

THE DRAGONFLIES (ODONATA) OF BURMA AND LOWER
SIAM—III.¹ SUBFAMILY AESCHNINAE.

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INTRODUCTION.

The preceding paper of this series was published so long ago as 1907. Following Mr. E. B. Williamson's kind suggestion, I propose to attempt to carry on in this and in subsequent parts the faunistic survey commenced by himself. In the first place I must express my regret that he should be unable to complete the work so admirably begun, and my appreciation of my own inadequacy to continue the series at the high level at which it started. I shall endeavor to follow the general plan of his two papers, and I have to thank him and likewise the authorities of the United States National Museum for the opportunity of dealing with the large and important collections on which this account is based.

The material available consists of: 1, Several thousands of specimens collected by Mr. R. A. Earnshaw in the Karenni and Toungu districts of Burma, the property of Mr. Williamson; 2, the collection made by Dr. W. L. Abbott in lower Siam, presented by him to the United States National Museum.

These rich stores have been supplemented by other smaller collections, the property of Mr. Williamson. These are, 1, a small collection from Candelay, Ceylon; 2, material from central India (Mhow), the northwest Provinces (Lucknow and Meerut), Burma (Rangoon), collected by Brunetti; 3, a few specimens from Penang; 4, a small collection from various localities in Annam and Tonkin; and lastly 5, three specimens from the southern part of the Celebes.

I am able to supplement the information obtainable from these sources by the fact that I have had access to the collections of the Calcutta Museum, to those of the Sarawak Museum, and to collections

¹ The first and second parts of the series, both by Mr. E. B. Williamson, are as follows:

The Dragonflies (Odonata) of Burma and Lower Siam.

I. Subfamily Calopteryginae, Proc. U. S. Nat. Mus., vol. 28, pp. 165-187, published Apr. 22 1905.

II. Subfamilies Cordulegasterinae, Chlorogomphinae, and Gomphinae, Proc. U. S. Nat. Mus., vol. 33, pp. 267-317, published Dec. 13, 1907.

made partly by myself, from the Malay Peninsula. With these last collections I have dealt or am dealing, in papers referred to where necessary in the sequel.

Mr. Williamson did not confine his survey entirely to Burma and lower Siam in dealing with the Calopteryginae and Gomphinae, but increased the value of his notes by including in them remarks on other oriental species; in this I hope to follow him. But though it is evident that I have at my disposal for study a very considerable amount of material, it will be evident equally that very much remains to be done before it becomes possible to assume that our knowledge of the occurrence and distribution of species constituting the oriental dragonfly fauna is in any degree exact.

A word as to the extension of this fauna will not be out of place. I regard it as occupying the following areas: The whole of British India, including Ceylon, but excluding Kashmir and Baluchistan; China south of the Yang-tze-Kiang; the whole of Indo-China; the Malay Peninsula and the Malay Islands as far as Flores; the Philippine Islands, the Celebes; Hainan, Formosa, and South Japan. In Flores and in the Celebes the oriental fauna meets and mingles with the Papuan; in China and South Japan with the Palaearctic.

NOTES ON RELATIONSHIP OF GENERA.

The present part deals with a subfamily, the Aeschninae, remarkable for the large size and superb powers of flight of many of its members. The group is a dominant one, and like most dominant groups it presents special difficulties to the systematist.

The arrangement of genera here employed is largely identical with that elaborated by Walker (1912) in his Monograph of the North American Species of the genus *Aeschna*. His table of genera is probably the best that can be constructed on our present acquaintance with the group, and any departures made therefrom in this paper are due to differences of opinion on matters of small importance.

But the table can not be regarded as a satisfactory phylogenetic system. For this we must wait for the accumulation of much knowledge, morphological, developmental, palaeontological that is not now in our possession; and the present arrangement of the genera must be taken as a grouping according to the level of development to which they have severally attained; mainly in respect to the specialization of venation, rather than as an indication of lines of descent.

As exemplifying the difficulties which beset the study of the phylogeny of the subfamily I instance here the "dentigerous plate" of the female.

This structure, a specialization of the sternite of the tenth abdominal segment of the female, is characteristic of the Aeschninae, and is not paralleled in any other Odonates. The specialization enables

the sternite to be used as accessory organ of oviposition, called for convenience the "dentigerous plate." It is found in a relatively undifferentiated and presumably primitive condition in such genera as *Anax* and *Aeschna*, and attains its highest development in *Gynacantha* where it has become a remarkable forklike structure, the two prongs of the fork having a length in most species of somewhere about 1 mm. Now, *Periaeschna*, a genus belonging to the Brachytron series, has its dentigerous plate almost identical with that of *Gynacantha*; not, it is true, quite so highly developed but still showing an identical plan. And further, in *Cephalaeschna*, also a member of the Brachytron series, we find a still less developed type of the same structure, again designed on the same ground plan.

So, were we to use this character as our sole criterion of relationship, we should be justified in regarding the three genera *Cephalaeschna*, *Periaeschna*, and *Gynacantha*, as representing stages of specialization along a single line of descent; and we could reasonably argue that *Gynacantha* had arisen from a different stock to that which has given rise to *Aeschna* and *Anax* and to their more immediate allies.

But this would of course imply that *Gynacantha* on the one hand, and *Aeschna* (and *Anax*) on the other, had developed independently an almost identical system of venation. In any case we are confronted with a dilemma from which I can see no way of escape.

Either *Periaeschna* and *Gynacantha* have developed independently an almost identical dentigerous plate, or *Gynacantha* and *Aeschna* have evolved an almost identical system of venation by convergence.

It is evident that some other character or combination of characters must be utilized to provide sufficient evidence. Such may be found ultimately in the genital structures of the male, in larval characters, or elsewhere. The necessary material, time, and knowledge are, I regret, not available for me.

EXPLANATION.

In the following account of the oriental genera I employ the Comstock-Needham nomenclature for the venation. Mr. Williamson's diagrammatic figure of the wing of a dragonfly of the family Aeschnidae published in the second paper of this series (p. 270, figs. 1-3) is a sufficient guide to the terms employed in the present account.

It will be noticed that the number of specimens of Aeschnines in the collections before me is remarkably small, when compared with the great numbers of Libellulinae and Coenagrioninae. Further no examples of the Brachytron group are included, so I am compelled to deal in a very general fashion with those genera, and to make my account of the subfamily a sketch of the oriental members thereof, rather than a full or critical account of the species. regret, I this

especially because it is evident that the genera of the *Brachytron* series requires careful revision, as does the synonymy of some of the species.

DISTRIBUTION.

The accompanying diagram will, I hope, serve to show at a glance the distribution of some of the more characteristic forms. If it be compared with a map showing the average yearly rainfall it will at once be evident that many of the genera seem to be especially dependent on a very copious rainfall for their existence. With this is perhaps to be correlated an observation I made whilst in the Malay Peninsula; that some of these insects seem to select for breeding

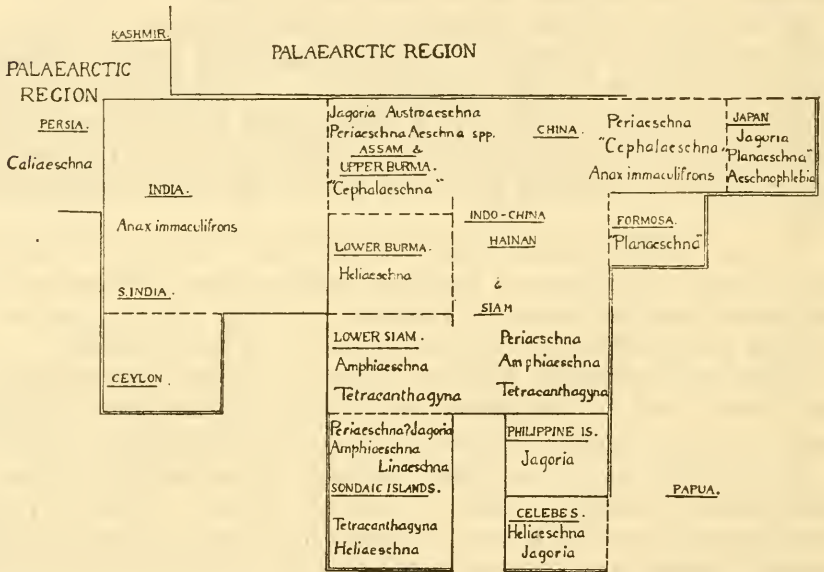


FIG. 1.—IN THE ABOVE DIAGRAM THE BOUNDARIES OF A REGION ARE MARKED BY A DOUBLE LINE. THE DEGREE OF DIFFERENTIATION BETWEEN AREAS WITHIN THE REGION IS INDICATED BY A SINGLE LINE OR BY A DOTTED LINE, ACCORDING TO THE CLEARNESS OF DISTINCTION OR OTHERWISE. SIMILARLY, THE BOUNDARIES OF THE REGION, WHERE THESE ARE NOT CLEARLY DEFINED, ARE MARKED BY A SINGLE LINE OR BY A DOTTED LINE. ONLY THE MOST CHARACTERISTIC GENERA ARE ENTERED.

purposes quite small pools, one might almost call them puddles, which are only kept supplied with water by rain. Nor are dragonflies by any means the only creatures which lay their eggs in such exiguous nurseries. I remember more than once finding frog-spawn in depressions little larger than a foot print, hopelessly desiccated with a few hours of sunshine.

CHARACTERIZATION OF THE SUBFAMILY AESCHNINAE.

Triangles of fore and hinder wing approximately equal, longitudinally elongated; subtriangles weak or absent. Radial and median supplements present. Two reinforced antenodal costal cross-nerves.

Eyes usually in contact mid-dorsally for a long distance. Labium with median lobe slightly incised, or with a longitudinal depression. Female with complete ovipositor.

Larva with elongated abdomen; mask flat, without setae (except in *Gynacantha*); lateral lobes narrow with apex of variable form; long movable hook.

Gizzard with four radially symmetrical fields carrying a few large, specialized teeth. Respiration effected by rectal gills of the duplex form. (Tillyard).

KEY TO THE ORIENTAL GENERA OF THE SUBFAMILY AESCHNINAE.

1. Radial supplement straight, separated from radial sector or its lower branch by a single row (usually) of cells only. Median supplement similarly placed with regard to M_4 . (Larva with processus dorsalis usually pointed, not bifid at the apex).....BRACHYTRON (group) 2
- Radial supplement curved concavely to radial sector, with three or more rows of cells between. Median supplement similarly arranged with respect to M_4 . Radial sector unforked, or unsymmetrically forked. (Larvae with processus dorsalis bifid at apex).....(AESCHNA group) 6
2. Radial sector not forked, M_2 with marked convexity anteriorly, just proximal to pterostigma. Lower appendage strongly bifid.....3
- Radial sector symmetrically forked; its branches nearly straight.
(BRACHYTRON series) 4
3. Venation open. Space between median supplement and M_4 with maximum breadth of two cells below the nodus for a length of two cells only...Jagoria.
- Venation dense. Space between median supplement and M_4 with two rows of cells, from before level of nodus to end of wing.....Linaeschna.
4. Median space without cross nerves.....Austroaeschna-Planaeschna.
- Median space with cross nerves.....5
5. Dentigerous plate of female simple or armed with two short spines
"Cephalaeschna" (Caliaeschna).
- Dentigerous plate of female armed with a pair of long decurved spines
Periaeschna.
6. Cells between R_s and R_{spl} arranged in very regular oblique rows. Anal angle of male hinder wing rounded, R_s unforked. M_2 with marked convexity forward under the pterostigma. Accessory longitudinal carinae on segments 3-8 of abdomen. Dentigerous plate simple..... (ANAX series) Anax.
- Cells between R_s and R_{spl} irregularly arranged. Anal angle of male hinder wing pronounced. R_s forked usually distal to pterostigma. Dentigerous plate of female simple or armed with four or more spines. Diurnal forms.
(AESCHNA series) 7
- Cells between R_s and R_{spl} irregularly arranged. R_s forked proximal to pterostigma. Anal angle of male pronounced.
Crepuscular forms. Dentigerous plate of female armed with a pair of long decurved spines..... (GYNACANTHA series) Gynacantha.
7. M_2 with convexity forward below pterostigma. Abdomen with traces of accessory lateral carinae on segments 4-7..... Anaciaeschna.
- M_2 without marked convexity forward. Abdomen without accessory lateral carinae..... 8
8. Dentigerous plate of female simple, armed only with small spines, usually not regularly arranged..... 9
- Dentigerous plate of female with four or more large spines, the median pair being larger than the others. Wings rather sharply pointed.....10

9. Median space with cross nerves. Arculus much angled..... **Amphiaeschna**.
 Median space without cross nerves..... **Aeschna**.
 10. Median space with cross nerves. Size moderate..... **Heliaeschna**.
 Median space free. Size very large..... **Tetracanthagyna**.

These genera may be grouped as follows:

BRACHYTRON GROUP.	AESCHNA GROUP.						
<i>Jagoria</i> .	<i>Anax</i> series: <i>Anax</i> .						
<i>Linaeschna</i> .	<table border="0"> <tr> <td rowspan="5" style="vertical-align: middle;"> <i>Aeschna</i> series..... </td> <td><i>Anaciaeschna</i>.</td> </tr> <tr> <td><i>Amphiaeschna</i>.</td> </tr> <tr> <td><i>Aeschna</i>.</td> </tr> <tr> <td><i>Heliaeschna</i>.</td> </tr> <tr> <td><i>Tetracanthagyna</i>.</td> </tr> </table>	<i>Aeschna</i> series.....	<i>Anaciaeschna</i> .	<i>Amphiaeschna</i> .	<i>Aeschna</i> .	<i>Heliaeschna</i> .	<i>Tetracanthagyna</i> .
<i>Aeschna</i> series.....			<i>Anaciaeschna</i> .				
			<i>Amphiaeschna</i> .				
			<i>Aeschna</i> .				
			<i>Heliaeschna</i> .				
	<i>Tetracanthagyna</i> .						
{ <i>Caliaeschna</i> ?							
{ <i>Cephaloeschna</i> .							
{ <i>Periaeschna</i> .							
{ <i>Planaeschna</i> ?							
{ <i>Austroaeschna</i> .	<i>Gynacantha</i> series: <i>Gynacantha</i> .						

I do not use the term *Boyeria* series for *Jagoria* and *Linaeschna*, because it seems to me that such a series does not exist, i. e., that the various genera with unforked radial sector and straight supplements can not all be referred to a single series. On the other hand I think a good case can be made out for a *Brachytron* series, as it would appear that all the genera here referred to that series and others that are nonregional are closely related to the typical genus *Brachytron*.

The suppression of the genus *Hemianax* is dependent on the amount of importance one attaches to the characters which separate *Hemianax ephippiger* from the species of *Anax*. Personally I think them of not more than specific value.

The inclusion of *Anaciaeschna* in the *Aeschna* series rather than with *Anax* is again a matter of opinion and of convenience. The genus is decidedly annectant.

Lastly in transferring *Heliaeschna* and *Tetracanthagyna* from the *Gynacantha* series to the *Aeschna* series I have been guided largely by the extreme differentiation in the genus *Gynacantha* of the dentigerous plate. That of *Heliaeschna*, so far as I know it, and of *Tetracanthagyna* seems to me to stand nearer to *Aeschna*. There is of course nothing decisive in the venation.

NOTES ON LARVAE.

The characterization of the main groups in the above table is largely drawn from Tillyard's *Biology of Dragonflies*.² Since writing it and the preceding part of this paper I have been able to secure some additional information on one or two points of interest. This had been derived in part from an examination of larvae of two species of *Cephaloeschna* (?) from the Himalaya, identified by examination of the venation, and from larvae of *Aeschna ornithocephala* MacLachlan from the same part of the world.

²The *Biology of Dragonflies*. Cambridge University Press, 1917, Cambridge, Eng.

The first two species are quite distinct from each other, both belong undoubtedly to the *Brachytron* series, and they are probably not congeneric. For convenience sake only I refer both to *Cephalaeschna*.

One of these "*Cephalaeschna*," which is represented by some 4 specimens, all probably in the last or penultimate instar, has the appendix dorsalis very definitely bifid, ending in a pair of pointed processes, whilst in the other species, of which I have also several examples, the same structure is simple.

I was fortunate enough to be able to mount a wing of the former species which showed very clearly the details of the tracheation. A very interesting point distinctly shown in this specimen is that the fork of Rs is not preceded by a fork in its tracheal precursor.

The trachea, however, give off on its anal side several (four or five) small but well-marked branches, which run to the anal margin of the wing. From each of these a fine twig is given off nearly at right angles to it; these twigs together form a line of delicate tracheation running parallel to the main trunk of Rs, and along their course the chitinous supplement (Rspl) is laid down. A precisely similar condition obtains with regard to M_4 and its supplement in this wing.

In the case of the larva of the second species of "*Cephalaeschna*" I have not been able to make out anything of the tracheation.

Turning now to the larva of *Aeschna ornithocephala*, a specimen in the last instar fortunately showed the tracheation with beautiful clearness. I was surprised to find in this specimen that both M_4 and Rs each give off a strong branch, practically a fork near the level of the beginning of their respective supplements, and that this fork follows the course taken by the supplement in either case; giving off in addition three or four branches to the hinder margin of the wing, whilst the anterior branch of the fork after running toward the apex of the wing turns analward at the level of the small imaginal "fork" without giving off any branch of importance. So that in this form, and presumably in other *Aeschnas* the median and radial "supplements" should be termed rather the median and radial branches. Tillyard's figure (p. 44, fig. 17-A-B) of the tracheation of *Aeschna brevistyla* in the *Biology of Dragonflies* shows the forking of M_4 but he does not figure enough of the wing to show the fork of Rs.

Lastly, in *Anax* the tracheation has been in part figured by Needham in his *Genealogic Study*. He shows there in a beautiful microphotograph of the larval wing of *Anax junius* Drury, that the median supplement is formed as in "*Cephalaeschna*" species along a line of secondary tracheal twigs derived from branches of M_4 ; and the radial supplement is formed in a similar manner, as I have been able to satisfy myself by an examination of larva of *Anax ephippiger*.

These observations explain the presence of an oblique vein near the commencement of the radial supplement in *Aeschna* (and presumably in *Gynacantha* and in other genera), this oblique vein following the lower branch of the fork of tracheal Rs. And similarly in the case of the median supplement.

They also explain why it is that in *Anax* there are several oblique veins in the area between Rs and Rspl, these veins representing the several regularly arranged branches of tracheal Rs (or again of M₄).

But whether *Aeschna* or *Anax* shows the more primitive arrangement of the tracheae I can not determine. In this connection Needham's remarks in his Genealogic Study deserve careful consideration.

Genus JAGORIA Karsch.

Up to the present unrecorded from Burma or Siam. Species are known from Sumatra, Borneo, the Malay Peninsula, the Philippine Islands, the Celebes, and from Japan; whilst an unpublished form occurs also near Darjiling, represented in the collection of the Indian Museum by a female specimen taken at an altitude of 2,140 meters (7,000 feet).

Jagoria seems to have as its nearest ally the American *Gomphaeschna*. *Linaeschna* from Borneo, with these two genera forms a small group of forms of a primitive appearance, which stand rather far apart from other genera of the Brachytron series.

The genus is remarkable for the strongly bifid interior anal appendage of the male, a feature shared by *Gomphaeschna* and *Linaeschna* and otherwise found amongst *Aeschninae* only in the primitive *Petalia* alliance. Another interesting character is that afforded by the lateral dilatation of the abdomen of the female, which, beginning at the distal end of the third segment, reaches its maximum at the fifth and disappears at the apex of the sixth segment, giving the abdomen a curious quasi-archaic appearance.

JAGORIA POECILOPTERA Karsch.

The type of the genus is *Jagoria poeciloptera* Karsch, from Luzon. (The male recorded under this name by Karsch from Singapore is probably rather an example of the next species *Jagoria modigliani*.) This is a species of small size; Martin notes the length of the hinder wing as being 45-37 mm. The pterostigma is said by the same writer to be short and narrow, and the wings of the female are marked with bright saffron color at their bases.

JAGONIA MODIGLIANI de Selys.

Jagonia modigliani de Selys, the best known species occurs in the Malay Peninsula, Borneo, and Sumatra. It is larger than the preceding; a female before me has the hinder wings 43 mm. in length, the pterostigma is 3.75 mm. and of a reddish-brown color. The whole

wing except the median space and the anal area is tinged with bright orange-brown; a teneral female, however, has the wing apices colorless. The male is said to have the wings uniformly of a yellow hue. The supratrangular space is crossed by a single nerve. Ris regards Needham's *Doloeschna elacatura* as synonymous with the present species.

JAGORIA VENATRIX Foerster and JAGORIA BÜHRI Foerster.

Two other species have been described by Foerster; *venatrix* from Buton, an island of the Celebes group, of about the same size as *modigliani*. The male only is known; and *bühri* from north Borneo closely allied to *poeciloptera*, but a trifle larger. The pterostigma is said to have a length of 2.5 mm., and the wings of the female to be entirely bright brown. Both species are unknown to me.

JAGORIA PRYERI Martin.

Jagoria pryeri Martin, from Japan, has the supratrangular spaces uncrossed, the hinder wing of the male is 38 mm. long, and the pterostigma 3.5 mm. and the wings are described as being yellowish. The inferior anal appendage of the male, the only sex known, is relatively shorter and broader than in other species of the genus.

JAGORIA, species.³

Lastly, the female specimen from Darjiling has the supratrangular spaces uncrossed and the wings colorless. The length of the hinder wing is 38 mm. and of the pterostigma 3 mm.

Genus LINAESCHNA Martin.

The Bornean genus *Linaeschna*, known from a single male specimen described and figured by Martin is, I think, certainly a close ally of *Jagoria*, though whether it is to be regarded as more primitive or more specialized I am quite unable to say.

Genus AUSTROAESCHNA de Selys.

Otherwise confined to Australia this genus is represented by a species from Assam. I can not find any character of importance sufficient to separate it generically from the Australian species. This interesting creature, known as *Austroaeschna intersedens* Martin, belongs to a small group of Himalayan species which seem to have relationship to Australian forms rather than to nearer neighbors. Such are *Lestes cyanea* de Selys and *Argiolestes melanothorax* de Selys. Another Aeschnine *Planaeschna milnei* (de Selys) from Formosa and Japan is regarded by Martin as an *Austroaeschna*; I have not seen an example, but venationally it certainly comes very near *intersedens*, and may well be congeneric with it. But for the present I think

³Now published as *Jagoria martini* Laidlaw (Laidlaw, Rec. Ind. Mus., vol. 22, pt. 2, pp. 76-77).

with Ris that the genus *Planaeschna* may be retained, pending a critical revision of the *Brachytron* series as a whole.

Genus CEPHALAESCHNA de Selys.

Plate 1, fig. 1.

For lack of material and sufficiently full information it is a matter of impossibility to deal in a satisfactory manner with the species grouped as a matter of convenience in this genus. In his monograph Martin adopted the course of suppressing the genus altogether, and referred a number of species to the Palaearctic genus *Caliaeschna* de Selys. He had been anticipated in this to a certain degree by Foerster who in 1908 described a Malayan species, belonging to the *Brachytron* series as *Caliaeschna laidlawi*. I prefer to regard *Caliaeschna* as a monotypic genus probably confined to Asia Minor, Persia, and neighboring countries, and to leave some at least of the other oriental members of the series in the Selysian genus.

But I admit this is merely the expression of an opinion which has not much substantial backing behind it and I believe that it is very likely that those members of the series here referred to *Cephalaeschna* may in future be found to stand in two or possibly even more genera.

The genus *Cephalaeschna* was defined by de Selys (1883) in his Synopsis, and accepted by Karsch (1891) in the Kritik. Karsch moreover added a second species to the genus, *Cephalaeschna sikkima*, the type being *Cephalaeschna orbifrons* de Selys.

C. orbifrons has a simple dentigerous plate in the female; that of *sikkima* is said to be armed with a pair of pointed spinelike processes. In this respect *acutifrons* Martin resembles *orbifrons*. I have before me the female of an undetermined species (probably = *Caliaeschna lugubris* Martin? = *Caliaeschna sikkima* Karsch) in which the dentigerous plate of the female is like that of *sikkima*.

Foerster's species *laidlawi*, seems to me from his description to belong rather to the next genus *Periaeschna*. Of *masoni* Martin, the female is unknown.

There is evidently considerable difference in the venation of these species. That of *acutifrons* is very dense, that of the female before me comparatively open; both have the pterostigma braced.

Cephalaeschna conspersa Tillyard has lately been assigned to a distinct genus *Dendroaeschna*, by its author.

In reviewing the genus *Cephalaeschna* I have been influenced largely by the fact that de Selys regarded its type species as generically distinct from *Caliaeschna*. The latter has an unbraced pterostigma, the interorbital suture is relatively short, and the triangles especially of the hinder wings relatively very small. Due weight should, I think, be also given to the very different characters of the areas occupied by the two genera, the arid or at least droughty regions ranging from

the Balkan Peninsula to Persia on the one hand, and the damp densely forested countries to the north and east of the Bay of Bengal on the other.

It is to be hoped that sooner or later an ample supply of material will enable some one to unravel the tangle in which these very interesting insects lie. For the present I refer to *Cephalaeschna* but only provisionally the following species: *acutifrons* Martin, *masoni* Martin, *sikkima* Karsch,⁴ *lugubris* Martin, and of course without condition *orbifrons* de Selys, all from the northeast Himalayas. *C. acutifrons* occurs also in Kwan-Tung.

LIST OF ORIENTAL SPECIES OF THE GENUS CEPHALAESCHNA.

1. *C. orbifrons* de Selys: Northeast Himalayas.
2. *C. sikkima* Karsch:⁴ Northeast Himalayas.
3. *C. acutifrons* Martin: Northeast Himalayas, Kwan-Tung.
4. *C. masoni* Martin: Northeast Himalayas.
5. *C. lugubris* Martin: Northeast Himalayas.

Genus PERIAESCHNA Martin.

Plate 1, fig. 2.

The single described species of the genus *Periaeschna magdalena* Martin is from Tonkin. The Indian Museum collection includes a pair apparently of the same species from the Garo Hills in Assam; and Ris tells me in a letter that he has a species of the genus, not necessarily conspecific, from Yunnan. For reasons given above I think that *Caliaeschna laidlawi* will probably be found also to belong to this genus.

In addition to the specialization of the dentigerous plate, *Periaeschna magdalena* has densely veined wings, and a small pterostigma with well developed brace. The male has the second abdominal segment rather inflated and the base of the third much narrowed. Its anal appendages are much like those of *Aeschna mixta* Latreille.

Genus ANAX Leach.

The Palaearctic species *Anax parthenope* de Selys has established itself in India as far south as Mysore in the peninsula. Several other species are found within the limits of the region. All of them frequent open sunny country and it is noteworthy that *ephippiger* Burmeister does not appear to have been recorded for any of the more densely forested areas, or equatorial territory, whilst it is exceedingly abundant in most parts of India, one observer saying that he has never seen such numbers of any other dragon fly in flight. This species, interesting as being partly migratory in its habits has also

⁴ Since these notes were sent to press the genus *Gynacanthaeschna* has been erected for this species by Fraser (Journ. Bombay Nat. Hist. Soc., vol. 28, June 1922, p. 618). The other species in my list are retained in *Cephalaeschna*.

a wide range over the Mediterranean countries. It has been usually referred to a genus *Hemianax* de Selys distinct from *Anax*, as it lacks the supplementary carinae on segments 4-8 of the abdomen found usually in *Anax*, and it has also a triangular lower anal appendage in the male, whilst other species of the genus have that appendage squarely truncate.

These characters are, I think, of not more than subgeneric value and I follow Tillyard in allotting the species to the main genus.

A second species is the beautifully colored *immaculifrons* Rambur which has been taken as far west as Damascus, and of which a geographical race is recorded for Hongkong by Ris. I have not been able to find any record of its capture in the Indo-Chinese Peninsula, or in the equatorial areas of the region.

The remaining oriental species of the genus are decidedly difficult to differentitate clearly, and their synonymy is obscure. The arrangement given below has been arrived at from a study of Ris's papers quoted in the sequel (Ris 1913, 1913*a*), and partly from his opinions given me in correspondence on the subject, as well as from examination of material available to me. As Ris has written me, it will at least serve as a working arrangement for the present.

ANAX GUTTATUS Rambur.

Without T-mark on frons. Thorax without black lines on sutures. Markings on abdominal segments 3-10 consist of yellowish brown spots, of which there are three on either side of the dorsum of segments 3-6. Length of abdomen of male about 55 mm., of which the third segment occupies from 8.5 to 9.5 mm. Upper anal appendages 6 mm. additional. Hinder wing 52 mm. long, pterostigma 5 mm. Range extensive, from the Seychelle Islands in the west to Samoa in the east.

I have seen specimens from India, Ceylon, the Malay Peninsula, and Borneo.

Doctor Ris remarks in a letter that the species appears to be well defined, and its characters constant.

ANAX GIBBOSULUS Rambur.

With a dark border to the anterior margin of the frons, connected by a bar of variable width to the black mark at the base of the frons. Markings on segments 3-9 of abdomen consists of small apical-lateral pale spots; in addition segments 3-5 have each a small basal lateral spot on either side.

Length of abdomen of male about 62 mm., the third abdominal segment is about 11.5 mm. long and is relatively more slender than in *A. guttatus*. The anal appendages are 6.5 mm. in length, and the hinder wing and pterostigma measurements are about 55 and 5 mm., respectively.

The precise range of the species is undetermined; it is chiefly found in the Moluccas and Papua. I have not been able to examine specimens; but Ris regards it as a monomorphic species.

Synonym.—*Anax panybeus* Hagen.

ANAX FUMOSUS Hagen.

With well-defined T-mark on frons. Thorax with black lines on the sutures. Coloring of abdomen richer than in the two preceding species, bluish-green spots on a black ground. Markings on segments 3-7 consist of paired apical and basal spots on each segment; on segments 4-6 the basal spots are transversely divided by a narrow black line into two.

Length of abdomen of male 48 mm., upper anal appendages, black in color, 6.2 mm. Third segment of abdomen 9 mm. long. Hinder wing and pterostigma 0.48 and 4 mm. in length, respectively.

I have seen specimens from the Himalayas (Coll. Indian Museum) and Japan (Brit. Mus.). The typical race is from Ternate. Doctor Ris tells me he possesses examples presumably of a form of this species from Java. He believes it to be a variable species probably with local races. The measurements given above are from an example from Darjiling. The precise range of the species is not determined.

Apparently the form described by Martin in the Monograph under the name *Anax bacchus* is really an example of *fumosus*. The true *Anax bacchus* Hagen is a synonym of *Anax parthenope* de Selys.⁵

LIST OF ORIENTAL SPECIES OF GENUS ANAX.

1. *Anax (Hemianax) ephippiger* Burmeister: India, Mediterranean countries.
2. *Anax parthenope* de Selys: India as far south as Mysore; Palaearctic.
3. *Anax immaculifrons* Rambur: Damascus, India to Hongkong.
4. *Anax guttatus* Rambur: Seychelle Islands to Papua and Samoa.
5. *Anax gibbosulus* Rambur: New Guinea, Moluccas.
6. *Anax fumosus* Hagen: North India, Japan, Celebes, Ternata.

Genus ANACIAESCHNA de Selys.⁶

Three species are included in this genus which has a wide range in the old-world tropics. Of these *Anaciaeschna jaspidea* Burmeister extends from India and Burma through Malaya and New Guinea to the Pacific. It has been recorded from Tahiti. The closely allied

⁵ A short account of the Aeschnine dragonflies of the Indian Empire has recently appeared in the Records of the Indian Museum, (vol. 22, pt. 2, no. 11).

This was written by myself before I had undertaken the present paper. In that account I have described briefly three series of specimens belonging to the genus *Anax*, as "series A, B, C" of *Anax guttatus*. I now regard "series A" as examples of the true *guttatus* of Rambur; "series C" as belonging to *fumosus* Hagen; whilst the single specimens which constituted "series B" I take to be either a form of *fumosus*, or possibly a hybrid *guttatus* and *fumosus*.

⁶ While this paper was in press Fraser (Journ. Bombay Nat. Hist. Soc., 1922, vol. 23, p. 699) has described an interesting and distinct new species from Southern Peninsular India under the name *A. donaldi*.

species, perhaps only a geographical race *Anaciaeschna megalopis* Martin, is from New Guinea, whilst the third species *Anaciaeschna triangulifera* MacLachlan, inhabits Madagascar and East Africa.

As its name implies the genus seems to link to *Anax* with *Aeschna*. Its species have traces of accessory lateral carinae on the abdominal segments 4-7, and the marked anterior curving of M_2 , immediately below the pterostigma otherwise characteristic of *Anax*, whilst the male has the anal area of the hinder wing excavated, and the radial sector is forked.

Genus AMPHIAESCHNA de Selys.

A genus containing two species confined to the more equatorial parts of the oriental region; apparently allied to *Aeschna* though somewhat primitive. As regards venation the arculus is remarkable. The lower limb of this structure is not in line with the upper limb, and shows more clearly than it does in most Aeschnines, its origin as a reinforced cross nerve. A similar condition obtains in *Coryphaeschna*, and I was at one time inclined to suspect a possible relationship between that genus and *Amphiaeschna*. However, after studying a pair of *Coryphaeschna ingens* kindly loaned to me by Mr. Williamson, I have come to the conclusion that there is no close kinship between the two genera. *Amphiaeschna* resembles *Heliaeschna* fairly closely in venation, excepting as regards the arculus,⁷ which in the latter genus is almost in a straight line. The dentigerous plates of the two genera are widely different, that of *Amphiaeschna* being rather *retrouse* armed with very small irregularly arranged spines. The species of *Amphiaeschna* are large handsomely colored insects; they inhabit thickly forested country, and probably breed in the small muddy pools that depend for their existence on a copious rainfall. I took two males of *grubaueri* in Perak about 305 meters (1,000 feet) above sea level flying about a forest pool of this kind, and with them a single male specimen of *Gomphidia perakensis* Laidlaw.

AMPHIAESCHNA GRUBAUERI Föster.

Represented in the collection before me by a single male, taken at Trang, lower Siam.

Of this species I have also seen two males from Perak caught by myself, now in the University Museum at Cambridge (England), and a single female from Mount Batu Lawi in Sarawak, Borneo.

I can find no specific differences between this species and *peramplo*, of Martin, which in my opinion must be regarded as a synonym of *grubaueri*.

⁷ Since this was written I have received a female of an undetermined species of *Heliaeschna* from the Malay Peninsula in which the arculus of the forewing resembles closely that of *Amphiaeschna*.

The hinder wing of the male is 62 mm. in length, the pterostigma is small, about 2.25 mm. long, and is well braced. The gray membrule is triangular in shape, and extends along one-third of the anal triangle. Both fore and hinder wings are tinged with rich brown at the base, the color extending as far as the first reinforced antenodal nerve in the costal space, and below this as far as the first median and submedian cross nerves. The anal area is uncolored. The upper lip, the ante and post clypeus are olive-green; the frons is dark brown, with a slightly metallic sheen near its apex. The vertex and small occiput are black.

The thorax is of a rich dark-brown color, with large yellow antehumeral bands, and two large yellow bands on either side.

The abdomen is 67 mm. long, and the upper anal appendages 6.5 mm. additional. Segments 2-6 are cylindrical, tapering a little from before backwards. The auricles are relatively small, armed with four or five large teeth. The postjugal part of 7 and the whole of 8, 9, 10 are broadened, and flattened dorsoventrally. The abdomen as a whole is dark brown, the apical segments progressively darker. The first segment is marked dorsally with lighter brown, as is the base of the second. Segments 2-6 have each an orange-yellow, apical ring, a trace of a similar ring showing on the seventh segment. The hindermost femora are long, reaching nearly the apex of the second segment. The female I have examined is teneral, the body and abdomen being crushed and broken. The length of the hinder wing is 63 mm.

In addition to the brown coloring of the wing bases, which is similar to that found in the males, all four wings have a transverse band of orange-brown extending across the wing from the nodus to the distal end of the pterostigma. Further, the base of the anal area is tinged with orange-brown.

The dentigerous plate is not unlike that of *Aeschna*, but appears to turn upward a little at its apex (possibly due to distortion). It carries a few small irregularly arranged spines. The anal appendages are short cylindrical processes.

A. grubaueri has been recorded from Malacca, Borneo, and Java.

AMPHIAESCHNA AMPLA (Rambur).

The other species of the genus, which is also the genotype, is *A. ampla* (Rambur). It is somewhat smaller than *grubaueri*, the length of the hinder wing being about 56 mm.

The males have brown markings at the bases of the wings, but are without yellow markings on the abdomen; whilst the upper anal appendages are without basal, ventral projection found in those of *grubaueri*.

The female has, in addition to the brown of the wing base, a light-brown transverse bar across the forewing between the nodus and

ptero stigma. The anal appendages are said to be very long, shaped like laurel leaves. The species occurs in Tonkin and Java; and will doubtlessly be found in intermediate territory.

Genus **HELIAESCHNA** de Selys.

Plate 1, fig. 3.

Six species of the genus are oriental and three Ethiopian. Förster has proposed to create a distinct genus for the Asiatic species with the name *Malayaeschna*. His reasons are that the latter have a longer triangle and wings more pointed relatively than the African species; and that whilst *Malayaeschna* has a four-toothed (or six-toothed) dentigerous plate the African *Heliaeschnas* have a two-pronged plate. It is worth remark that De Selys in his generic definition describes the dentigerous plate of *fuliginosa*, the genotype, in identical terms with that of *Gynacantha*.

The venational characters do not seem to be of much weight, and as the female of several of the species is unknown I do not here adopt Förster's genus, though I think it quite likely that his suggestion will prove ultimately to be well advised. The species of this genus appear to bear a fairly close resemblance to those of *Gynacantha*, and there is some justification for regarding them as representing an ancestral form of the latter genus. We may count the cross veins of the median space as a primitive character, and it is quite reasonable to see in the dentigerous plate a type of structure from which the highly specialized *Gynacantha* fork may have arisen. But the problem of *Periaeschna* must not be forgotten in this connection.

Another characteristic is the absence of the brace to the pterostigma in some of the species at any rate (*idae*, *fuliginosa*) whilst in *uninervulata* it is usually present.

Of the six species recorded from Asia, two *H. gladiostyla* Martin and *H. filostyla* Martin are from the Celebes. They are both unknown to me, but seem related to *H. idae* Brauer and to *H. crassa* Kruger from Borneo. Of these two latter the first is somewhat the larger, and has the hinder wing 54 mm. long and the abdomen 55 or 56 mm. in length, whilst *crassa* has measurements for the same structures, 50 mm. and 50 mm., respectively. The female of *idae* has a brown stripe occupying the subcostal space and running from the base of the forewing to the nodus, whilst a transverse band of lighter brown extends across the wing between the nodus and pterostigma. The hinder wing has only a dark basal mark in the costal and subcostal spaces extending to the level of the arculus.

These four species, of which I have seen *idae* only, seem to be related to each other in possessing rather pointed wings, and in the shape of the upper anal appendages of the male, these latter being in each case very long and slender (in *idae* they are 7.5 mm. long)

and at least three times as long as the lower appendage. The Bornean species *simplicia* Karsch has the upper anal appendages straight, flattened dorsoventrally, and shaped like a hunting knife. The length of the hinder wing is about 45 mm.

Lastly, *uninervulata* Martin, recorded from Borneo, Engano (Sumatra), and now from Burma, is distinguished from the other Asiatic species by its more rounded wings, by the single cross nerve in the median space, and by the upper anal appendages of the male, which resemble those of the African species *weelei* Martin, being broad and bladelikey with semicircular infolding of the inner margin and out-curved apex.

HELIAESCHNA UNINERVULATA Martin.

One male (in poor condition) Burma. R. A. Earnshaw, collector; collection E. B. Williamson.

The pterostigma is small, and in this specimen well braced. Martin's photograph (of a female) shows the pterostigma of the hinder wing unbraced.

The coloring of the specimen is entirely faded, and the abdomen in fragments.

Length of hinder wing 41 mm., of pterostigma 2.5 mm.

LIST OF ORIENTAL SPECIES OF THE GENUS HELIAESCHNA.

1. *H. gladiostyla* Martin: The Celebes.
2. *H. filostyla* Martin: The Celebes.
3. *H. idae* Brauer: Borneo.
4. *H. crassa* Kruger: Borneo.
5. *H. simplica* Karsch: Borneo.
6. *H. uninervulata* Martin: Borneo, Engano (Sumatra), Burma.

Genus TETRACANTHAGYNA de Selys.

Plate 1, fig. 4

The species comprised in this genus, probably the largest and bulkiest of all living dragonflies, seem to be a luxuriant development of the same stock as that from which *Heliaeschna* is derived. Not only is there a close similarity between the dentigerous plates of the two genera, but there is also a general resemblance in the venation, and both have at least in certain cases an unbraced pterostigma. The venation of *Tetracanthagyna* is certainly the denser, a feature almost certainly connected in this case with great size, and acquired secondarily. The males do not show narrowing of the abdomen at the second and third segments, this is perhaps a primitive character.

No species has been recorded from Burma, but the known range of the genus includes Tonkin, the Malay Peninsula, Borneo, and Sumatra, and it has been my good fortune to capture a single example of the genus, a female of *T. brunnea* MacLachlan, in Kelantan in

the north of the peninsula, whilst I have seen a second female of the same species from the Malay State of Jalor which lies within the boundaries of lower Siam.

Five species have been named in the genus, but one of these names is probably a synonym.

The largest species, the most gigantesque of recent Odonata, is *T. plagiata* Waterhouse, recorded from Borneo, Sumatra, and the Malay Peninsula. The female may have a span of over 170 mm. The wings have a longitudinal brown costal band; and a transverse band of the same color is found, in the female only, between the nodus and pterostigma. *T. vittata* MacLachlan appears to differ only in that the wings of the female are without the transverse brown band. Doctor Ris has pointed out that it is possible that *plagiata* may have dimorphic females, *vittata* in that case becomes a synonym of *plagiata*. *T. brunnea* MacLachlan, from the Malay Peninsula and Borneo, is much smaller, with a span of rather less than 140 mm. The wings of the female are colored much as in *plagiata*, but the sides of the thorax are uniformly brown, whilst in *plagiata*, the thorax has two pale brown bands on either side. *T. degorsi* Martin, from Borneo, of about the same size as *brunnea* has a longitudinal band on the wings in both sexes, a very small yellow pterostigma, and the sides of the thorax rather greenish in hue. Lastly, *waterhousei* MacLachlan, from Borneo and Tonkin, has unbanded wings, a very small pterostigma with a black mark immediately below it, giving it rather the appearance of occupying a double row of cells; and the sides of the thorax each with two pale brown bands. The female is again of about the same size as that of *brunnea*.

The specimen of *brunnea* that I caught was fluttering about the trunk of a large forest tree. The flight did not impress me as being particularly powerful.

LIST OF ORIENTAL SPECIES OF THE GENUS TETRACANTHAGYNA

1. *T. brunnea* MacLachlan: Malay Peninsula and Borneo.
2. *T. plagiata* Waterhouse: Borneo, Sumatra, Malay Peninsula.
3. *T. degorsi* Martin: Borneo.
4. *T. waterhousei* MacLachlan: Borneo, Tonkin.

Genus AESCHNA Fabricius.

Unlike the other zoogeographical regions, with the sole exception of *Notogaea*, the oriental region is characterized by a dearth of species belonging to this genus.

Those which do occur, leaving out of account Japanese species which may in part at any rate have been derived from the Palearctic area, are found in the northeast ranges of the Himalaya and in Assam. Further it seems to me that of the three recorded species, one *petalura* Martin, is deserving of generic distinction. Not only

has the female very remarkable anal appendages, but there are well-marked venational characters, notably the short triangles, and the course of the supplements almost parallel to Rs and M₄, respectively (according to Martin's figure), which differentiate the species strongly from other *Aeschnas*.

The two remaining species do not appear to be particularly closely related to other species of *Aeschna*, nor indeed to one another, though they show one peculiarity in common. In both species the apex of the dentigerous plate of the female carries a series of regularly arranged denticles radiating from the apical margin. In the case of all the other species of the genus that I have examined the denticles are arranged irregularly and on the ventral surface.

A. erythromelas MacLachlan is a large and handsome species found in northeast India and Tonkin. The hinder wing has a length of 55 mm. The thorax in both sexes is reddish-brown, with green antehumeral and lateral bands. The abdomen has segments 1-7 brown with small median and terminal markings of yellow on each. Segments 8-10 are black. The upper anal appendages of the male are spatulate. *A. ornithocephala* MacLachlan from Assam and the northeast Himalaya is smaller, the hinder wing having a length of 48 mm. The venation is open, and the triangle shorter than is usual in the genus; the pterostigma is small, 3 mm. long. The anal appendages of the male somewhat resembles those of the Japanese *A. melanictera* Selys and as in that species the male has a prominent spur on the dorsum of the tenth abdominal segment. Doctor Annandale has observed females of this species ovipositing in the muddy banks of small pools on the Himalayas, some feet away from the water.

LIST OF ORIENTAL SPECIES OF GENUS AESCHNA.

1. *A. petalura* Martin: Northeast ranges of the Himalaya and Assam?
2. *A. erythromelas* MacLachlan: Northeast India, Tonkin.
3. *A. ornithocephala* MacLachlan: Assam and northeast Himalaya.

Genus GYNACANTHA Rambur.⁸

A good account of the oriental species of this rather difficult genus was given by Kruger in 1898.

He listed the following species: *G. furcata* Rambur, *subinterrupta* Rambur, *rosenbergi* Brauer, *hyalina* de Selys, *basiguttata* de Selys, *nigripes* de Selys, *bayadera* de Selys, *limbalis* Karsch, *musa* Karsch, *dohrni* Kruger, *maclachlani* Kruger, 11 species in all. Of these *rosenbergi* almost certainly does not occur within the limits of the region, and *nigripes* is a race or color variety of MacLachlan's species *khasiaca*.

⁸Since these notes were sent to press Fraser has described three new species of this genus; one from Bengal, *G. o'doneli* (Journ. Bombay Nat. Hist. Soc., 1922, vol. 28, p. 700) is allied to *millardi* but is smaller; two others *bainbriggei* and *hanumana* (Mem. Dept. Agric. India, Ent. Ser., vol. 7, no. 7, p. 75 and 76 respectively) come from the Himalayas.

Martin added one species in his Monograph, viz, *saltatrix*.

Ris described a new species *demeter* from Borneo (1911).

The same author made an important faunistic contribution to our knowledge of the genus in 1913 in his paper on "Nova Guinea," in which he characterizes two new species from north Celebes, *nausicaa*, and *penelope*, and gives useful figures of the anal appendages of the males of these and of certain other species. In addition *japonica* Bartenev must be regarded as belonging to our fauna; Ris has recorded it from Formosa (1916), and remarks that it is the species which was formerly recorded from Japan as *rosenbergi*. Lastly Fraser has recently described a new species *millardi* from India, but I have not yet seen his account. So that our list is a fairly long one, including some 16 names.

I have been able to examine specimens of the undermentioned forms: *hyalina*, *basiguttata*, *khasiaca*, *bayadera*, *dohrni*, *saltatrix*, and *millardi*.

Summarizing the distribution of the species of the genus we may say that a considerable number of species are apparently restricted to the more equatorial parts of the region especially to the great Malay Islands, a few are restricted to the northern half, and a certain number range over at least a large part of the whole area. Southern India and Ceylon are very imperfectly known. Kirby⁹ reports *subinterrupta* and *furcata* for Ceylon but the latter must, I think, be a mistaken determination. The genus is in some respects the most specialized of all the Aeschnines; it is so far as I know the only Odonate genus that is definitely crepuscular in its habits. Physiologically it seems to differ from other dragonflies in that dead specimens are particularly liable to "grease" and lose their coloring to a greater extent than any others. The anal appendages of the females are rarely preserved intact in collected specimens. Major Fraser tells me that they often have the appearance of having been nibbled off, but most probably they are damaged either during copulation or in oviposition. They do not so far as I know resemble except in a general way those of the male, and are usually stalked and lanceolate.

The coloring when well preserved is soft and beautiful, of such a nature as to conceal the insect very effectually when at rest on foliage. *Gynacantha* is the only genus of Aeshnines that is definitely holotropical, not extending to more temperate climates (except for *G. japonica*).

GYNACANTHA MILLARDI Fraser.¹⁰

The most distinct, and also the latest species to be described is *millardi*. It differs from all its Asiatic congeners, and resembles

⁹ Kirby, Journ. Linn. Soc. London, vol. 34, 1893, p. 558.

¹⁰ *Gynacantha millardi* Fraser, Journ. Bombay Nat. Hist. Soc., vol. 27, p. 147.

certain South American species (e. g., *nervosa* Rambur) in having the abdomen almost cylindrical throughout. The nerves of the wings are of a medium brown color, the pterostigma is of a creamy yellow, and there is no definite T-mark on the frons. The thorax is uniformly grass green with a beautiful enamel-like surface; the legs are brownish-yellow throughout, with dark brown spines. The length of the abdomen is 42 mm. with an additional 5 mm. for the anal appendages. The hinder wing is also 42 mm. long.

I have a pair from Poona given me by Major Fraser, and I have also seen an immature male from Chota Nagpur, in the collection of the Indian Museum. So that the recorded range of the species is in northern Peninsular India.

GYNACANTHA BASIGUTTATA de Selys.

G. basiguttata is a large species, the abdomen and hinder wing of the male having a length of about 50 mm. each, whilst the anal appendages of the same sex are 6.5 mm. long. The abdomen is strongly compressed at the middle of the third abdominal segment and the auricles are large. A T-shaped mark is present on the frons. Both fore and hinder wings are tinged with deep brown in the costal and subcostal spaces, from the wing base to the level of the first antenodal nerve; the legs are black. The readiest guide to the determination of the species is found in the shape of the anal appendages of the male. These are markedly spatulate, the apical third being flattened and dilated so that each is shaped not unlike the business end of a wooden golf club, save that the "head" is not inclined to the "shaft" at so great an angle as in the case in the club.

This species has a wide range, from Burma and the Indo-Chinese Peninsula, through the Malay Peninsula and islands, to the Philippines and Celebes reaching apparently the Loo-Choo Islands to the north. Ris had pointed out (1911) that Martin's Figure 197 on page 193 in his Monograph is not a figure of the anal appendages of the male of this species, but more probably of those of *dohrni*. Another species with spatulate anal appendages in the male is *musa*. In this case the apices of the appendages are obliquely truncate, and the lower appendage is more than one-half as long as the upper pair, whilst in *basiguttata* the lower is only one-third as long. The legs are brown. The wings are without basal coloring; in size the species is about equal to *basiguttata*.

G. musa is restricted apparently to Java; reported doubtfully from New Guinea.

Three males, one from Khow Sai Dow Mountain about 305 meters, (1,000 feet), Trong, lower Siam, the two other specimens from Trong, lower Siam; collector Dr. W. L. Abbott, collection U.S.N.M.

This species is readily distinguished, so far as the male is concerned, from its eastern congeners by the shape of the anal appendages.

Length of abdomen 49 mm., of hinder wing 48 mm., of anal appendages 6.5 mm., and of pterostigma 4 mm.

GYNACANTHA DOHRNI Kruger.

Plate 1, fig. 5.

The next three species, all recorded from Borneo, may be regarded as forming a natural group, characterized by the great widening of the base of the abdomen, which when viewed from above is approximately circular in outline whilst the narrowing of the third segment is extreme; by the great size of the auricles, by the absence of a T-shaped mark on the frons, and by the brown color of the legs. The upper anal appendages of the males are very long and slender, not less than four times as long as the lower appendage. Of the three, *dohrni* from Sumatra, Java, and Borneo has the base of the hinder wing tinged with brown in the subcostal and cubital spaces as far as the level of the first antenodal nerve, whilst the innermost well of the anal triangle is also tinged with the same color.

The female has similar markings at the base of the hinder wing, but in this sex the whole wing is richly and evenly suffused with golden-brown. The anal appendages of the male have a small internal subbasal projection, and the pointed apices are directed almost straight backwards. The appendages, upper pair, have a length of 7.2 mm., whilst the wings are about 43 mm. in the male, and 47 mm. in the female.

GYNACANTHA DEMETER Ris.

G. demeter from Borneo is very similar. The male has the wing base hyaline or very lightly suffused with yellow. The upper anal appendages of the male are similar to those of *dohrni*, but shorter, only 6 mm. in length, with the more sharply acuminate apices directed rather laterally. The female in this species also has the wings strongly suffused with brown, which in some specimens deepens in tone between the nodus and pterostigma. In size this species approximates closely to the last.

GYNACANTHA MACLACHLANI Kruger.

G. maclachlani, the third of the group, has the upper anal appendages of the male without a subbasal projection, about 6.5 mm. in length, a little more dilated apically than is the case in the two previous species, which it resembles closely in size. Kruger in his original account gives the length of the abdomen at 44-46.5 mm. and of the hinder wing 45 mm. The pterostigma seems to be smaller than in either *dohrni* or *demeter*, 3 mm. as against 3.5 mm. (Martin gives New Guinea as a habitat for this species, but as his measurements are very different from those given by Kruger I can not feel sure that he is dealing with Kruger's species. Ris rejects his record

as unlikely.) Another species *bayadera* resembles this small group in being without a T-shaped mark on the frons, and in having brown legs. But it differs markedly in having the abdominal base much less distended, the auricles relatively much smaller, and the third abdominal segment much less narrowly constricted. The lower anal appendage is nearly half the length of the upper pair which are about 5 mm. long. The species is a small one with the hinder wing of the male about 37 mm. long; the wings are relatively broader than are those of the three last species. It has apparently a much wider range than those species and is recorded from the Himalayas, India, Burma, the Malay Peninsula, and islands as far as the Celebes.

GYNACANTHA HYALINA de Selys and SUBINTERRUPTA Rambur.

The two species *hyalina* and *subinterrupta* are evidently very closely allied; both have a well-defined T-shaped mark on the frons. The base of the abdomen is more inflated, and the auricles relatively larger than in *bayadera*, but not to the same extent as in *basiguttata* and still less than in *dohrni* and in its immediate allies. The upper anal appendages of the males are about 6 mm. long, shaped like a single-edged straight sword, more than twice as long as the lower appendages in the case of *hyalina*, three times as long or a trifle more in *subinterrupta*. Both are species of moderate size, the hinder wing having a length of about 43 mm. and the abdomen of 46 mm. Ris gives the following as among the chief characters separating *hyalina* from *subinterrupta*. Pterostigma distinctly and invariably shorter (3 mm. as against 3.5 mm). The T-shaped mark of the frons broader both in the longitudinal and in the transverse part. The coloring is also different, *hyalina* according to Ris is brilliant blue and green in the adult, *subinterrupta* with a nuance of brown only; *hyalina* has the knees dark brown, *subinterrupta* has the legs entirely light brown.

Both species have a wide distribution. Ris gives for *hyalina* Formosa and the Philippines, for *subinterrupta* Celebes, Java, and Lombok. The United States National Museum has two specimens of *hyalina* from lower Siam, and I have examined specimens (females only) in the Indian Museum labeled *hyalina* by de Selys, himself, from Assam.

GYNACANTHA HYALINA de Selys.

Two males, Trong, Lower Siam, Dr. W. L. Abbott, collector; collection of the U.S.N.M.

One specimen immature, both faded to a dark dull brown. The anal appendages resemble almost exactly those figured for the species by Ris, and are exactly like those of an Indian specimen before me.

Length of abdomen 43 mm., of hinder wing 43 mm., of upper anal appendages 6.5 mm., of pterostigma 3 mm.

GYNACANTHA JAPONICA Bartenef.

The most northerly ranging species of this genus, *japonica*, is apparently closely allied to the two preceding species and has been distinguished from *hyalina* only since 1909.¹¹ The anal appendages of the male are about 6.5 mm. long; narrow with parallel sides, with very blunt apices, and with a distinct internal subdorsal projection. The lower appendage is about one-fourth the length of the upper pair.

In size *japonica* stands very near *hyalina*, the male having the hinder wing 42 mm. long and the abdomen 45 mm. The same measurements in the female are 47 mm. and 50 mm., respectively.

GYNACANTHA SALTATRIX Martin.

The small species *saltatrix*, of which I have seen a single male from the Mangaldai district of Assam is related to the group *subinterrupta*, *hyalina*, *japonica* by the shape of the anal appendages of the male, by the possession of a well marked T-shaped mark on the frons and by the degree of inflation of the base of the abdomen and size of the auricles. The type specimen from Tonkin has the hinder wing 35 mm. in length and the abdomen 42 mm. The example seen by me has the following measurements, hinder wing 36.5 mm., abdomen 42 mm. Upper anal appendages 5 mm., pterostigma 3.5 mm., breadth of hinder wing at nodus 11 mm. The lower anal appendage is nearly one-half the length of the upper pair. The wings are without basal markings, whilst in the other members of the group the subcostal and cubital spaces have a brown tinge barely reaching the level of the first antenodal nerve. In my specimen the color is much faded; the thorax appears to be of an almost uniform dull green-brown; the legs are uniformly brown. The dorsal surface of the abdomen is black, with a slightly metallic luster, the first segment and the basal half of the second are blue laterally, the auricles are blue edged with black. Segments 2-10 have each a pair of apical lateral yellow spots, very minute from 2-5, increasing therefrom to 9, on which segment they extend for its whole length, widening distally. The sides of the distal half of the second segment, and the ventral surface of the whole abdomen is yellow. The upper anal appendages are brownish black; the lower appendage is pale yellow, its apex tipped with black.

GYNACANTHA KHASIACA MacLachlan.

The other northern species *khasiaca* from Assam is a larger and more robust insect. Martin figures a race *nigripes* (de Selys MS) to which race Kruger also refers. The locality given for this race

¹¹ Bartenef, Samml. Zool. Mus. Univ. Tomsk. 11-12, p. 7 (Russian), p. 14 (English), 1909 pl. 2, figs. 7, 9, 10

Tibet is a mistake, de Selys in several cases referred material from the East Himalayas to Tibet where Assam would have been correct. Moreover I doubt if the race *nigripes* can be regarded as valid. Martin gives as one of the points separating it from the typical *khasiaca* that the wings of *nigripes* are without a tinge of saffron at the base; whilst his colored figure of *nigripes* shows the saffron tinge very distinctly. I have been able to compare two males, one in excellent condition from Kobo in the north of Assam, the other much faded from the Mangaldai district also in Assam. The former certainly comes from a district which Selys referred to as Tibet. It is however a brightly colored insect, not at all like Martin's figure which is copied from a very discolored example.

In the Kobo specimen the lower lip is dull yellow, the upper lip front of the head, and eyes, olive-green. There is a well-developed T-shaped mark, the vertical part being very broad.

The thorax is of a bright olive-green, the mid-dorsal carina, the humeral sutures, and a line in the position of the first lateral suture sharply defined with black. The inter-alar space has bright blue markings. The femora are dark brown, their anterior surfaces almost black. The tibiae and tarsal joints are brown. The abdomen is black, the base of the first segment dark brown. The second segment has a large anterior and posterior blue spot on either side, the auricle is blue, its margin finely outlined with black. The mid-dorsal longitudinal line of the segment is blue, and on either side of this there is a median linear blue mark and a posterior blue spot, in addition to the lateral blue markings. The third segment has a basal lateral blue mark. Otherwise the abdomen is wholly black save that the sixth segment has a small pair of transverse linear marks before its middle, and that the apex of each segment ventrally is brown. The anal appendages are exactly as figured by Martin; black in color, the lower appendage about two-thirds the length of the upper pair. The base of the wings are just perceptibly tinged with saffron for a length of about 2 mm.

The hinderwing of this specimen is 43 mm. long and 12 mm. in breadth. The abdomen (somewhat flexed) is about 47 mm. in length and the upper anal appendages 6 mm.

The Mangaldai specimen which is much faded resembles closely in coloring Martin's figure.

I think we may conclude that the race *nigripes* is founded on a specimen in which the coloring is badly retained, and that the race is in all probability not valid.

GYNACANTHA FURCATA Rambur.

The next species *furcata* was founded on a female specimen which was without a T-shaped mark on the frons. Ris has expressed the

opinion that this specimen probably belonged to one or other of the species subsequently described under the names *dohrni*, *demeter*, or *maclachlani*, all of which like the type specimen of *furcata* occur in Borneo.

The specimen figured by Martin (1910, fig. 202, p. 198) as the male of *furcata*, from Tonkin, can hardly in Doctor Ris's opinion (1913) belong to that species as it has a well marked T on the frons. For the present therefore it must be regarded as an unnamed species. The anal appendages are similar in shape to those of certain African species.

GYNACANTHA LIMBALIS Karsch.

The very large species *limbalis* known only I believe from a single male from Java is not likely to be confused with any of the oriental species at present known, on account of its large size, the hinder wing measuring according to Martin 61 mm.; and because the wings have a costal band of color extending nearly the whole length of the wings. There is a T-shaped mark on the frons, and the abdomen is much narrowed at the third segment.

GYNACANTHA NAUSICAA Ris and PENELOPE Ris.

The remaining species are both from the Celebes and are both described and figured by Ris in Nova Guinea. The first *nausicaa* has a T-shaped mark on the frons. The wings are relatively narrow with long triangles. The upper anal appendages of the male gradually and regularly widened distally, ending in a backwardly directed rather blunt apical point. The lower appendage is a little less than half the length of the upper pair. The hinder wing is 47 mm. long and 13 mm. across. There is only a single row of cells in the field lying between M_1 and M_2 . The upper anal appendages measure 6 mm.

The second species *penelope* has the longitudinal part of the T-mark feebly developed or absent. The wings are relatively broad, with two rows of cells in the field M_1 - M_2 . The upper anal appendages of the male have their outer margin regularly convex, not much widened distally, and end in a point which is directed rather laterally. The hinder wing is 45 mm. long and 13 mm. wide at the nodus. The upper anal appendages are 6.5 mm. long, the inferior appendage less than one-half as long.

G. nausicaa has the thorax green, with green and blue markings on the abdomen. *G. penelope* has olive-green markings on the thorax and abdomen. Both have light reddish-brown legs.

GYNACANTHA BAYADERA de Selys.

One male, Khow Sai Dow Mountain, 305 meters (1,000 feet), Trong, Lower Siam, January-February, 1899, Dr. W. L. Abbott, collector; collection of the United States National Museum.

The species has an extensive range, apparently from Sikkim to Formosa, and as far to the southeast as the Celebes. The single specimen has the anal appendages exactly similar to those figured for the species by Ris from a specimen from north Celebes; the coloring is much faded.

Length of abdomen 50 mm., of hinder wing 38 mm., of anal appendages 4.5 mm., and of pterostigma 3.25 mm.

LIST OF ORIENTAL SPECIES OF GENUS GYNACANTHA.

1. *G. furcata* Rambur.....Borneo (female type) (*furcata*?).
2. *G. subinterrupta* Rambur.....Celebes, Java and Lombok, Ceylon.
3. *G. hyalina* de Selys.....Formosa and the Philippines, lower Siam (2 males), Assam (females).
4. *G. basiguttata* de Selys.....Burma and Indo-Chinese Peninsula. Through Malay Peninsula and Islands to Philippines and Celebes, reaching apparently the Loo Choo (Rhu Kyu) Islands to the north.
5. *G. limbalis* Karsch.....Java.
6. *G. musa* Karsch.....Java, New Guinea?
7. *G. dohrni* Kruger.....Sumatra, Java, Borneo.
8. *G. machlachlani* Kruger.....Borneo.
9. *G. khasiaca* MacLachlanAssam.
10. *G. saltatrix* Martin.....Mangaldai district of Assam (1 male). Tonkin (male type).
11. *G. demeter* Ris.....Borneo.
12. *G. nausicaa* Ris.....North Celebes.
13. *G. penelope* Ris.....North Celebes.
14. *G. japonica* Barteneff.....Formosa, Japan.
15. *G. millardi* Fraser.....Northern Peninsular India.
16. *G. bayadera* de Selys.....Sikkim to Formosa, and southeast to the Celebes.

SUMMARY OF ORIENTAL SPECIES OF AESCHNINAE.

The number of species (or well-marked subspecies) allowed in the above account for each genus is tabulated below:¹²

<i>Jagoria</i> 6.	<i>Amphiaeschna</i> 2.
<i>Linaeschna</i> 1.	<i>Aeschna</i> 3.
" <i>Austroaeschna</i> " 2.	<i>Tetracanthagyna</i> 4.
" <i>Cephalaeschna</i> " 5. ¹³	<i>Anaciaeschna</i> 2.
<i>Periaeschna</i> 1.	<i>Anax</i> 6.
<i>Heliaeschna</i> 6.	<i>Gynacantha</i> 19.

Making a total of 57 species in all.

Aeschnophlebia de Selys from Japan is regarded by Ris as coming near *Brachytron*. As it is probably a Palaearctic form it is omitted in this list.

¹²In this summary the species recently described by Fraser have been included. These species are not treated in the text and are only mentioned in footnotes.

¹³One of these has been removed to a new genus, see footnote 4.

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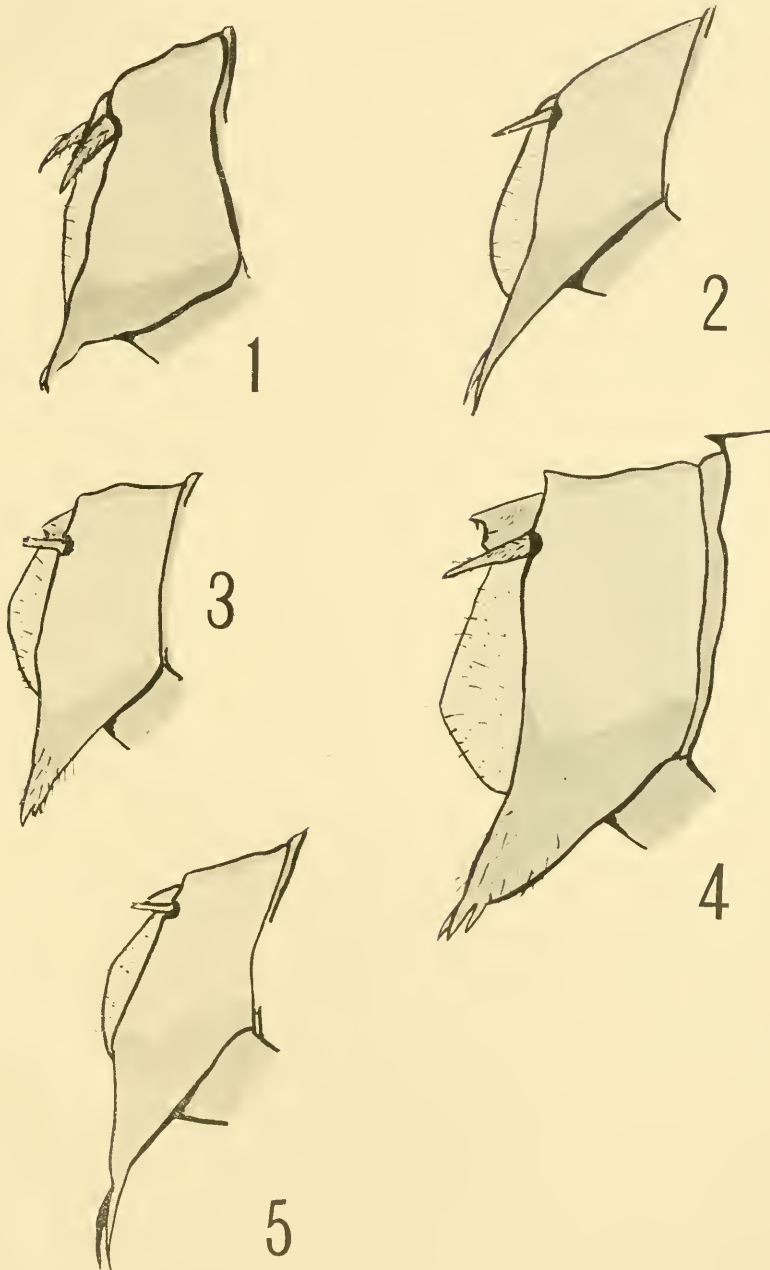
For faunistic work dealing especially with the Aeschninae of the oriental region, I use as foundation Martin's Monograph of the Subfamily, dated 1908-1910; in which he records the known distribution of all species described up to that date.

I have added to the list also a reference to a paper by Kruger on the Aeschnines of Sumatra and neighboring countries, and the important papers by Ris and Tillyard on the species of the same subfamily found in New Guinea and Australia, respectively. In both these accounts there is material of interest for the student of the oriental Fauna.

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EXPLANATION OF PLATE.

- FIG. 1. Lateral view of apex of abdomen of "*Cephalaeschna*," species, female, allied to *sikkima* Karch. Drawn from a specimen from Assam in the collection of the Indian Museum.
2. Lateral view of apex of abdomen of *Periaeschna magdalena*, female. From a specimen from the Garo Hills, Assam, in the collection of the Indian Museum.
3. Lateral view of apex of abdomen of *Heliaeschna idae*, female. From a specimen from Borneo, in the collection of the author.
4. Lateral view of apex of abdomen of *Tetracanthagyna brunnea*, female. From a specimen from Jalor, Siamese Malay States, in the collection of the author.
5. Lateral view of apex of abdomen of *Gynacantha dohrni*, female. From a specimen from Borneo, in the collection of the author.



AESCHINE DRAGONFLIES FROM BURMA AND LOWER SIAM

FOR EXPLANATION OF PLATE SEE PAGE 29

