, 17, p. 60. — Hab.: China (remarks).

1868 BRAUER, Verzeichniss Neuropt., II, Idem, 18, p. 742 (*Macromia*). — Same specimen.

1871 ♂♀ **Selys,** Synopsis Cordulines, pp. 91-93 sep. — Hab.: Japan and China.

1883 SELYS, Odon. Japon, Ann.Soc.ent.Belg., 27, p. 110. — Hab.: Japan; Shanghai.

1890 CABOT, Immature State Odon., Mem.Mus.Comp.Zool., 17, 1, pp. 9-11, Pl. 1, fig. 1, 1a-d (*Epophthalmia sp.*?). — Hab.: China, Canton (larva).

1904 NEEDHAM, New Dragon-fly Nymphs U.S.Nat.Mus., Proc.U.S.Nat.Mus., 27, p. 698 (*Azuma* gen.nov.). — Hab.: Japan (larva).

1904 BUTLER, The Labium of the Odonata, Trans.Amer.Ent.Soc., 30, p. 125, Pl. VI fig. 5b-c (*Azuma*). — Hab. ign. (larval labium).

1906 ♂♀ MARTIN, Cat.Coll.SELYS, Cordulines, pp. 63-64. — Hab.: Tonkin, China. Japan (Tonkinese record not mentioned in Mission Pavie 1904!).

1909 WILLIAMSON, North Amer. Drag. Macromia, Proc.U.S.Nat.Mus., 37, p. 370, fig. 1 (*Azuma*; wing-photograph). — Hab.: Japan, Myiazaki.

1914 MARTIN, Gen.Ins., 155, Odon.Lib.Cordulinae, p. 25, pl. I fig. 9 (wings), pl. 2 fig. 16 (insect) (*Azuma*). — Hab.: Australie (errore!), Japan, China, Tonkin.

1916 ♂ RIS, SAUTER's Formosa Ausb., Suppl. Entom., 5, p. 71 (*Azuma*). — Hab.: Japan, Kobe, Harima.

1917 TILLYARD, Biology of Dragonflies, Cambr., pp. 83-85, fig. 32 M (*Azuma*; larval labium).

1922 OGUMA, Japanese Dragonfly-fauna Libellulidae, Deutsch.ent.Zeitschr., Heft I, p. 112 (*Azuma*). — Hab.: Japan, Honshiu, Kiushiu.

1925 SJÖSTEDT, Odon. China, Arkiv f. Zool., 17, p. 2 sep. — Hab.: China, Kiangsu.

Material studied: — 1 ♂ ad., labeled: Japon (SELYS), M. elegans Br. (SELYS), Epophthalmia elegans Br., Rév. R. Martin 1906 (MARTIN) in Mus. Brussels; 1 ♀ juv., labeled: par Mus. Civ. 1891 (SELYS), Epophthalmia elegans Hagen ♀ Japon (SELYS), E. elegans Br., Rév. R. Martin 1906 (MARTIN) in Mus. Brussels; 1 ♀ juv., Shanghai 1907, leg. W. SCHWINGHAMMER; 1 ♀ ad., China, Prov. Fo-Kien, G. SIEMSSEN leg., vend. 1.X.1912; both in Mus. Hamburg; 1 ♀ semiad., Formosa, Polisha, VII. 1908, leg. H. SAUTER, in Mus. Leiden.

Original description (1865):—

"**Macromia** Ramb. **elegans:** nigra, flavo-maculata; fronte aenea, bituberculata, lateribus flavis, clypeo flavo, infra fascia transversa nigra; labro palpisque flavis, late nigro marginatis; occipite nigro, vertice viridi-aeneo; bifido. Thorace viridi-aeneo, striis duabus humeralibus fasciisque lateralibus obliquis flavis; abdomine nigro, flavo fasciato et maculato; alis fusco-hyalinis, apice obscurioribus, pterostigmate parvo, nigro; venis nigris, costa flavo-lineata; area discoidali biseriatim reticulata. Appendicibus analibus superioribus maris nigris, parum curvatis, basi latis, apice subito angustatis, margine externo angulato, interno integro, vix tuberculato, concavo. Appendice inferiori superioribus aequali, triangulari, apice bifida. Appendicibus analibus feminae rectis, brevissimis, segmento ultimo maris supra tuberculato. Nervis antecubitalibus 15—16, postcubital. 8—9.

Long.corp.	♂ 75,	♀ 81 mm.
„ alae sup.	51,	54 „
„ abdom.	52,	58 „
„ pterostigm.	3½,	3⅔ „

Patria: China, Shanghai. Von HAGEN als *Epophthalmia elegans* früher versendet, doch meines Wissens nicht beschrieben".

In the Novara-Expedition the latin diagnosis practically remains unaltered and at the same time a very full description of the Shanghai specimens is added in german. For the sake of completeness, and to facilitate a comparison with the closely allied Formosan insect, the above mentioned description may entirely be reproduced:—

"Schwarz, gelb gefleckt, Thorax und Kopf an den dunklen Stellen metallisch grünglänzend; Scheitel grünglänzend, zweispitzig, Stirne oben längs der Mitte gefurcht, zweihöckerig, metallisch grün, an der Seite gelb; Clypeus [postclypeus!] gelb, längs des Ansatzes der Oberlippe eine breite, schwarze Querbinde [anteclypeus!]; Oberlippe am Grunde gelb, am freien Rande breit schwarz eingefasst, Unterlippe gelb, die Seitenlappen schwarz gesäumt, besonders breit an ihrer Berührungslinie längs der Mitte, daher der Kopf von unten gesehen schwarz, mit drei gelben Flecken erscheint. Fühler, Hinterhauptsdreieck und der ganze Hinterkopf glänzend schwarz. Vorderseite des Kopfes schwarz-, Hinterseite fein weiss behaart. Thorax metallisch-grün glänzend, Zwischenflügelraum, zwei breite Schulterlinien, welche den oberen Rand nicht erreichen, dann eine breite, schiefe Seitenstrieme am Hinterrande des Meso- und Metathorax und die Unterseite dieser blassgelb. Beine sehr lang, schwarz, nur die Trochanteren des vorderen Paares unten gelb. Flügelwurzel schwarz, am Grunde der Costa ein gelber Fleck. Flügel bräunlich hyalin, besonders gegen die Spitze gebräunt und beim Manne auch am stark winkelig nach innen vorspringenden Basalende des Hinterrandes. Nodulus im Vorderflügel doppelt so weit vom Grunde als vom Pterostigma entfernt, im Hinterflügel jedoch beiläufig in der halben Flügellänge gelegen. — Flügeladern schwarz, die ersten Antecubitalqueradern am Grunde gelb gestreift, Costa am Vorderrand schwarz, hinten mit gelber Linie. Im Discoidalfelde im Vorderflügel zwei Zellreihen vom Dreieck fast bis zum Ende des *Sector trianguli sup.* Dreieck derselben fast rechtwinkelig, schmal, mit einer Querader. 15—16 Antecubital-, 8—9 Postcubitalqueradern. Pterostigma klein, kurz, schwarz. *Membranula accessoria* grauweiss, nach hinten zu dunkler. Hinterleib beim Männchen am Grunde nach unten verdickt, compress, dann fast cylindrisch bis zum sechsten Ring, vom Hinterrand dieses bis zum Ende depress, spindelförmig erweitert, beim Weibe mehr compress, die hinteren Ringe nicht so stark verbreitert, schwarz, oben der zweite Ring mit gelber Querbinde zwischen den gleichgefärbten Öhrchen des Männchen, beim Weibchen an derselben Stelle die Binde breiter. Dritter bis sechster Ring am Vorderrand mit sehr feiner gelber Querlinie und dahinter mit zwei grossen (jederseits einen) viereckigen gelben Flecken, die nach rückwärts zu kleiner werden; siebenter Ring mit einem die ganze vorderen Hälfte einnehmenden gelben Fleck, der am Hinterrande jederseits dreilappig und in der Mitte am längsten ist, bis über diese hinausreichend; achter Ring am Grunde mit schmalem gelben Querfleck; neunter Ring ganz schwarz; zehnter beim Männchen am Grunde schwarzbraun, in der hinteren Hälfte in der Mitte gelb, von seinem Grunde erhebt sich ein kegelförmiger Höcker, dessen Spitze in zwei stumpfe Körnchen gespalten ist; — beim Weibe ist der zehnte Ring ohne Höcker und ganz schwarz. Anhänge des Männchens schwarz, die oberen so lang wie der untere, leicht einwärts gekrümmt, bis zum äusseren Drittel sehr breit, dann am Aussenrande daselbst, nach einer stumpfen vorspringenden Ecke, plötzlich nur halb so breit, das schmale Endstück am Ende stumpf und etwas verdickt, glatt und durch eine Furche in zwei Felder getheilt. Die übrige Fläche

ist in der äusseren Hälfte körnig rauh und am zweiten Abschnitt des Aussenrandes, d.i. vom zahnartigen Höcker bis zum Ende körnig gezähnt. Der Innenrand ist glatt und concav, gegenüber dem äusseren Höcker fast unmerklich verdickt und borstig schwarz behaart, am Grunde erweitert er sich zu einem winkligen Höcker, der leicht entgeht, weil er sich dem Rande des letzten Ringes anschliesst. Der untere Anhang ist dreieckig, am Seitenrande etwas bauchig, an der Spitze seicht gespalten, stumpf, zweihöckerig, längs der Mitte oben vertieft und braun. Die Anhänge des Weibchens sind sehr kurz und fein, gerade, am Ende feinspitzig, sie überragen kaum das Ende des Leibes und die untere Blase und sind kürzer als der letzte Ring. Die Scheidenklappe ist kurz, breit, am Hinterrand gerade und in der Mitte tief spitzwinklig eingeschnitten; braungelb, am Rande schwarz. Die Unterseite des Hinterleibes ist schwarz, an den letzten Ringen besonders beim Weibchen braun, sonst zeigen der 2., 3. und 6.—10. Ring am Grunde zwei gelbe Flecken; beim Weibchen ist auch der sechste Ring unten noch einfärbig. Ausser den schon erwähnten Punkten zeigt das Weibchen breitere, gelbe Flecke am Hinterleib und die Trochanteren der Vorderbeine sind oben sehr schmal geschwärzt. Der Mesothorax ist bei beiden Geschlechtern vorne dicht und fein weiss behaart, eben so die Basis des Hinterleibes.— Körperlänge ♂ 75, ♀ 81 Millim.; Länge des Hinterleibes ♂ 52, ♀ 58, der Anhänge ♂ 3, ♀ 1⅓, des Vorderflügels ♂ 51, ♀ 54, des Pterostigma ♂ 3½, ♀ 3⅔ und Länge des Hinterschenkels ♂ 13, ♀ 14 Millim. Vaterland: China (Shanghai)."

To this excellent description no additions are required. A drawing (not coloured) of the entire male insect and two outline-figures of its anal appendages on Tab. II are pretty well succeeded, though obviously some slight inaccuracies have crept in when looking on some of the wing-veins. These figures were drawn by H. SOMMER.

According to HAGEN (loc. cit., p. 60) the appendix inferior of the male may be as long as the superiors or even slightly shorter. In the specimen from Japan it overlaps the tips of the superior ones for a trifle, as already observed by DE SELYS who described this male in the Synopsis.

To Mr. MORTON I owe a drawing of the anal appendages of a male from China not differing from that of a second one reproduced in the present paper. The same author has kindly pointed out his views with respect to the variability of this species which, so far as colours are concerned, cannot easily be separated from its nearest ally described hereafter. In order not needlessly to repeat myself I have discussed MORTON's correspondence on the subject under the next species, since most of his remarks refer to that insect.

When comparing other species of the genus, the number of nodal crossveins in *elegans* is comparatively low: —♂ antenod. $\frac{14\text{-}16}{11}$, postnod. $\frac{8\text{-}9}{9\text{-}11}$; ♀ $\frac{13\text{-}14}{10\text{-}10}$, $\frac{8}{9\text{-}10}$ (Shanghai), $\frac{16}{11}$, $\frac{8\text{-}9}{11}$ (Japan), $\frac{14}{10}$, $\frac{9}{10}$ (Formosa), the total

number of cross-veins added up in both front and hind wings being variable between $\frac{43}{39} - \frac{49}{44}$.

It varies greatly in size: BRAUER gives ♂ abd. + app. 55, fw. 51; ♀ 58 + 1⅓, 54 (China), and SELYS ♂ abd. (excl. apps.) 52 - 58, hw. 54; ♀ 56 - 58, 58 mm. — The measurements of all specimens under examination are: ♂ abd. + app. 55-61, hw. 54-55 : 16, pt. $\frac{3.5\text{-}3\,8}{3.5\text{-}3.6}$; ♀ 56 - 62, 52½ - 58, $\frac{3.5\text{-}<4}{3.5\text{-}\,3.8}$ mm. The male in the Brussels Museum is apparently the largest specimen recorded; its measurements are: 61, 55: 16, $\frac{3\,8}{3.6}$ mm.

The females do not markedly differ from each other; all examples agree in having the tips of all wings yellowish enfumed and their wing-bases, especially the basal portion of the hinder pair, comparatively narrow.

It is impossible to confuse this splendid species with any of its allies, except perhaps with the doubtful specimen described below, the male of which may be distinguished by characters given in the tabular description. The coloured picture of the male in WYTSMAN's Genera Insectorum is perfectly characteristic, as most of the drawings in that work.

Distribution. — A species inhabiting eastern continental Asia including Japan and reaching at least as far southwards as Formosa. Perhaps Tonkin should also be added as a habitat, although this country was only once given by MARTIN who omitted the record some years afterwards. The few exact localities available to me in literature are Shanghai and Canton, and the provinces Fo Kien and Kiangsu in China; Kobe, Harima, Honshiu and Kiushiu in Japan. The Formosan female in the Leiden Museum is the only doubtless specimen known from that country.

Concerning habits and flight no data are available in literature.

The larva has been described and figured *postea.*

Epophthalmia elegans, subsp.? (textfig. 3 and pl. 1 fig. 1).

Material studied: — 1 ♂ ad., Formosa, without date, in coll. K. J. MORTON.

The description of the unique specimen (partly assimilated into the tabular key on page 32 of this paper) may be amplified as follows:—

Insect of huge size with bright metallic green and black coloration, brightest yellow markings on thorax and very sharply limited, rather peculiarly restricted spots on abdomen.

Dorsal surface of frons and vertex brilliant metallic green, slightly intermingled with blue. Eyes chestnut-brown. Ground-colour of synthorax uniform metallic green, very shining; spaces between the wings black, spotted with yellow. All light markings sharply limited, clear yellow. Legs jet-black excepted coxae and trochanters which are spotted with yellow.

Wings hyaline; a faint yellowish shade in the postero-basal corner of hinder pair. Neuration black except interior side of costa which is narrowly lined with yellow from base up to the nodus. Pterostigma black, covering about two underlying cells. All triangles crossed. Supratriangles with two or three cross-veins in front wing, one in hind wing. Subtriangles in front wing with their proximal (interior) side irregularly broken. Anal loop shaped as in typical *elegans* but only containing seven cells, the central one wanting. Nodal index: $\frac{9.14.}{10.12.}\left|\frac{14.10.}{11.10.}\right.$ $(\frac{47}{43})$.

Abdomen comparatively slender, wholly deep black with bright conspicuous, very sharply cut yellow markings as described *antea*. Venter black. Anal appendages see fig. 3.

Length: abd. + app. 59, hw. 52: 15, pt. $\frac{4}{4}$ mm.

Mr. MORTON kindly gave me his opinion on this example, at the same time adding some of his observations on the variability of true *elegans*; he remarks:— "The fine example from Formosa is perhaps very near the big Japanese species, yet is seems a less heavy insect and also I think there is a slight but distinct difference in the shape of the superior appendages" (in litt., 18th Jan. 1928) and: — "With regard to the *Azuma* from Formosa, I confess that apart from the slightly less bulky appearance and the noticeable, although not great, difference in the shape of the sup. apps., I could see little else to distinguish it from *elegans* ..... The yellow abdominal markings in the ♀ of *elegans* are much larger than in the ♂ and the markings are present even on the 6th segment, and they are hardly interrupted on the dorsal carina except perhaps on the 3rd, although on some of the other segments the carina is a little darker, giving just a hint of being interrupted. In the ♂, the markings excepting the large one on 7th, are less extensive and the interruption at the dorsal carina on the anterior segments more decided; as SELYS says in the Synopsis, those on 6th are smaller, in fact I was not perfectly sure of their presense until I had washed the segment with toluol which revived the spots in one ♂ but in the other one which I have, the spots on this segment have either disappeared beyond recovery or have never been present. On the posterior part of segment 10 of the ♂, there is a very large pale dorsal spot which SELYS does not appear to mention ..... but I have made the enclosed rough camera-lucida drawing of the apps. of *elegans* which I think gives a fair idea of their appearance." (in litt., 28th Jan. 1928).

The identification of this much discussed insect has given me a lot of trouble. As already hinted at on several occasions it is most closely allied to the former species with which it agrees in almost every respect. Added to this, the country whence the example came is also occupied by *elegans* but no males of this latter species have hitherto been recorded from Formosa so that it remains an open question whether the Formosan representative is

a very similar, though perhaps distinct, species or only a geographical race of the true *elegans* from Japan and China. The occurrence of two related species in the same country is not astonishing; on the other hand the modern conception of zoogeographical problems does not exclude the possibility of racial intermingling demonstrated by a single species in the same region. However it may be, it seems wise for the present not to give it specific or subspecific rank but to await further material from Formosa before connecting the two forms in whatever way. It may be recognized in future with the aid of the coloured picture appended to this paper and drawn by one of our native artists as carefully as possible.

Epophthalmia frontalis SELYS 1871 (textfig. 4 and pl. 1 fig. 2).

1871 ♂ Selys, Synopsis Cordulines, pp. 93-94, 95 sep. — Hab.: „Malaisie?"
1906 ♂ MARTIN, Cat.Coll. SELYS, Cordulines, p. 62, *nec* fig. 79 (apps.); Pl. II fig. 12 (insect). — Short description of type specimen.
1914 MARTIN, Gen.Ins., 155, Odon.Lib. Cordulinae, p. 26. — Hab.: Malaisie, teste SELYSI.
1921 FRASER, Indian Drag., X, J. Bombay N. H. Soc., 27, p. 681. — Description, teste SELYSI.

Material studied: — 1 ♂ ad., labeled: Deyrolle, Malaisie? (SELYS, white label), Epophthalmia frontalis Selys ♂ (SELYS, white label), 59 (in lead-pencil, indicating it having been drawn for the monograph), Epophthalmia frontalis Sel., Rév. Martin 1906 (MARTIN), Epophthalmia frontalis Selys (MARTIN, Type, in red print).

Original description:—

"59. **Epophthalmia frontalis,** DE SELYS.

♂ Abdomen 53. Aile inférieure 48.

♂ Ailes hyalines, un peu salies au bout; un léger vestige brun à l'extrême base des inférieures et un nuage brun clair enfumé à l'angle anal; membranule gris clair; ptérostigma brun foncé couvrant 1½ cellule (long de 3½ mm); 14 antécubitales, 6—7 postcubitales, 3 hypertrigonales, 5—6 médianes; 2—3 cellules puis 2 rangs postrigonaux aux supérieures. Réticulation noirâtre, costale finement jaune en dehors.

D'un brun noirâtre varié de jaune. Lèvres et face roussâtre avec deux petites taches basales transverses à la lèvre supérieure, une raie basale complète au nasus et quatres taches basales ovales formant une série transverse au front, savoir: une à chaque côté de l'échancrure et une latérale entre celle-ci et les yeux se dessinant sur le front, qui est noirâtre acier. Thorax brun noirâtre un peu châtoyant, ayant en avant les sinus antéalaires, une raie antéhumérale un peu courbée ne les touchant pas, et sur les côtés une raie oblique jaune faisant le tour du thorax entre les ailes. Abdomen cylindrique, renflé à la base, et un peu épaissi aux 6—10e segments, noirâtre annelé de

jaune foncé savoir: un anneau submédian complet aux 2 et 3e, occupant presque la moitié basale aux 4—7e; plus étroit et basal aux 8 et 9e; et le dessus du 10e jaunâtre pâle. Les côtés et le dessous des trois derniers segments brun clair. Pieds brun noirâtre.

10e segment un peu bossu à sa base en dessus. Appendices anals brun foncé, les supérieurs un peu plus longs que le 10e segment, épais, un peu courbés en crochets. Leur première moitié se termine en dehors par un coude anguleux; leur bout est mousse. Appendice inférieur un peu plus long, triangulaire à peine recourbé en haut, l'extrémité un peu tronquée.

♀ Inconnue.

Patrie: Malaisie? (Coll. Selys).

N.B. Voir la comparaison avec les espèces voisines à l'article de la *vittata.*"

After giving the following diagnosis of *E. australis*: — "L'*australis* se sépare par la costale noire, la membranule noirâtre, la tête sans marques jaunes, le devant du thorax avec une raie jaune, très-courte inférieure, les anneaux jaunes de l'abdomen très-étroits", the above cited 'comparaison avec les espèces voisines' runs as follows:—

"La *frontalis* en est l'opposé: les quatre taches assez grandes du front et les deux de la base de la lèvre supérieure, puis la bande du nasus, enfin les anneaux jaunes de l'abdomen très-larges." (l.c. p. 95 sep.).

One of the most carefully described and yet the most mysterious species of the genus.

The type-specimen was intentionally redescribed and arranged in the key because it is certainly *bona species.* In the Brussels Museum I was able to convince myself at once of the inaccurately drawn figure of the anal appendages reproduced in MARTIN's monograph. When comparing this figure 79 with the camera lucida drawing in this paper, it is evident that MENGER's figure is incorrect and possibly was taken from an other species, although I do not know to which it might belong. Seen from above the superior ones are much straighter and in side view the distal portion carries a number of small denticles. Besides, the tenth abdominal segment of the type male of *frontalis* bears a distinct slightly notched cone at its base, whereas on the figure in the monograph the same segment appears completely flattened.

The coloured drawing of the entire insect on Pl. II in the same work (fig. 12) is passable, though not very characteristic: the head is much too large, the wings are too short and the alternating colours of the abdomen all too diagrammatic. In reality this species is very similar to *E. vittata vittata* in general aspect, though more compactly built, and the yellow spots on the dorsal portion of the frons as well as the different shape of the superior anal appendages will serve to its recognition.

One of the most striking features of this insect to which no special attention has been paid (but possibly being only of individual value!) is the considerable widening of the basal portion of the hind wing, which feature is not nearly so striking in any of the other species. The anal triangle of right hind wing is incidentally traversed by two cross-veins.

Nothing is known about its habitat and all records or identifications following the original description must be considered as problematic or false, except, perhaps, the specimen mentioned below.

From FRASER's notes on the species (loc. cit. 1921) the following lines may be quoted:—

"The abdominal rings are not a very variable guide as they vary greatly in breadth in *vittata* and are broad in *vittigera*. The spots on the front are the only specific differences and it is more than probable that *frontalis* is merely a local variety of the two species mentioned. The anal appendages of the three species do not present any marked differentiation."

It is obvious that the author's remarks are incorrect. The markings on the abdomen in *vittata* and *vittigera* are largely different and not at all broad in the last mentioned species. Moreover there is a well-marked difference in the shape of the anal appendages between *vittata* and *vittigera* and lastly FRASER's statement that *frontalis* is merely a local race of the two (sic) species is not based on a comparison, as *frontalis* and *vittigera* were unknown to him.

Epophthalmia species (cf. **frontalis** SEL.) (textfig. 5).

Material studied: — 1 ♂ semiad. (rather defective and deformed by pressure), labeled: Khasia Hills, Assam (unknown hand), Kasia Hills Heine (SELYS, yellow label) in Museum Brussels.

Closely allied to *frontalis* and perhaps a distinct species.

A single immature specimen of rather problematic position but evidently very near *frontalis* and not especially related to the *vittata* Formenkreis. Apart from its smaller size and less heavy appearance it differs markedly from *frontalis* in the shape and the venation of its wings, the superior anal appendages being also different (fig. 5). Unfortunately of both species only a single male example is present, so that nothing definite can be said about the extent of individual variation as regards wing-venation or shape of the anal appendages. When comparing other species of the genus of which more material is available (*vittigera, australis*), in a series of males of each of these species the structure of the above mentioned organs does not seem to be very variable, so that I am rather inclined to think the Assam male representing a distinct species. The specimen lacks an identification-label, and even MARTIN seems to have overlooked it when studying the *Epophthalmia*'s in the old DE SELYS collection. To the diagnosis given in the tabular description (pp. 34-35) no additions are required.

A second — very doubtful — specimen, possibly belonging to a species allied to *frontalis* but not inserted in the descriptive account, bears the following labels: — Tocklay [N. India], 8.XI.1919, "head cut off in net" (unknown handwriting), and: Epophthalmia frontalis ♂ (in FRASER's hand). This example is in excellent condition, wholly adult and may be a true *frontalis*. The caudal appendages are somewhat different in shape but there is a distinct lateral tooth. As, however, its head is simply wanting, I am again not capable of identifying it, although FRASER referred it to *frontalis*. The specimen may be briefly characterized as follows:—

Synthorax dark metallic green with clear yellow bands slightly narrower than in *vittata* and much narrower than in typical *frontalis*, especially so the lateral yellow fascia. Wings hyaline, shaped as in *vittata*. Pterostigma of equal form, nodal index $\frac{8.15.}{11.12.}\left|\frac{15.8}{13.9}\right.$ ($\frac{46}{45}$). Anal loop normal, 9-10 celled, with central cell. Hind wings, as in most species of the genus, with anal angle cloudy yellow. Ground-colour of abdomen from base to end of segm. 6 deep black with yellow rings well-defined behind, slightly smaller than in *vittata* and even more so when comparing *frontalis*. The ring on dorsum of segm. 2 comparatively narrow, entire. Remaining segments (7—10) from dark reddish brown gradually passing to light brown including the appendages. Basal yellow rings on 7—8 conspicuous, on 7 occupying about ¼ of the length, that on 8 narrower, broadest on mid-dorsum. Segm. 9—10 unicolorous. Shape of abdomen as in *vittata vittata*.

Superior anal appendages distinctly concave when seen in profile, with a well-developed extero-lateral tooth at the middle (versus *vittata* and its races!) Inferior appendage about 1 mm longer than upper pair.

Length: abd. + app. 52, hw. 48 mm.

In spite of its lamentable decapitation I venture to say that, in my opinion, this male has no affinities to the *vittata*-group of the genus, being perhaps identical with the species from Assam, described and figured above. I can not find any difference of much importance in the anal appendages between these two insects (fig. 5).

Epophthalmia vittata vittata BURMEISTER 1839 (textfig. 7, 15).

1839 ♂ BURMEISTER, Handb. der Entom., II, p. 845 (*vittata*). — Hab.: Madras.
1867 ♂ Hagen, Not.b.Stud.BRAUER's Novara-Neur., Verh.zool.bot.Ges.Wien, 17, pp. 59-60 (*vittata*). — Type specimen described.
1868 ♂ BRAUER, Verzeichniss Neuropt., II, Idem, 18, p. 742 (*Macromia*). — Record of same specimen.
1871 ♂♀ Selys, Synopsis Cordulines, pp. 94-95, 96 sep. (*vittata*). — Hab.: Andaman Is., Thibet, Bengal, Madras.
1898 ♂ CALVERT, BURMEISTER's Types Odon., Trans.Amer.Ent.Soc., 25, pp. 56-57 (*vittata*). — Type examined.
1906 MARTIN, Cat.Coll.SELYS, Cordulines, p. 62 (*vittata*). — Hab.: India, Andaman Is., Thibet.

?1909 WILLIAMSON, North Amer.Drag.Macromia, Proc. U.S.Nat.Mus., 37, p. 371, fig. 2 (*Epophthalmia, species*? Burma, wing-photograph).
1914 MARTIN, Gen.Ins., 155, Odon.Lib.Cordulinae, p. 26. (*vittata*). — Vide sub 1906.
1919 FRASER, Descr. new Indian Odon. larvae a. exuviae, Rec.Ind.Mus., 16, pp. 459-460, pl. 32 fig. 1 (insect); pl. 34 fig. 2 (labium) (*frontalis*). — Hab.: India, Poona (larva).
1921 FRASER, Indian Drag., X, J.Bombay N.H.Soc., 27, pp. 679-680 (pars!), fig. 2 (drawing of wings) (*vittata*). — Hab.: W.Pen.India, Poona.
1923 LAIDLAW, Drag.Fauna Malay Peninsula, I, J.Mal.Br.Roy.Asiatic Soc., I, pp. 332-333, fig. 1 (*Azuma*). — Drawing of larval wing-pads (Calcutta specimen).
1924 FRASER, Report Odon.Andaman Is., Rec.Ind.Mus., 26, p. 409 (*Azuma*). — Hab.: Andaman Is. (teste SELYSI).
1924 FRASER, Survey Odon. W.India, Ibidem, pp. 446-447 (*Azuma cyanocephala*). — Hab.: Penins.India: Nilgiris, Malabar.

Material studied: — 1 ♂ ad., labeled: Ind. or (in ink), Stev. (SELYS), Epophthalmia vittata, Burm. ♂ (SELYS), Epophthalmia vittata Burm., Rév. Martin 1906 (MARTIN); 1 ♂ semiad., labeled: Thibet, Dup. (SELYS, orange label), Epophthalmia vittata Burm., Rév. Martin 1906 (MARTIN); 1 ♀ ad., labeled: Bengale (SELYS, pink label), M. vittata ? Burm. à renvoyer ♀ ♂ (SELYS, yellow label), Epophthalmia vittata Burm. ♀ (SELYS, white label), Epophthalmia vittata Burm., Rév. Martin 1906 (MARTIN); 1 ♀ ad., labeled: Macromia vittata ? Burm. ♂ (SELYS, yellow label), Vittata B. (SELYS, orange label), Epophthalmia vittata Burm., Rév. Martin 1906 (MARTIN). — All specimens in Mus. Brussels. — 1 ♂ ad., S. Penins. India, Malabar, Palghat, 16.VI.1921, leg. T. N. HEARSEY (ex coll. FRASER), in coll. m., with the following remarks on the paper: — "♂ No. 1. Eyes a peacock blue-green. Markings on thorax bright yellow and greenish black, on abdomen bright ochreous with dark brown bands. 7 to 10 segment brown. Palghat 16.6.21, in cop. with No. 2." (T.N.H.). — 1 ♂ ad., labeled: Azuma cyanocephala ♂, Poona [W. Penins. India], 1918 (FRASER), in coll. F. F. LAIDLAW.

Original description:—

"1. E. v i t t a t a*: fusca, fronte supra ocellorumque tuberculo chalybaeo; thoracis vittis sex, striga mesonoti ante alas, metanoto, abdominisque cingulis flavis.

♂. cercis operculo anali flavo brevioribus, obtusis, aduncis flavis; alae posticae in basi nubecula fulva. Long. 3".

♀. non vidi.

Von Madras; aus der Sendung des Herrn K i n g an den vormaligen Missionär Herrn S c h m i d t erhielt das Hallenser Museum diese höchst ausgezeichnete Art. Flügelzellen sehr gross, das braune Randmahl ist lang, aber doch kürzer als 2 Zellen. In jedem Flügeldreieck eine Querader; in dem Raum hinter dem Dreieck der Vorderflügel anfangs 2 Zellenreihen, obwohl das Dreieck sehr hoch ist.".

From this very short diagnosis only a fair idea of the appearance of BURMEISTER's insect could be obtained, the author's remark *'thoracis vittis sex ...'* also giving rise to some divergence of opinion, but afterwards all doubt was abolished by HAGEN who re-examined the type, giving a very careful description of it:—

"1. *E. vittata* BURM. Ich habe die Type ein Männchen aus Madras genau beschrieben und zwar stets im Vergleich mit *E. elegans.*

Unterlippe und ihre Lappen hellbraun, etwas röthlich, ohne gelben Seitenfleck; Oberlippe röthlich braun mit schmälerer strohgelber Basalbinde; Rhinarium röthlich braun; Epistom strohgelb, mit querer brauner Binde als Verlängerung des Rhinarium-Randes; die beiden Eindrücke braun. Stirn blau, metallglänzend, mit kleineren gelben Seitenflecken, und einem zweilappigen gelben Fleck oben in der Mitte der Aushöhlung. Fühler schwarz, Ende der Borste braun; Scheitelblase gross, metallblau, mitten ausgeschnitten, zweizipflig. Augen hinten schwarz, unten neben dem Munde ein brauner Fleck. Hinterhaupt klein, schwarz, wenig erhaben, hinten polirt, etwas gewölbt. Thorax röthlich braun, mit metallblauem Schein oben und seitlich neben den Binden. Die gelben Binden oben etwas schmäler und gekrümmt, mit stumpfem Ende; die gelbe Binde, die zwischen den vier Flügeln hindurch geht, etwas schmäler; eine zweite Seitenbinde fehlt ganz. Thorax unten hinter den Füssen röthlich braun, Leib etwas länger und schlanker, Basis und Spitze weniger aufgetrieben. Die Färbung scheint wie überhaupt bei dem ganzen Thiere nicht vollendet ausgebildet; erstes Segment braun, oben gelb an der Basis; zweites Segment mit schrägerer Binde, welche oben die Basalhälfte freilässt; in der Mitte der Basis ein kleines gelbes Dreieck; viertes bis sechstes Segment braun, die Basalhälfte gelb, doch sind beide Farben nicht scharf getrennt; die folgenden Segmente schmutzig ledergelb, mit dunkleren Seitenflecken. Das letzte Segment ist nicht gegen die Spitze verengt, auch nicht abhängig, sondern eben, mit zwei sehr genäherten kleinen Basalhöckern; Spitzenrand kürzer, Appendices gelb; die oberen etwas länger als das letzte Segment, blattartig, wenig gekrümmt, Spitzendrittel verjüngt, aussen schräge abgeschnitten, der Zahn wenig markirt. Unterer Appendix etwas länger, nach oben gekrümmt, schmäler, verjüngt gegen die mit zwei Hökerchen versehene Spitze. Oehrchen an der Seite des zweiten Segments klein gelb, nach hinten gespitzt; Bauchrand desselben Segments gut entwickelt, an der Spitze gestutzt, nach innen verdickt; Lamina anterior gerade, der Rand etwas dicker aufgebogen, und gegen die Spitze verengt; Hamulus breit blattartig, die Spitze stark verjüngt, kürzer fast gerade. Füsse schwarz, die Hüften und die Vorderschenkel unten röthlich braun. Flügel spitzer; 15 bis 16 Antecubitales, sonst wie bei *E. elegans;* Membranula weiss, längs dem Rande des Flügels braun; Pterostigma etwas kürzer besonders an den Hinterflügeln, deren Basis etwas angeraucht ist.

Länge 78 mill.; Leib 57 mill.; Flügel 52 mill.; Appendices 3 mill.; Pterostigma 3 mill.; Flügelspannung 104 mill.; Kopf 10 mill."

From this excellent and very careful description it appears evident that SELYS was right in referring the specimens in his own collection to BURMEISTER's species. HAGEN's description is typical for apparently almost fully mature examples in which, however, the metallic shine on the frons and on synthorax has not yet attained its highest intensity, thus giving the insect a "general colouring of ochreous brown, marked with yellow", as FRASER says (loc. cit. 1921). The male specimen from Poona, W. India, agrees so perfectly with the description of the type from Bombay as given by HAGEN that I could almost follow this step by step, although the Poona insect still seems to be slightly younger than HAGEN's. Older examples from the same locality were characterized by FRASER as follows: — "In the male, the upper part of the front of thorax and the brown part of the sides less so, are a fine, metallic green. The costa is finely yellow on the superior surface only, and as far out as the stigma, which is deep brown, almost black. The upper part of frons and the vesicle are metallic green, with a bright yellow spot just in front of the vesicle. The neuration of the wings is similar to *E. vittigera,* Ramb., from Java and Borneo and doubtfully, Assam. The yellow annules on the abdomen differ somewhat, as follows: — that on the 3rd occupies its middle third, on the 4th, 5th and 6th nearly as much as the basal half but the apical border of the rings is much clearer cut than the basal, which is diffuse, the annule on the 7th occupies the basal third and on the 8th and 9th, obscurely, the greater part of dorsum.

Female similar but the facial markings more obscure and the rings on the abdomen much broader, of which the ground colour is pale ochreous brown. In old specimens the greater part of the wings is suffused with a dirty yellow, rather patchy in its distribution." (l.c. 1921, p. 680).

Besides, the following remark on the coloration of the female wing was given: — "At the base of the hindwing, between the costa and the submedian nervure, a brownish ray, extending as far out as the 1st antenodal nervure. The outer fifth of the wings is usually clouded with a dirty yellow or pale brown."

With these notes my specimens are in full harmony.

I have made up a composition of characters demonstrated in both young and fully matured examples; the reader will find this in the tabular description (pp. 36-37).

Originally the interpretation of the different species at the end of SELYS's description of *vittata* made it appear to me as if *vittigera* were almost identical with our species: — "La *vittata* en est excessivement voisine, mais paraît distincte de la *vittigera* par les appendices anals jaunâtres, les ailes peu ou point brunes à la base, la lèvre supérieure avec deux taches, une tache basale unique au front (et une à chacun des côtés de celui-ci)." — This observation, however, was easily understood and not astonishing at all when carefully reading over SELYS's description of *vittigera* in behalf of which some Javan examples of *vittata sundana* were also employed! This became clearly evident at

the time of looking over the material in the Brussels Museum (cf. the enumeration of specimens under *vittata sundana*).

As regards neural characters the following data, borrowed from the available material, are perhaps not superfluous:—

Nodal indices ♂: Palghat $\frac{7.15.}{10.11.}\left|\frac{15.9}{11.10}\right.$ ($\frac{46}{42}$), Ind. or. $\frac{7.17.}{9.12.}\left|\frac{16.6}{12.9}\right.$ ($\frac{46}{42}$), Poona $\frac{7.17.}{11.12.}\left|\frac{16.7}{11.10}\right.$ ($\frac{47}{44}$), Thibet $\frac{-.16.}{9.11.}\left|\frac{15.-}{12.10}\right.$ ($\frac{\text{def.}}{42}$). Nodal indices ♀: hab. ign. $\frac{7.14.}{8.11.}\left|\frac{15.7}{11.8}\right.$ ($\frac{43}{38}$), Bengal $\frac{7.15.}{8.11.}\left|\frac{15.6}{12.9}\right.$ ($\frac{43}{40}$). Old specimens of rather buff coloration with dark brown to almost black pterostigma.

Life History. — Not very much is known about the life-history of this species. A single adult larva was studied by Dr. LAIDLAW, and two others were briefly described and figured by Dr. FRASER, from examples taken near Poona (vide postea).

The next observations are taken from FRASER's report on *vittata*:—

"Widely but sparingly distributed from Igatpuri to Malabar and probably to the extreme south of Travancore. I found it moderately common at Mahableshwar and Poona during April and May and at the latter place took quite a number sleeping at midday in mango trees in the Empress Gardens. Here exuviae were occasionally found along the banks of the rapidly flowing Mullah canal but in Coorg it breeds in still waters and I have found numbers of exuviae clinging to grasses bordering the small pulp tanks in coffee plantations. Kallar is the only locality in the Nilgiris in which I have observed it and it is unknown from the Palni Hills. Mr. T. N. HEARSEY has sent me a number from Palghat, Malabar, where he states that it is fairly common (In the Bombay Nat. Hist. Journal I quoted *A. vittata* in error for this insect as from Poona)."

A specimen from the Andaman Islands was recorded by SELYS in the Synopsis but it is not present in the collection of the Brussels Museum; an examination of this insect could have been of very high interest. Does it still exists?

Epophthalmia vittata cyanocephala HAGEN (textfig. 6)

1867 ♂ **Hagen**, Not.b.Stud. BRAUER's Novara-Neur., Verh.zool.bot.Ges.Wien, 17, pp. 60-61 (*cyanocephala*). — Hab.: Ceylon.

1868 BRAUER, Verzeichniss Neuropt., II, Idem, 18, p. 742 (*Macromia*). — Hab.: Ceylon, teste HAGENi.

1871 ♂ SELYS, Synopsis Cordulines, pp. 97-98 sep. (*cyanocephala*). — Description, teste HAGENi.

1893 KIRBY, Cat.Neur.Odon.Ceylon, J. Linn.Soc.London, Zool., 24, p. 557 (*cyanocephala*). — Hab.: Ceylon, loc. diff.

1906 ♂ MARTIN, Cat.Coll. SELYS, Cordulines, p. 63, *nec* fig. 80, *nec* Pl. II fig. 13 (insect) (*cyanocephala*). — Hab.: Ceylon, teste auctt.

1914 MARTIN, Gen.Ins., 155, Odon.Lib.Cordulinae, p. 26 (*cyanocephala*). — Idem.

1921 ♂ FRASER, Indian Drag., X, J. Bombay N. H. Soc., 27, pp. 678-679 (*pars*!) — Idem.

1924 ♂♀ **Laidlaw,** Cat.Odon.Ceylon (Coll. GREEN), Spolia Zeylanica, 12, 47-48, pp. 342-343 (*Azuma*). — Hab.: Ceylon, Kandy.

Material studied: — 1 ♂ ad., Ceylon, Kandy, 17.IX.1924, leg. Mr. HENRY, in coll. LAIDLAW.

Original description:—

"Ein Männchen meiner Sammlung aus Ceylon von NIETNER.

Länge 71 mill.; Leib 51 mill.; Flügel 50 mill.; Appendices 3½ mill.; Pterostigma 3½ mill.; Flügelspannung 106 mill.; Kopf 10 mill.

Der Beschreibung nach unterscheidet sich das stark ausgefärbte Männchen von *E. vittata* in folgenden Merkmalen. Lippen und Kopf vorn bis zur Stirn schwarz; an der Basis der Unterlippe jederseits ein gelber querer Fleck; Epistom oben mit gelber schmaler Querbinde, die in der Mitte durch die schwarzen Quereindrücke schräge gespalten wird; im Aussenwinkel des Epistoms und an der Seite der Stirne ein kleiner gelber Fleck. Die gelben Binden auf dem Thorax oben gerade, nicht gekrümmt. Die gelbe Seitenbinde schmäler. Leib kürzer, schwarz; erstes Segment in der Mitte der Basis mit sehr kleinem gelben Dreieck; zweites Segment mit ähnlichem Fleck und schmaler Mittelbinde, die seitlich schräge über die Oehrchen zur Basis läuft; drittes Segment oben mit zwei grösseren, viertes mit zwei kleinen gelben Mittelflecken; Basalviertel des siebenten Segmentes gelb; zehntes Segment gegen die Spitze braunroth; unten ist der Analrand des Segments gegen die Basis hin gelblich. Die Oberfläche des letzten Segments und die schwarzen Appendices stimmen in Form und Verhältniss meiner Zeichnung nach mit *E. elegans*, doch sind die oberen in dem verschmälerten Spitzentheil unten vielfach mit spitzen Höckern besetzt, die ich bei *E. elegans* nicht angemerkt habe. Lamina anterior mit doppelter verdickter Spitze; Hamulus verschieden, sein äusserer Rand an der Spitze in einen kleinen nach oben umgebogenen scharfen Haken verlängert, während bei *E. vittata* nach meiner Zeichnung der untere Rand in einen geraden Zipfel ausläuft. Flügel wie dort; 17 Antecubitales; Füsse ganz schwarz.

Ich habe in meiner Ceylon-Synopsis diese art als *E. vittata* BURM. aufgeführt, und hielt das Stück für ein ausgefärbtes Männchen. Ich meine aber, dass die angeführten Differenzen namentlich der Genitalien, und die Kürze des Leibes die Abtrennung der Art rechtfertigen.

In der Ceylon-Synopsis habe ich Rambodde als Fundort aufgeführt; vielleicht irrig, denn das vorliegende Männchen habe ich von DOHRN erhalten, ehe ich persönlich mit NIETNER in Verbindung stand, und aus jener Zeit stammt ein beträchtlicher Theil der von NIETNER eingesandten Neuroptera aus den tiefer gelegenen Gegenden der Insel, namentlich aus Colombo." [sic].

The reasons why considering the dark Ceylonese *Epophthalmia* as a subspecies of the Indian *vittata* BURM., and not as a distinct species, may be obvious from the characters given in the table before. Structurally *vittata* and *cyanocephala* are very similar to each other, and if there were no constant differences in the colour design of the body the two races could be regarded as belonging to one and the same form. These colour-differences however, are very clearly demonstrated, and HAGEN as well as KIRBY and LAIDLAW agree in their understanding of this phenomenon. Not to mention those colour-changes which are due to age and phase of maturation — differences which in most cases are easily understood — I regard this case of melanism as of sufficient evidence and importance.

In HAGEN's description of the accessory genitalia of *cyanocephala* a wrong impression of the shape of the hamulus is called forth by his statement that this should be structurally different from that of *vittata vittata*. This is certainly not the case, the different shape of the hamulus evidently being due to a distortion or at any rate unnatural situation of the organ between the lobes, the correctness of this view being sufficiently guaranteed after having made a careful comparison of the hamuli in all the species of the genus which I have examined.

BRAUER and SELYS appear not to have seen any specimen of the true *cyanocephala,* and the single supposed example mentioned by RENÉ MARTIN in the monograph does not belong to this subspecies. In reality MARTIN examined a teneral male of *vittata sundana,* the Javanese race of *vittata,* which is labeled "Java, Ploem", and is still in existence. All figures of *cyanocephala* sensu MARTINI-1906 have been drawn from t h i s very immature Javan specimen, the neuration (even the cross-veins!) shown on Pl. II fig. 13, as well as the colour-pattern of the abdomen being exactly identical to those of this insect. I could not find any other specimen in the Brussels Museum agreeing with the figure of the anal appendages and the coloured plate of the entire insect. Here confusion has gone too far! Under the blue drawer-label *"cyanocephala"* the above named male of *vittata sundana* has been placed; it bears the following pin-labels: Java, Ploem (SELYS's hand), Epophthalmia cyanocephala Hag. ♂ (SELYS's hand), 58 (large pencil figures on orange label, apparently from MARTIN, indicating that it was figured for the monograph!) and Epophthalmia cyanocephala Hag., Rév. R. Martin 1906 (MARTIN). The insect is entirely decomposed by pressure and therefore it must have been impossible to make an exact figure as fig. 80 of the anal appendages and a fig. 13 on Pl. II of the entire insect. Hence it is beyond dispute that the artist of these figures has largely indulged himself in fancies.

Next to mention is the "Catalogue of Dragonflies (Odonata) recorded from Ceylon, based on material collected by Mr. E. E. GREEN, with description of a new species", of Dr. LAIDLAW and containing also some interesting remarks concerning our insect. As the female is here briefly mentioned for the first

time, it seems worth while to copy the author's notes entirely, however fragmentary they are:—

"1 ♂ ad., May. 2 ♀♀ teneral. Kandy, September, 1911.

Closely allied to *E. vittata* (Burm.) from the mainland this species is, I think, sufficiently distinct to deserve a specific name. It is one of the largest and handsomest of the Libellulidae.

♂ Abd. 50 + 2.5, N.W. 47.5 mm.

♀ Abd. 53 mm, N.W., 50 mm.

The female specimens are both teneral, their colouring seems to differ, but little from that of the male. The wings, however, are marked with a smoky-brown in the costal and sub-costal spaces as far as the arculus, and in addition have a golden-yellow tinge from about half-way between the nodus and pterostigma to the apex."

It is very unfortunate that no better females were at hand. I am wholly unable to decide whether the female of *cyanocephala* can be distinguished from *vittata vittata* or not.

The fine specimen which Dr. LAIDLAW kindly sent to me for examination and description was also captured near Kandy. It was taken in September and is of slightly larger size than the male recorded by LAIDLAW in his paper. Its wings are almost hyaline, slightly yellowish at the tips, the cloudy yellow spot in the anal field of the hinder pair of wings being present, and the pterostigma is black. The nodal index is $\frac{7.15.}{10.11.}\left|\frac{16.8}{12.10}\right.(\frac{46}{43})$.

Epophthalmia vittata sundana subsp. nov. (textfig. 1, 8, 16 and pl. 1 fig. 3).

1871 ♂ SELYS, Synopsis Cordulines, pp. 96-97 sep. (*pars*!) (*vittigera*). — Hab.: Java (Immature specimens only).

1906 ♂ MARTIN, Cat.Coll.SELYS, Cordulines, fig. 80 (anal apps. ♂) & Pl. II fig. 13 (insect). (*cyanocephala*). — Unreliable figures, restored from freshly emerged specimen.

Material studied: — 1 ♂ juv. (abdomen and anal apps. deformed by pressure), labeled: Ploem, Java (SELYS, yellow label), Epophthalmia cyanocephala Hag. ♂ (SELYS, white label), 58 (in lead-pencil on orange label, indicating that it has been drawn for the monograph), Epophthalmia cyanocephala Hag., Rév. Martin 1906 (MARTIN); 1 ♂ ad., labeled: Batavia, Lantsberg (SELYS, yellow label), Epophthalmia vittigera Ramb. ♂ (SELYS, white label), Epophthalmia vittigera Rb., Rév. Martin 1906 (MARTIN); 1 ♂ semiad., labeled: Java, Fruhst. 5 (SELYS, yellow label), Epophthalmia vittigera Rb., Rév. Martin 1906 (MARTIN). — All specimens in Mus. Brussels. — 1 ♀ semiad., labeled: Java Auctie v. Eyndh., unidentified, in Mus. Leiden. — 10 ♂, 1 ♀ ad., W. Java, Buitenzorg, 250 m; Botanical Garden, Victoria-Pond, 14.XII.1929, 21.II, 21.III, 12.IV., 22—24.VIII, 20.IX, 27.IX, 3.X.1930, leg. M.A.L.; 2 ♂ ad., W. Java, Depok, ca. 150 m, between Batavia and Buitenzorg, 14.V.1930, leg. K. B. BOEDIJN, and 9.XI.1930, leg. M.A.L.

Rather smaller than typical *vittata*. Yellow markings in front of head less conspicuous, those on thorax and abdomen much reduced. Abdomen a trace shorter. Male anal appendages different, of more delicate build and with more pronounced edges, the superiors always distinctly concave when seen in profile.

The following additional description is taken from living or well-preserved specimens:—

♂. — Eyes brilliant emerald-green during life, warm blackish brown in dried examples. Light facial markings clear yellow, those on synthorax and abdomen of a more deeper tint. The spots on abdomen, even in living specimens, not sharply limited anteriorly. Synthorax with metallic green reflex especially vivid along the sutures. Ground-colour of abdomen, up till the end of segm. 7 black, rather buff, thence very dark velvet-brown. Tenth segment again more shining, dark brown. Appendages reddish brown (fig. 8).

Wings entirely hyaline save for a small yellow cloud in the postero-basal corner of hinder pair. Pterostigma deep black. Membranula grayish white fading to blackish apically. Anal loop normal, usually containing ten cells, central cell always present. Nodal index variable between $\frac{43}{35}$ - $\frac{46}{41}$ (antenodals $\frac{14\text{-}16}{9\text{-}12}$, postnodals $\frac{6\text{-}8}{8\text{-}10}$). Accessory genitalia and penis as described on page 29 (fig. 1).

♀. — See tabular description (pp. 44—45). Anal loop with 12—13 cells. Antenodals $\frac{16\text{-}18}{11\text{-}12}$ postnodals $\frac{7\text{-}8}{9\text{-}10}$.

Holotype male (Buitenzorg, 21.III.1930) in Mus. Buitenzorg.

Allotype female (Buitenzorg, 3.X.1930), idem.

The favourite haunt of this beautiful insect is the Victoria pond, the largest of a series of ponds situated near the Governor's palace in the Botanic Garden at Buitenzorg, about 250 m long and from 15—50 m wide.

Some sunny enclosures near the outlets of this pond which, it must be said, continuously supply it with new water from other ponds carrying it off from the opposite side, are partly occupied by a dense growth of aquatic vegetation such as the common Hydrilla verticillata, waterlilies, and large carpetings of Salvinia but these places are always avoided by *Epophthalmia*. It especially prefers the eastern shore where shading and overhanging Nephelium trees only partly transmit the morning rays of the sun. Along this shore the pond is shallow, mud-bottomed and, with the exception of floating islets of Salvinia, is free from any aquatic vegetation, containing thick layers of dead leaves, driftwood, etc. In the dry season the water-mark is sunk so much as to permit large stones to make their appearance.

Here the *sundana* males are found patrolling to and fro the whole grassy border, following anxiously each of its bends, traversing the sunlight openings and disappearing again under the dense shade of the overhanging trees, after few moments returning and sailing past with the same raving speed. The

flight is very swift but not so strong as described for nearctic *Macromia,* and not nearly so as the excessively swift-winged libelluline genera *Tholymis* and *Zyxomma,* usually not higher than one or two feet above the surface of the water and highly characteristic in view of a peculiar and very graceful balancing. Seldom and only when meeting an unfamiliar obstacle they suddenly change their trend, sometimes flying straight out to the middle of the pond, but always soon come back.

The males are on the wing almost the whole year round, since my records are from medio August to the end of May, apparently being absent only during June and July. Only two or three examples are seen at any one time and each male's beat is about 200 m long. Its capture is especially troublesomed by the presence of the very irascible males of *Ictinus decoratus,* a common species along the same pond in the wed season, which are so persistent in pursuing the larger species that it was only occasionally observed during that time.

The males are seen over the water between the morning hours 9 and 11, on cloudless days a solitary specimen may be noticed at about midday, but never in the afternoon.

Evidently the females are very rare and only come to the pond for the act of oviposition. This was observed five times, after having spent many hours on various days at exactly the same course of the pond which is also frequented by the males. The female flies close to the border of the pond, keeping near the surface of the water. When the dark edge under overhanging foliage is reached she chooses a spot in shallow water among partly exposed stones, hardly keeping in check her rapid balancing flight at this point, and nervously tapping the surface of the water with the end of its abdomen from three to eight times with long intervals between each dip, then suddenly turning back and repeating this action from the other side.

On October 3 1930 at last, while collecting at Victoria pond, I very fortunately took my first female during oviposition, and succeeded in catching up about forty eggs from it by loosely holding the insect's thorax and regularly stripping the end of its abdomen against a piece of soft cartoon, placed in a small bottle filled with water, thus allowing the specimen to continue oviposition immediately after capture.

As soon as possible the eggs were then brought to the laboratory for breeding purposes, a report on this investigation being given on pp. 75-77 of the present paper.

E. vittata sundana seems to prefer warm and shallow waters rather more than lakes, as distinguished from *vittigera* which is more frequently met with in temperate regions in larger and deeper pools or lakes. In the surroundings of Buitenzorg both species were found, but hitherto they were not yet seen flying in company of each other.

The exact dates on which oviposition was observed are: — 15.XI.1929, 12.IV, 23.VIII, 24.VIII and 3.X.1930.

Epophthalmia australis HAGEN 1867 (textfig. 9 and pl. 1 fig. 4).

1867 ♂ **Hagen**, Not.b.Stud.BRAUER's Novara-Neur., Verh.zool.bot.Ges.Wien, 17, pp. 61-62. — Hab.: Celebes.
1868 BRAUER, Verzeichniss Neuropt., II, Verh.zool.bot.Ges.Wien, 18, p. 742 (*Macromia*). — Same habitat.
1871 ♂ Selys, Synopsis Cordulines, pp. 98-99 sep. — Hab.: Moluccas & Celebes.
1878 SELYS, Odon.rég.Nouv.Guinée, Mitt.Zool.Mus.Dresden, p. 295. — Hab.: Celebes (Moluccas not mentioned!).
1901 MARTIN, Odon.Cont.Australien, Mém.Soc.Zool.France, ann. 1901, pp. 227. — Hab.: Australia (*errore*!), Celebes; Borneo (*errore*!).
1906 ♂ MARTIN, Cat.Coll.SELYS, Cordulines, p. 63. — Hab.: Borneo (*errore*!), Celebes, Moluccas.
1914 MARTIN, Gen.Ins., 155, Odon. Lib.Cordulinae, p. 26. — Same habitat.
1915 RIS, Beitr.Odon.Neu-Guinea Reg., Nova Guinea, Zool., 13, 2, p. 123, Cat. — Hab. cited after SELYS.

Material studied: — 1 ♂ ad., (holotype) labeled: Celebes, Limbotto, Rosenberg (printed), and 7. Hag. 65 (written in ink on orange label) in Mus. Leiden; 1 ♂ ad., labeled: Moluques, Lorquin (SELYS, pink label), Epophthalmia australis Hag. ♂ (SELYS), E. australis Hagen ♂, Rév. R. Martin (MARTIN) in Mus. Brussels; 3 ♂ ad., N. Celebes, Paloe, Kalawara, 3, 10 and 12.XII.1912, leg. Dr. L. MARTIN, in coll. RIS; 1 ♂ ad., S. Celebes, Maros, VI. 1929, leg. G. OVERDIJKINK, in Mus. Buitenzorg.

Original description:—

"Ein Männchen stark ausgefärbt aus Celebes. Grösser wie die vorige Art [*E. v. cyanocephala* HAG.], nur die Flügel 52 mill.; das Pterostigma der Vorderflügel etwas kürzer als 3 mill., das der Hinterflügel wenig länger als 2 mill.

Der vorigen Art sehr ähnlich, jedoch Mund und Kopf sehr dunkel röthlich braun ohne gelbe Flecke, die auch seitlich an der Stirne fehlen. Die sehr schmale und kurze gelbe Binde reicht vorn am Thorax nur bis zur Hälfte seiner Höhe und ist gerade.

Leib schwarz, die Basalhälfte des zweiten Segments stark braun behaart, eine gelbliche Binde daselbst kaum angedeutet, seitlich deutlicher. Die gelben Flecke auf dem dritten und vierten Segment kleiner; das Basaldrittel des siebenten Segmentes ledergelb, in der Mitte mit kurzem weitergreifenden Lappen. Leib unten an der Basis und vor der Spitze des Segments rothbraun. Appendices wie bei *E. vittata,* die untere breiter als bei der vorigen Art.

Lamina anterior spitzer, mehr erhaben, weniger tief ausgekerbt. Hamulus wie bei der vorigen Art. Flügel wie bei der vorigen Art, jedoch der Analwinkel der Hinterflügel schmäler, viel weniger abgerundet; das Pterostigma kleiner."

This rather short description is sufficiently characteristic to distinguish *australis* from the other species of the genus since all its important features are summarized in the same. Differences in the shape of the anterior genital lamina, as noted by HAGEN, are very slight and, from my experience, rather dependent on the optic angle from which it is looked at by the observer. Judging from the fairly rich material which I was able to compare, *australis* is a very uniform species and no serious difficulties arose in separating it at once from *vittigera* or from *vittata cyanocephala.*

It is dark long-winged species of compact building with a large head and reduced dull orangish markings on thorax and abdomen, in old males the upper part of the head and the thorax being of a very brilliant metallic blue or purplish colour. SELYS's description of the male from the Moluccas is very good, though the present state of preservation of the insect indeed leaves to be desired. The three specimens from N. Celebes do not differ in any way from the two others and such is the case with the single male from Maros, in the extreme south of the island.

All literature dealing with this species appeared since the date of the Synopsis is of no value as it refers to other species of the genus or merely contains quotations from the two original descriptions.

Some neural characters may still be of use:—

Nodal indices: Celebes (Type) $\frac{8.16.}{11.11.}\left|\frac{17.8}{11.11}\right.$ ($\frac{49}{44}$), Moluccas $\frac{10.18.}{11.11.}\left|\frac{18.8}{12.10}\right.$ ($\frac{54}{44}$), Maros $\frac{8.15.}{10.10.}\left|\frac{16.8}{12.10}\right.$ ($\frac{47}{42}$), Kalawara $\frac{7.17.}{10.11.}\left|\frac{17.8}{11.9}\right.$ ($\frac{49}{41}$), $\frac{7.18.}{11.11.}\left|\frac{18\,8}{12.10}\right.$ ($\frac{51}{44}$), $\frac{8.17.}{12.11.}\left|\frac{16.8}{10.10}\right.$ ($\frac{49}{43}$). Number of cells in the anal loop 8—11, with or without central cell. The pterostigma is decidedly smaller than in any of the other members.

E. australis has never been figured in any way. Perhaps this is the reason why it was so often confused with its nearest ally, viz., *vittigera.* A coloured drawing of the entire insect may give an idea of its general appearance, the outline figures of the anal appendages may, I hope, be of some assistance too.

Epophthalmia vittigera (RAMBUR) 1842 (textfigs. 10, 11, 13, 14).

1842 ♀ **Rambur,** Hist.nat.Insectes, Névroptères, p. 140 (*Macromia*). — Hab. ign.

1871 ♂♀ SELYS, Synopsis Cordulines, pp. 96-97 sep. (*pars*!). — Hab.: Java (Exx. juven.vide sub *vittata sundana*).

1904 MARTIN, Mission Pavie, Zool., Névropt., p. 211. — Hab.: Java, Tonkin, Assam.

1906 ♂♀ MARTIN, Cat.Coll.SELYS, Cordulines, pp. 62-63 (*pars*!). — Hab.: Java, Assam, Borneo (Exx.juven.vide sub *vittata sundana*).

1911 ♂♀ **Ris,** Libellen v.Sintang, Borneo, Ann.Soc.ent.Belg., 55, pp. 248-251, fig. 14 (wing-photograph ♂ Perak), 15 ab (anal apps. ♂, Sintang), 16 ab (genit. ♀, Sintang) (*australis*). — Hab.: C. W. Borneo; Perak.

1913 LAIDLAW, Proc.Zool.Soc.London, 1, pp. 69-70 (*australis*). — Hab.: N.Borneo.

1914 ♂ **Martin,** Gen.Ins., 155, Odon.Lib.Cordulinae, p. 26, Pl. 2 fig. 15 (insect). — Hab.: Java, Borneo, Assam.

1920 LAIDLAW, Contrib.Drag.Fauna Borneo, IV, Proc.Zool.Soc.London, p. 317 (*Azuma australis*), p. 318 (*A. vittigera*). — Hab.: Borneo, teste auct.
1921 ♂♀ FRASER, Indian Drag., X, J. Bombay N.H.Soc., 27, pp. 680-681 (*pars*!). — Hab.: Java (Assam, Borneo). Descr. teste SELYSi.
1926 FRASER, Notes Drag. Dutch East Indies, etc., Treubia, 8, livr. 3-4, p. 472 (*Azuma*). — Hab.: Java, Burma.
1930 HINCKS, Sarawak Museum Journ., 4, 1, no. 12, p. 53. — ♂♀ Sarawak (record).

Material studied: — 1 ♂ ad. (terminal abd.-segm. wanting), labeled: Batavia Lantsberg (SELYS, yellow label), unidentified; 1 ♂ ad., labeled: Java (SELYS, yellow label, remainder illegible), Epophthalmia vittigera R. ♂ (SELYS, yellow label), vittigera Rambur. 124. ♂ Java (unknown handwriting, on large orange label); 1 ♀ ad., labeled: A (on white square label, probably RAMBUR's type), 125 (printed), Epophthalmia vittigera R. ♀ (SELYS, yellow label), vittigera Rambur. 125. ♀. Java (unknown handwriting, idem); 1 ♀ ad., labeled: Java Fr. (SELYS, square yellow label), Epophthalmia vittigera Rb., Rév. Martin 1906 (MARTIN); 1 ♀ juv. (head and abd.-segm. 5—10 wanting), labeled: Java, par M. Pulsk (SELYS, yellow label), Vittigera R. (SELYS, orange label); 1 ♂ ad., labeled: Vanderh. Timor (SELYS, yellow label), Vittigera R. (SELYS, orange label), Fig. Gen. Ins. (printed in blue), Epophthalmia vittigera Rb., Rév. Martin 1906 (MARTIN). — All in Mus. Brussels. — 1 ♂ ad., W. Java, G. Gedeh, Tjibodas, 1450 m, IX.1895, I. Z. CANNEGIETER leg. (E. vittigera Ramb., det. RIS; 1 ♀ ad., Java or., MULIÉ; 2♀ in bad condition, Java, MULLER; 1 ♂ juv., W. Sumatra, Padang Pandjang, ROLLE vend. 1909; 1 ♂ ad., Br. N. Borneo, Mt. Marapok, Dent Province, leg. G. (E. vittigera Ramb., det. RIS). — All in Mus. Leiden. — 1 ♂ ad., in spirit, Malacca, Singapore, 24.VII.1909, leg. SCHWINGHAMMER, in Mus. Hamburg. — 1 ♂ ad., def., Malacca, Perak, F. M. S. Perak Mus., Tai Ping (Azuma australis, det. LAIDLAW); 1 ♂ juv., Malacca, Kuala Lumpur (Id.); 1 ♀ ad., Malacca, Ulu Pandau, Singapore, VIII. 1921 (Id.); 1 ♂ ad., Br. N. Borneo, Rebau, leg. J. C. MOULTON (Id.). — All in coll. LAIDLAW. — 1 ♂ ad., W. Java, Buitenzorg, 250 m, 25.IX.1918, leg. W. ROEPKE; 1 ♂ 1 ♀ ad., Centr. W. Borneo, Sintang, 8.III.1910 & 3.XI.1909. leg. L. MARTIN (E. australis Hag. forma, det. RIS, revision after 1911!). — All in Coll. Dr. F. RIS. — 2 ♂ ad., Palawan, Tay Tay, 19.IV. & La Laguña, 12.V.1913, JANSON vend., in coll. K. J. MORTON. — 1 ♀ semiad., W. Java, Depok, between Batavia and Buitenzorg, ca. 100 m, 4.V.1930, G. HEINRICH leg.; 1 ♀ ad., W. Java, Preanger, Garoet, 700 m, 16.XII.1930, W. C. VAN HEURN leg., both in Mus. Buitenzorg.

I seriously regret not being able to include a transcription of RAMBUR's first report on this species, although the conviction grows upon me that the female in the Brussels Museum, determined by DE SELYS as *vittigera* and originally bearing a very old label with 'A' in reality is the type, and that afterwards somebody else may have added a second label with Java as indication of habitat. This, however, is only a supposition and it seems at any rate

useful to copy SELYS's description of *vittigera* as it refers to the first known examples of which the habitat is known with certainty. It runs as follows:—

"Abdomen ♂ 50—53; ♀ 57—60. Aile inférieure ♂ 48—51; ♀ 51—54.

Ailes hyalines (chez le ♂ un nuage jaune pâle à l'angle anal et l'extrême base portant une marque brune rudimentaire aux supérieures, mais occupant aux inférieures l'espace entre la costale et la médiane jusqu'à la 1re antécubitale. — Chez la ♀ la marque brune mieux distincte aux supérieures et formant aux inférieures une bande entre la costale et la sous-médiane atteignant la 3e antécubitale; enfin le 5e terminal des ailes supérieures presque toujours lavé d'ochracé sale). Membranule grise, plus foncée contre le bord anal; ptérostigma brun noirâtre, surmontant 1½ à 2 cellules (long de 3 mm); 15—20 antécubitales, 7—8 postcubitales; 3—4 hypertrigonales; 5—7 médianes; 3 cellules postrigonales, puis 2 rangs. Réticulation noirâtre, costale à peine jaunâtre jusqu'au nodus.

D'un brun noirâtre, varié de jaune. Lèvres et face brun roussâtre, une ligne basale transverse sinueuse, interrompue au milieu, et le fin bord latéral au nasus, jaunâtres. Dessus du front bleu acier métallique (chez la ♀ jeune avec une tache médiane basale [error?] et une de chaque côté du front contre l'oeil, jaunâtre, pâle). Thorax brun noir à reflets bleuâtre métallique. Les sinus antéalaires en avant, une raie antéhumérale étroite, droite, ne les touchant pas et sur les côtés une médiane étroite faisant le tour du thorax entre les ailes, jaunes. Abdomen cylindrique, renflé à la base, un peu épaissi aux 6e—10e segments, noirâtre, annelé de jaune ainsi qu'il suit: un anneau submédian étroit aux 2—6e segments, presque interrompu en dessus, excepté au 2e; l'anneau aux 7e et 8e est plus près de la base, et au 8e il n'est pas interrompu. Pieds noirâtres, fémurs bruns.

♂ 10e segment un peu bossu à la base. Appendices anals brun noirâtre; les supérieurs un peu plus longs que le dernier segment, un peu courbés en tenailles, épais; le bord externe est droit dans sa première moitié, puis forme un coude à dent anguleuse; le bout mousse. Appendice inférieur un peu plus long que les supérieurs, triangulaire à peine recourbé en haut, le bout un peu tronqué.

♀ Les raies et anneaux jaunes un peu plus larges. Appendices anals noirâtres, coniques, très-pointus, plus courts que le 10e segment, qui est aussi long que le 9e. Écaille vulvaire paraissant consister en deux lamelles en forme de feuilles de laurier rapprochées, aissi longues que la moitié du 9e.

Jeunes. Vestige de deux marques pâles à la base de la lèvre supérieure. Les anneaux jaunes de l'abdomen plus larges aux 4—7e segments (chez le mâle la base des ailes sans marque brune, le 10e segment et les appendices anals brun jaunâtre) [error, = *vittata sundana*].

Patrie: Java. (Coll. Selys.).

N.B. Voir la comparaison des cinq espèces voisines à l'article de la *vittata* dont la *vittigera* n'est peut-être qu'une race locale."

I may especially point to the fact that the somewhat aberrant shape of the male anal appendages clearly finds expression in this description, the darkly

spotted wing-bases and the wholly metallic upper part of the frons being also mentioned. The single juvenile female in Mus. Brussels lacks its head so that I can not say whether very young specimens have a light spot on the dorsal surface of the frons or not. In none of the examples examined by me a light point or spot is perceivable. This lets me suppose that SELYS's observation is due to a mistake.

As already hinted at SELYS's remarks on the young males refer to *vittata sundana*.

The more darkened specimens from Sintang in Borneo, both male and female, were excellently described by RIS in 1911, together with a male from Perak. The figures accompanying that description are reproduced in the present paper and show at a glance that RIS was not right in referring his insects to *australis*, a species which has not been found in Borneo and is not likely to occur there. There is some variation in the relative extension of the yellow or brownish spots all over the body, the intensity of the dark ground-colour and the shading of the metallic reflex being also a little different when comparing specimens from different habitat. As to that, I may especially point to a very strikingly pronounced parallelism between *Macromia cincta* RAMB. and *Epophthalmia vittigera*: in both species the yellow ornaments on the body gradually become more reduced in examples from the eastern parts of their distribution, the golden-brown spots at the wing bases and the intensity of the remaining dark colours at the same time becoming more extended and deepened. There is much evidence this development of melanism being influenced by the same — probably climatic — factors and that the same ways of distribution were followed.

The species will at once be recognized when looking at the splendid picture of the male insect in R. MARTIN'S Cordulinae, of WYTSMAN'S 'Genera Insectorum', drawn from the Timor male in the Brussels Museum.

E. vittigera is apparently the least rare member of the genus throughout the whole of its occupied area. MARTIN adds Assam and Tonkin to its habitat, the last mentioned country being omitted by the same author in a later paper, and FRASER (loc. cit.) says that he has seen specimens from Burma. There is no reason whatever in calling these statements in question but I am wholly unable to fortify them.

My own experiences with this species are very poor and so far I had no opportunity of taking any specimen myself, although we found two skins at lake Koeripan, north of Buitenzorg, and I observed a single male patrolling the steep border of lake Tjigombong between Buitenzorg and Soekaboemi. This was flying above open water and could easily be identified from the boat with my glass, but its capture failed as I was much engaged at the same time in catching the red-bodied *Urothemis* and *Rhodothemis*, also occurring there in some numbers. It was further repeatedly seen by Mr. DRESCHER along lake Padalarang, north of Bandoeng but never could it be taken according to its only exceptionally coming within the reach of an insect-net. The larva is described and figured below.

LARVAE.

The following notes are based on a rather limited number of *Epophthalmia* larvae, partly sent to me for identification by Dr. E. TITSCHACK of the Hamburg Museum, partly lent from Dr. LAIDLAW's collection. The two skins which I refer to *E. vittigera* RAMB., were taken by us during a visit to a lake not far from Buitenzorg, Java.

The peculiar and highly specialized labium has already been dealt with by CABOT (loc. cit., 1890) and Miss BUTLER (loc. cit., 1904) so far as *elegans* is concerned in his "Biology of Dragonflies" (1917), TILLYARD made use of the same species in giving a figure of the lateral lobe of the labium which, however,

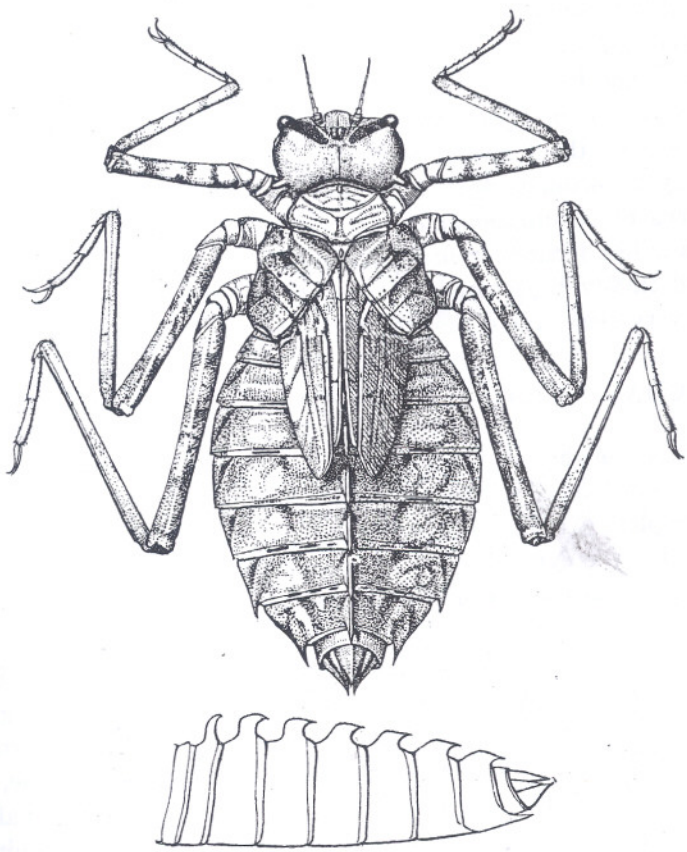


Fig. 17. *E. elegans* BRAUER, ultimate larval instar, Fo Kien, China (Mus. Hamburg). Below left lateral view of abdomen, showing dorsal hooks.

is not correct, the most distally situated tooth being omitted in the figure, probably because exactly this tooth often escapes notice in consequence of the strongly bent tip of the lobe in natural position (cf. also CABOT's figure!). In all my examples of *elegans*, as well as in the other species, this tooth is equally developed and only little variable in size, like the other ones.

Besides, special attention may be called to the very close and rather unexpected similarity of the labia in the three examined species. While making some illustrations for this purpose I was much surprised to find them so perfectly agreeing that no useful differences could be detected, — the more reason why not placing the sino-japanese *elegans* in a separate genus.

The very full description of the larva of *elegans* as offered by CABOT, is, for the most part, also applicable to the other species of the genus. Only few additions or omissions were necessary. The figures given are fairly good although the somewhat distorted attitude of the entire insect on pl. 1 (fig. 1) does not give a perfect idea of its true appearance.

In the next given key only those characters are employed which do not appear to be variable. Other larval structures than those discussed in the text, as i.e. the mandibles or the internal organs, have been left out consideration and were not examined by the author.

As the author has neither reared the species nor collected any of them while in the act of emerging, there remains, of course, a little doubt as to the correctness of their identification.

It is very unfortunate that I am wholly unable to deal completely with the adult larva of *vittata sundana,* the more so as exactly this species breeds within half a mile's distance from the laboratory. As, however, a limited number of eggs could finally be secured, a description and some figures of both the egg and the very remarkable first larval instar of *sundana* are here appended.

CHARACTERS OF THE FULL-GROWN LARVA.

Head small, roughly rectangular in general outline, about twice broader than long. Eyes situated in the antero-lateral corner, small, very prominent, knob-like, completely rounded. Head with very short thin hair on the sides below and behind the eyes. Frontal line not protruding in dorsal view, without distinct horn in the middle but with a short process of about the same length as first antennal joint, variable in shape (fig. 19). Ocelli indicated. A rather deep broadly triangular excavation between the eyes, divided by a straight suture with a depressed narrow space on each side. Vertex in the middle of the excavation, behind the antennae, inflated cordate or knob-like, divided by a longitudinal depression. Sides of the head convex, on each outer hind angle, which is always completely rounded, a nipple-shaped projection of slightly variable length. Antennae seven-jointed, about as long as the head; the two basal joints thickest, the first cylindrical, long, the second half as long and much narrower, rather rounded at tip. Remaining joints long and extremely thin: the third as long as the two basals together or slightly shorter; fourth joint about twice shorter than

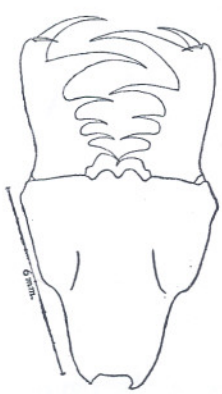


Fig. 18. *E. elegans* BRAUER, interior view of labium.

third, of equal length or a trace shorter than the fifth joint; sixth and seventh joints as long as fifth or distinctly longer (fig. 23).

Labium of very large size and extraordinary shape, extending between the middle legs as far as an elevated transverse ridge between the hind legs; basal part long with two strong, rounded, longitudinal ridges underneath, enlarged anteriorly forming in the middle at its free margin two smooth and rounded lobes, divided from each other by a rounded depression. Lateral lobes strongly developed, of very peculiar shape, comb-like, about as long as the basal parts, rather narrow and but incompletely interlacing. The interior edge with six very strong hook-like teeth, separated from each other by deep rounded spaces. Teeth asymmetrically developed. At the left lobe the four, at the right lobe the three basal teeth shortest and of

Fig. 19. *E. elegans* BRAUER, anterior part of head, dorsal view. Last joints of antennae cut off.

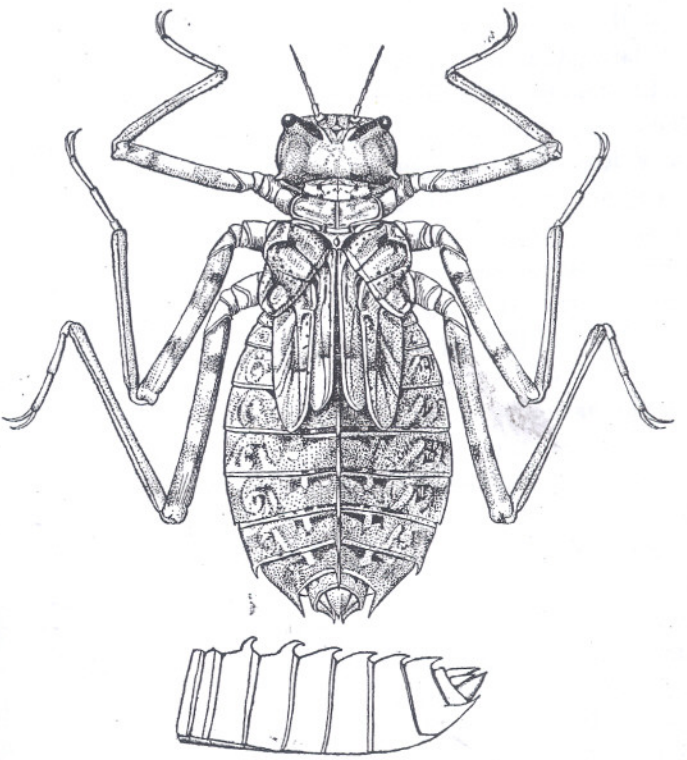


Fig. 20. *E. vittata vittata* BURMEISTER, ultimate larval instar, Calcutta, India (coll. LAIDLAW). Below left lateral view of abdomen, showing dorsal hooks.

subequal length, the first (basal) tooth swollen at base, crenulated interiorly. The fifth tooth of left and right lobes longest of all, weakly serrate interiorly, sixth tooth longest on left lateral lobe. The apical half of all teeth black.

When closed the first (basal) pair of teeth crossing each other. All setae absent. Movable hook spine-like, very short (figs. 18, 21, 29).

Prothorax rather narrower than the head; an elevated ridge in front, and an elevated ridge around the whole hinder part, which is traversed by another elevated ridge. Posterior ridge protruding on either side, giving off a bluntly pointed process. Stigma large. Dorsal parts of synthorax subquadrangular or rather trapezoidal, divided into three oblique, convex and somewhat angular portions.

Wing-pads reaching to a level between fifth and sixth segment or to the end of fifth, lying parallel to each other on the back, conspicuously spotted with black. Venation clearly visible in freshly moulted examples (fig. 20).

Legs widely distant, strong, much flattened and very long. Hind femur reaching at least to the end of segm. 7, tibia about same length as femur, tarsus half as long as tibia. First tarsal joint very short, the two others long, of equal length; claws shorter than last tarsal joint, slightly curved, without teeth. Femora always with three more or less distinct dark bands.

Abdomen large, broadly ovate, much wider than thorax, its greatest width at or before the middle, roof-shaped and sharply crested; side margin sharp. Middle segments of about equal length, segm. 9 rapidly narrowing, its hind margin more or less concave, segm. 10 small and much shorter than the foregoing. Lateral spines on segm. 9 and 8 always present, sharp and nearly straight, that on 8 small, on 9 much longer, reaching at least slightly beyond end of segm. 10. Dorsal hooks on segm. 3—9 or 4—9, compressed, acute and connected with the whole length of segments, their tips pointed towards the end of abdomen, extending beyond the segments. Hooks on segm. 3 or 4—5 cylindrical, more or less raised. Last segment without any indication of dorsal hooks. Anal appendages about as long as half the diameter of segm. 10, forming a thick short pyramid of about same length and width. Appendix dorsalis as long or slightly shorter than the cerci, broadly triangular and much flattened dorsally; cerci thick at base, slightly upturned and sharply pointed at tips, their outer margin distinctly concave. Cercoids somewhat shorter than the appendix dorsalis, pricker-shaped. Ventral side of abdomen slightly convex with two incurved longitudinal sutures at some distance from the side, these side-portions flattened and straight. Body rather smooth, pubescence of abdomen short and thin, longest at the sides of basal segments and along the lateral and posterior margins of segm. 9, elsewhere poorly developed. Coloration light ochreous or dull yellow with a rather uniform brown design as shown in fig. 20. In the other species the colours have much faded or the body is somewhat encrustated with mud or loam.

Total length of the body from 32—35 mm.

The above description is applicable to the larvae of *E. elegans, vittata vittata,* and *vittigera.*

Key to the species. [1])

1. Dorsal hooks present on segm. 3—9 of abdomen, that on 3 long and slender, raised straight upwards, those on 4—9 with their basal portions long, much raised anteriorly and strongly nodding, their upper distal margins straight. Greatest width of head situated in the middle. Nipple-shaped processes short, about 0.5 mm long. Distance between the eyes 6.2 mm. Abdomen broadly ovate, greatest width much before the middle, from segm. 6 tapering, rather pointed. Hind femur short, reaching to end of segm. 7, its length (incl. troch.) 13.5 mm. Total length of body 34.8—35.2 mm. (figs. 17—19, 23c). ..... **elegans** (BRAUER).

—. Dorsal hooks present on segm. 4—9 of abdomen only, those on 4 and 5 sub-equal, slenderer and more erect than the others which are rather low and not raised anteriorly, their upper margins being evenly rounded towards the much pointed tips. Abdomen ovate, widest at or slightly behind the middle, hardly or not tapering towards the end and less pointed ..... 2.

2. Shape of head more transverse, widest behind the middle. Nipple-shaped processes about 1 mm long. Frontal process between the antennae slightly longer than first antennal joint, triangular, bluntly pointed in front. Eyes widely separated, their distance 6.0 mm broad. Sixth antennal joint about as long as fifth. Hind femur almost reaching end of segm. 8 (not so far in the exuviae!), 14.8 mm long. Greatest width of abdomen 13 mm. Total length of body 33.5 mm (figs. 23b, 28—29). ..... **vittigera** (RAMB.).

—. Head smaller and comparatively less broad, widest at the middle. Nipple-shaped processes about 0.6 mm long. Frontal process between the antennae small, reaching to end of first antennal joint, its anterior margin completely rounded. Eyes slightly more protruding and more approximated, their distance 5.5 mm broad. Sixth antennal joint much longer than fifth. Hind femur shorter, reaching to end of segm. 7, 14.0 mm long. Greatest width of abdomen 13 mm. Total length of body 32.5 mm (figs. 20—23a). **vittata vittata** BURM.

Epophthalmia elegans (BRAUER) (textfig. 17—19, 23c).

Material studied: — 14 larvae ult, in alcohol, China, prov. Fo-Kien, and idem, Futshiau, C. G. SIEMSSEN vend. 9.XI.1906, in Mus. Hamburg.

This species needs no ample discussion. The illustrations may give a better impression of its appearance than a long description. CABOT's larva from Canton is evidently somewhat contracted and deformed in the liquid. The author gave the following measurements: — length of body 31 mm; breadth 15 mm; legs 35 mm.

[1]) I may emphatically remind that the differences employed in this key are based on a very limited number of specimens, except as regards *elegans*, where practically no deviations were found while measuring about a dozen of specimens. Yet I consider this key to be only an indication for future research.

Epophthalmia vittata vittata BURM. (textfig. 20—23a).

Material studied: — 1 larva ult, in alcohol, labeled: India, Calcutta, Azuma spec. (LAIDLAW's hand), in coll. LAIDLAW.

This specimen most probably belongs to continental *vittata* and is well distinguished from the Malaysian nymphs mentioned below, although the differences are slight and only perspicuous when comparing them with the others. Among other characters given in the key the differently shaped head will serve to its recognition. The figure of the hind wing is a copy of that given by LAIDLAW in his paper "The Dragonfly Fauna of the Malay Peninsula", in the Journ.Mal.Branch of the Royal Asiatic Soc., I, 1923, pt. 2. In that work it was offered as an example of the tracheation of an anisopterous dragonfly. The author's explanation of the different veins runs as follows:—

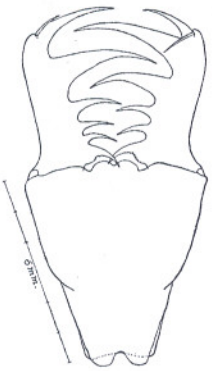


Fig. 21. *E. vittata vittata* BURMEISTER, interior view of labium.

"C. Anterior margin of wing; note that there is no costal trachea.

Sc. Subcostal trachea.

M + R. Trunks of median and radial trachea, running together.

Cu + A. Trunks of cubital and anal trachea, running together.

R. Distal part of radial trachea. Rs 'Radial sector'.

M1 M2 M3 M4. Branches of median trachea.

Cu1 Cu2. Branches of Cubital trachea.

N. Nodus. Pt. Pterostigma. T. Triangle. ST. Supra triangle.

Arc. Arculus. Ac. Anal crossing. AL. Anal loop. Br. Bridge-vein. Rspl. Radial supplement.

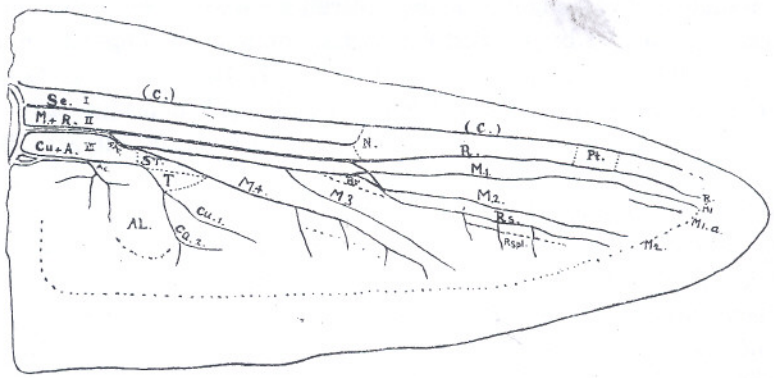


Fig. 22. *E. vittata vittata* BURMEISTER, tracheation of hind wing in ultimate larval instar, Calcutta, India (After LAIDLAW).

Note. Important *veins* not pre-formed as tracheae are indicated by dotted lines. The outline of the whole figure marks the outline of the larval wing case, the anterior margin of the wing is shown at C and the posterior margin is

indicated by a dotted line. I. Costal space. II. Subcostal space. III. Median space.

This figure may be taken as representing the tracheation of the typical anisopterous wing. Note especially the way in which Rs crosses M1 and M2 where these fork from each other, and how the bridge-vein (Br) carries it back on to the trunk of the media." (pp. 332—333).

The remaining wing-pads were used for the same purpose by the author of the present paper, and I can wholly affirm the correctness of LAIDLAW's interpretation of the terminology of the veins.

In this larva the natural design is as excellently demonstrated as if the specimen were alive, and I am strongly of opinion that the last moult took place at most a few weeks before its capture.

In 1919 Col. FRASER published some notes on an *Epophthalmia* larva from Poona, India, taken from "running streams amidst curtains or masses of water-weed" (loc.cit. p. 460, sub *frontalis*), but, as is also applicable to nearly all other species discussed in the above mentioned paper, the description given is rather short and incomplete, the outline-drawing of the insect itself as well as that of the labium being of little use to the student. Apparently FRASER has not consulted CABOT's work on the larval stage of Corduliinae, and it would seem to me that the author's remarks on p. 459 of his paper are rather premature: — "The curving and cupping of the antlered lobes of *Epophthalmia* foretells the evolution of the cupped mask of the Libellulines. One has only to web in the spaces between the elongated teeth to obtain such a mask. This bears out the theory that the Libellulinae are an offshoot of a Corduline stem."

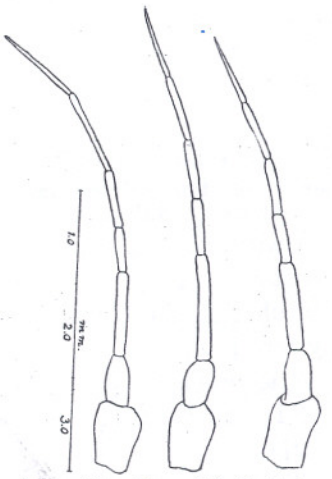


Fig. 23. *Epophthalmia* spp. Antennae in ultimate larval instar of *vittata* (Calcutta), *vittigera* (Deli, Sum.), and *elegans* (Fo Kien, China).

Just the reverse, I believe the peculiar transformation of the mask during ontogeny rather points to a recently adapted, very capricious and p r o p e r specialization.

Epophthalmia vittata sundana LIEFT. (textfig. 24—27).

T h e e g g. — As already stated on p. 63 of this paper the eggs are deposited in the common Libellulid manner, viz. by dropping them freely into the water during flight, merely by striking the tip of the abdomen from time to time against the water's surface. *Epophthalmia* thus practises e x o p h y t i c oviposition. It is a well-known fact that this method of oviposition is closely correlated with the shape of the egg, this always being of a more or less rounded form. However, in certain Libelluline genera ovipositing in the same way, the eggs are distinctly elongate, in the Trameine genus

Zyxomma for instance even more so than in many zygopterous dragonflies practising endophytic oviposition. In *Epophthalmia* the eggs are also strongly ovate and it is very difficult to say whether the elongate form of the eggs may be considered as a remains of earlier conditions or is the result of high specialization.

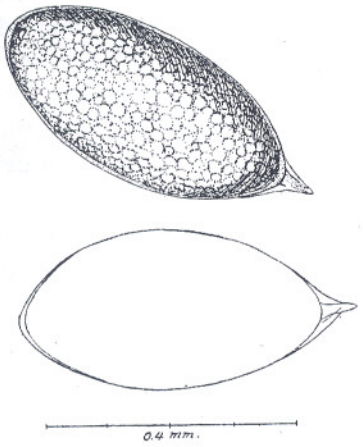


Fig. 24. *E. vittata sundana* LIEFTINCK. Eggs, about 24 hours after oviposition (alive), laid in captivity, Buitenzorg.

In my papers on the life-history of *Procordulia* and *Zyxomma petiolatum* I hope to come back on the subject.

The egg is extraordinary small for such large an insect, 470—500 μ long, 240—250 μ broad, light yellowish in colour, strongly pedicelled, and almost devoid of a gelatinous shelter when freshly deposited. After about 48 hours this protecting layer had become much swollen and each egg was now tightly fastened on to the substratum (vide p. 63). This was cut to several pieces, each of them being placed in small petri-dishes filled with water and a small quantity of green algae, and finally kept in the laboratory. All eggs hatched successfully between October 13 and 15, the time of incubation thus being very short, only ten days.

The prolarva was not observed.

First larval instar (fig. 25—27).

The young specimens were removed from the egg dish and placed separately in other petri-dishes, which were kept in a shaded part of the laboratory in front of an open window, and were exposed for half an hour each day to the sunlight.

No food was given during the first instar, because plenty of Protozoa and Rotatoria were involuntarily present of their own accord amidst plots of algae, small pieces of wood, etc. Several specimens died and many of them disappeared by some unknown means from the covered dish in which they were kept. On Nov. 7 only three in all were still living, but apparently in good condition. A few

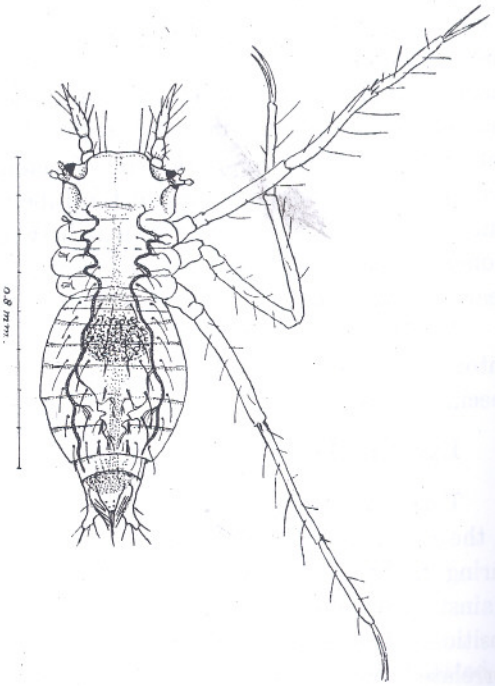


Fig. 25. *E. vittata sundana* LIEFTINCK. First larval instar, dorsal view, few minutes after hatching (alive), Buitenzorg.

days later, on Nov. 11, two exuviae of the first instar were found but the moulted specimens were not discovered, and again shortly afterwards the remaining larvae were absent altogether. Thus the second larval instar was not observed at all and the experiment found an unfortunate and early ending.

Apart from its sluggishness and its minute size, the young larva is greatly distinguished by its very effective means of protection.

From each side of the upper part of the head a strongly projecting outgrowth of the vertex can be easily observed, which, on its slightly branched apex bears two greatly modified setae. These setae are thick and short, and are divided into numerous rather closed spines. Moreover, each of the thoracic pleurae is provided with a single divided seta which strongly reminds the needled and adhesive fruits of Bidens; rather similar complex setae arise also from the dorsum of abdominal segments 8—9.

The significance of these peculiar modifications of the body-wall is easily understood when observing the young *Epophthalmia* larva *in situ*. Soon after emergence the little creatures hide themselves among tufts of water-weed and algae, involuntarily picking up all kinds of small particles which gradually become attached to the spinulose setae of the body, covering its whole surface in such a manner as to render the insects very inconspicuous. It was found rather difficult to clean the older nymphs entirely in order to make satisfactory drawings of them, and therefore only just emerged specimens could be used.

The following is a brief description of the first larval instar, drawn up from three living specimens. No attempts have been made to deal with internal structures, as the material available was too limited for such purposes.

The newly hatched larva is an extremely small, very sluggish, hyaline creature with enormously prolonged legs which are spread almost straight out when slowly wandering about on the bottom of its domain.

When looked at from aside, the body appears somewhat curved, the head being distinctly upturned so that the frontal part of it and the labium are turned towards the observer. The apex of the abdomen is very movable, and can be freely retracted or telescoped within the preceding segments.

The head is large, more than 1½ times as wide as long, almost rectangular in shape. Eyes widely distant, slightly projecting in front and situated at the anterior edge of the head. Epicranium very distinct, strongly elevated and well-separated laterally from the postocular lobes; on each lateral margin this part of the head bears a strongly projecting off-shoot, directed vertically upwards and divided apically into two short side-branches which, themselves, are provided with an apparently movable, somewhat brush-shaped seta of very singular appearance (fig. 26).

Labium. — Mentum rectangular, very weak, not projecting in front, reaching as far back as end of prosternum, about 0.2 mm broad at base, 0.28 at apex, with its apical margin nearly straight. Setae absent. Lateral lobes subtriangular, their exterior border strongly curved and the mesal margin with six large and pointed teeth, the interspaces being broadly rounded. First crenation from the outside divided. Movable hook short and rather stout. Lateral setae distinct, 1.1 in three specimens examined, situated well beyond the middle of the margin (fig. 27).

Fig. 26. *E. vittata sundana* LIEFTINCK. Dorsal view of left lateral portion of head, in a newly hatched larva, showing branched frontal process, eyes, and base of antennae. Below, a divided seta of metanotum in the same specimen (drawn to scale). Buitenzorg.

Thorax robust, almost square, very slightly broader than head, the segments of subequal length. Each of the thoracic segments possesses at dorsum, on the pleurae, a single short, somewhat cupula-shaped seta, which is strongly hollowed at apex, its margin being so deeply indented as to form a ring of sharp spines (fig. 26a). Only one pair of simple setae on dorsum of separate segments. Legs excessively long and slender, the hinder leg being much longer than the body, measuring about 1.1 mm.

Abdomen short and weak, longer than head and thorax taken together, widest in the middle. First three segments very short, seventh to ninth longest, tenth shorter and sometimes wholly retracted within the foregoing segment. Dorsum of segm. 2—9 with three pair of long setae, the median two increasing in thickness and decreasing in length from before backwards. On 6—7 these setae are spine-like, on 8—9 each is broadened towards the end but shorter and, besides, are distinctly forked at tip. Segm. 10 only with two small median forked setae on dorsum.

Fig. 27. *E. vittata sundana* LIEFTINCK. Interior view of left lateral lobe of labium, in a newly hatched larva, showing lateral seta, apical teeth, and movable hook. Buitenzorg.

Anal appendages and rectal valves of large size when wholly stretched, very retractile. Appendix dorsalis elongated triangular with apex abruptly truncated, bearing two setae of equal length. Cerci at first straight, then strongly curved outwards, much projecting beyond appendix dorsalis. Anal appendages, excepted anal valves, with long setae.

Total length of living specimen	0.9 — 1.0 mm.
Width of the head	0.3
Length of abdomen, incl. apps.	< 0.6
Greatest width of the same	< 0.4

Epophthalmia vittigera (RAMB.) (textfig. 23b, 28—29).

Material studied: — 1 larva ult, in alcohol, labelled: Deli, Sumatra, W. BURCHARD leg., ded. 12.X.1895, in Mus. Hamburg. — 2 exuviae, Java occ., lake near Koeripan, west of Depok, 150 m, between Batavia and Buitenzorg, 20.VII.1930, leg. Miss TERA VAN BENTHEM JUTTING, in Mus. Buitenzorg.

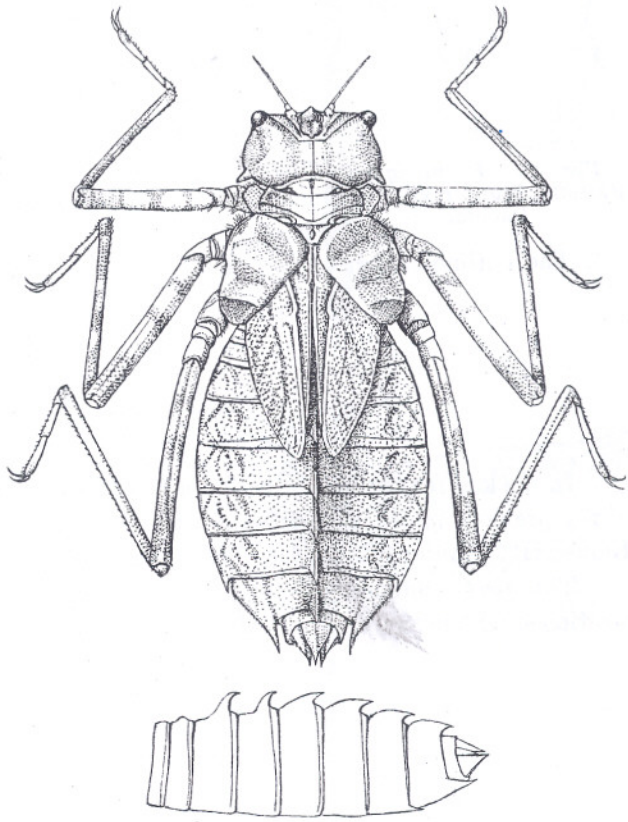


Fig. 28. *E. vittigera* RAMBUR, ultimate larval instar, Deli, Sumatra (Mus. Hamburg). Below left lateral view of abdomen, showing dorsal hooks.

The comparative description is from the single alcoholic Sumatran larva and from the two exuviae collected at lake Koeripan. The skins were found attached to a dead tree-stump fallen into the water on shore, about one foot above the water's surface. I have no specimens of this species taken emerging and not a single *Epophthalmia* was observed by us at the time of picking up the exuviae, but I am almost sure that they belong to *vittigera* as this species was found near Depok. In addition, their very striking resemblance to the nymph from Deli, in N. E. Sumatra, which no doubt is a true *vittigera*, strengthens this opinion, the more so since the shape of the head as well as the ratio of length of the antennal joints are exactly identical in our material. In spite of all that, the smaller species *vittata sundana* may also occur in the same place, but I suspect its larva will turn out to be rather different.

Both rather thin-skinned exuviae are evenly covered with a layer of rusty-coloured loam, wholly making disappear the original design of the body.

Like most of the others certainly a mud-dwelling species.

While this paper is in process of publication there comes to hand a copy of Dr. JAMES G. NEEDHAM's recent book "A Manual of the Dragonflies of China; a Monographic Study of the Chinese Odonata", Zoologia Sinica, Ser. A. Invertebrates of China, Vol. 11, fasc. 1, 344 + 11 pp., twenty plates, issued by the Fan Memorial Institute of Biology, Peiping, China, October 1930.

Fig. 29. *E. vittigera* RAMBUR, interior view of labium.

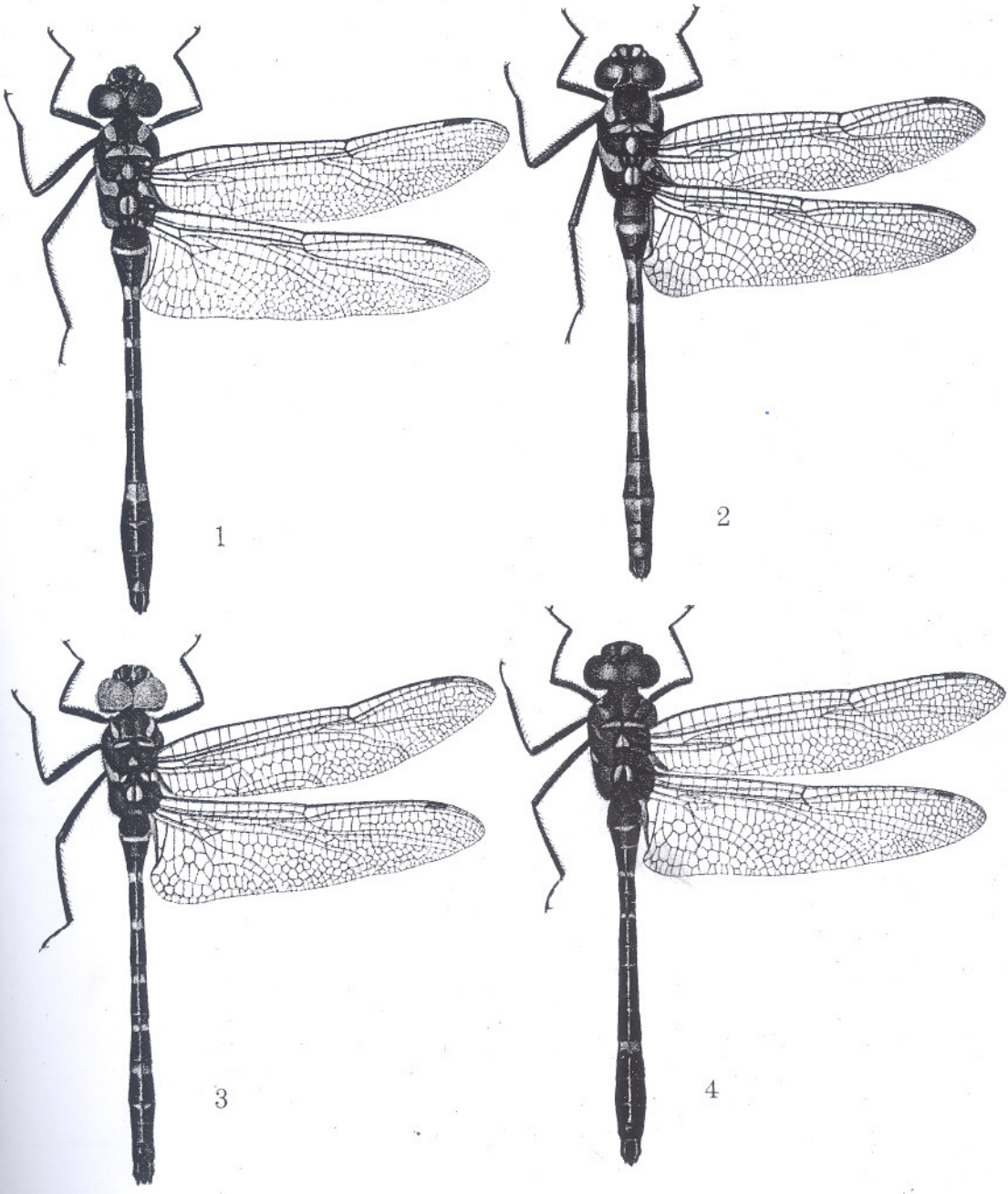
This book contains, on pages 108 and 109, a short description of both imago and larva of *Epophthalmia elegans* BRAUER (sub *Azuma* NEEDHAM), the larva being figured on Pl. XI fig. 5 (insect) and 5a (labium).

It may be noted here that the description of the larva, drawn up from a specimen taken near Nanking, does not appear to be very careful, as is the case with numerous other species discussed in this book, the notes on the labium of *elegans* being in fact wholly incomprehensible, and do not apply to *Epophthalmia* at all. The outline-sketch of the larva of this insect is rather caricatural.

ERRATUM.

In the key for the identification of oriental *Protoneurinae*, as given on p. 150 of my previous paper "Contributions to the Dragonfly-Fauna of the Dutch East Indies, II", *Treubia*, 12, 2, Oct. 1930, the following correction should be made:—

The *first* sentences of lines 7 and 9 from the bottom, relative to the position of the nervure *Ac*, should be *transposed*.



G. Abdoelkadir pinx.

EPOPHTHALMIA (Males).

Fig. 1. — *Epophthalmia elegans* Br., *subspec.?* (Formosa); 2. — *E. frontalis* Selys, type („Malaisie"); 3. — *E. vittata sundana* subsp. nov., type (Java); 4. — *E. autralis* Hagen, type (Celebes).

All natural size.