STUDIES IN SIRICIDAE, ESPECIALLY OF EUROPE AND SOUTHERN ASIA (HYMENOPTERA, SYMPHYTA).

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Contents.

	PAGE
Introduction:	
(*a*) General ...	27
(*b*) The Length of the Ovipositor as a taxonomic Character ...	28
(*c*) The Genera ...	32
(*d*) The Species ...	32
Key to the Genera of the World ...	33
Sirex, L., with a Key to the Females of the Species occurring in Europe	35
Xeris, Costa ...	38
Urocerus, Geoffroy, with a Key to the Females of the Species occurring in Europe ...	38
Tremex, Jurine, with a Key to the Males and Females occurring in Europe	41
Eriotremex, gen. nov., with a Key to its Females ...	42
British Siricidae ...	44
(*a*) Recorded British Species ...	44
(*b*) Is there a native Siricid Element in Britain ? ...	44
(*c*) Is there a native British Form of *Urocerus* ? ...	45
(*d*) Is the dark Form of *Sirex juvencus* native in Britain ? ...	46
The Siricidae were not derived from the Jurassic Pseudosiricidae ...	46
Himalayan and Oriental Siricidae ...	47
Summary ...	49
References ...	49

Introduction.

(a) General.

As living larvae of Siricidae have been introduced from time to time in timber, it was more than ever necessary, when drawing up keys to the British species, to study also the forms occurring in other parts of the world, especially continental Europe and North America, whence so much timber has been brought to Britain.

Unfortunately, as with most Hymenoptera, the collections of these insects in the British Museum are entirely inadequate for such a study. With this in mind, a revision of the world species was contemplated, with the help, it was hoped, of workers in other countries.

The British Museum collection was, some time ago, enriched by representatives of certain North American species received in exchange from Dr. J. C. Bradley (Cornell), and the material already in the collection was critically examined and named by the same authority. More recently representatives of several species from Asia were received in exchange from Dr. V. V. Gussakovskii (Leningrad), after he had completed the part of his monograph dealing with the Palaearctic SIRICIDAE. Further exchanges and also loans were being arranged with various foreign museums now sadly cut off from us ; nevertheless, it seems advisable to collect together these preliminary studies, especially in so far as they concern the European and British species. They include a key to the genera of the world and keys to the females of all the known species occurring in Europe.

Besides Dr. J. C. Bradley and Dr. V. V. Gussakovskiĭ, whom I have already mentioned, I am also indebted to Dr. A. C. Stephen, for the loan of Scotch SIRICIDAE from the Royal Scottish Museum, and to Prof. G. D. Hale Carpenter, D.M., M.B.E., for lending me the types of *Tremex insignis*, Smith, and *T. insularis*, Smith, and giving me access to other SIRICIDAE in the Hope Department, Oxford.

(b) The Length of the Ovipositor as a Taxonomic Character.

Previous workers (Konow 1905, Bradley 1913, Waterston 1928, Gussakovskiĭ 1935, Conde 1935 and Takeuchi 1938), in studying these insects, have compared the length of the ovipositor, or parts of the ovipositor, with the length of the abdomen in characterising species ; I have found this gives very unsatisfactory results as the abdomen frequently becomes telescoped in drying, and I have, therefore, sought for some more reliable standard for comparison. This I have found by comparing the total length of the ovipositor sheath (measured from the base of the oblong plate or second valvifer) with the length of a forewing (measured from the apex of a tegula). This character I shall refer to as the ovipositor/forewing ratio. The point in the venation to which the ovipositor sheath would reach if stretched along the fore margin of the forewing from the tegula serves as a rough guide in separating the different forms of *Urocerus* (fig. 2).

It is not being suggested that the length of the forewing is a standard measure of the size of an insect ; in fact it is not unlikely that some races of these insects have longer wings in proportion to their size than other races. Where the ovipositor is very short compared with the forewing, the apical portion of the ovipositor sheath (referred to hereafter as the sawsheath) compared to the whole ovipositor sheath (sawsheath plus oblong plate) may give a more decisive result (see fig. 1).

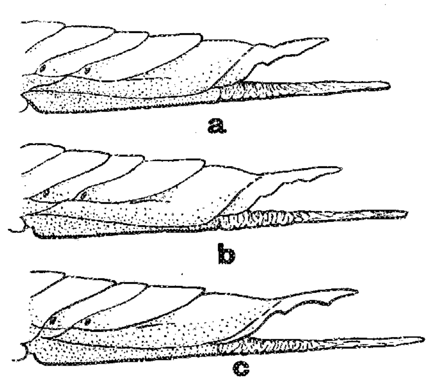

Fig. 1. Lateral view of ovipositors of *Sirex* to show different proportions of apical portion (sawsheath) to basal portion (oblong plate) : (*a*) *Sirex noctilio*, F. ; (*b*) *S. juvenсus*, L. ; (*c*) *S. cyaneus*, F.

These two ratios (the ovipositor/forewing and the sawsheath/ovipositor) were selected partly because they appear to approach a constant value for each race, which is independent of the total size of the insect. This last characteristic is very important because of the enormous range in total size which may occur in these insects as in so many wood-borers. It is proved by plotting the logarithms of the ovipositor/forewing ratios against the log. of the forewing lengths and the log. of the sawsheath/ovipositor ratios against the log. of the ovipositor lengths for each race; in each case, where this was done, the result was a straight line at 45°.

The ratios were measured in all the specimens of all the species available, and their means and standard errors were calculated. The results are given in Tables I–III.

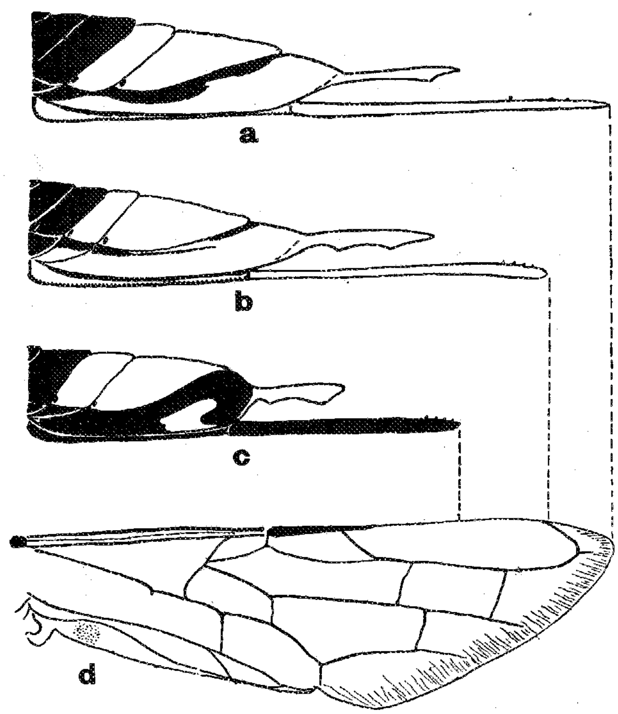

Fig. 2. Lateral view of ovipositors of three races of *Urocerus gigas*, L., comparing their lengths with that of a forewing: (*a*) *Urocerus gigas argonautarum*, Sem.; (*b*) *U. gigas gigas*, L.; (*c*) *U. gigas taiganus*, subsp. nov.; (*d*) forewing.

These Tables are provided in the hope that the ratios will become standard characters in future work on SIRICIDAE. Unfortunately the necessary measurements for estimating the sawsheath/ovipositor ratios have never been given in previous descriptions and those for the ovipositor/forewing ratios only for the species described by Semenov-Tian-Shanskiĭ (1921), Conde (1935) and Takeuchi (1938).

No obvious inverse correlation was found between mean total size of a species and its ovipositor length (Table I). Presumably, therefore, if the length of ovipositor indicates the depth of oviposition in wood, then the oviposition habits must differ between the species.

The asterisks* in the Tables indicate that the ratios for those particular specimens were calculated from these published measurements and not from actual specimens before me.

Measurements were made to the nearest 0·5 mm.

TABLE I.

	No.	Mean forewing mm.	Mean ovipositor mm.	Mean ov. : fw. ratio (Table II)	Mean sawsh. : ov. ratio (Table III)
SIRICINAE—					
Sirex areolatus, Cress.	(1)	21·0	21·0	1·00	1·55
S. cyaneus, F.	(21)	21·5	18·0	1·19	1·85
S. dux, Sem.	(1+1*)	23·0	21·5	1·07	1·85
S. edwardsi, Brullé	(3)	19·5	13·0	1·47	2·27
S. ermak, Sem.	(1)	13·0	11·0	1·18	2·00
S. imperialis, Kirby	(2)	20·0	15·5	1·29	2·10
S. juvencus, L.	(9)	20·0	15·0	1·34	2·00
S. nigricornis, F.	(3)	18·0	11·5	1·54	2·20
S. noctilio, F.	(28)	20·0	13·5	1·47	2·10
S. tianshanicus, Sem.	(1)	15·5	13·5	1·15	2·00
S. varipes, Wlk.	(1)	18·0	14·0	1·29	2·00
Siricosoma tremecoides, Forsius	(1)	22·5	15·5	1·44	2·20
Urocerus albicornis, F.	(9)	18·0	15·5	1·19	1·76
U. antennatus, Marlatt	(2)	21·0	22·0	0·96	1·65
U. augur, Klug	(6)	25·5	24·5	1·03	1·64
U. californicus, Norton	(4)	25·5	22·5	1·13	1·65
U. cressoni, Norton	(2)	18·0	14·0	1·27	1·95
U. fantoma, F.	(3)	21·0	15·0	1·41	1·90
U. gigas argonautarum, Sem.	(3)	20·5	20·5	1·00	1·70
U. g. flavicornis, F.	(20)	22·5	18·0	1·25	1·81
U. g. gigas, L.	(27)	24·0	20·5	1·11	1·70
U. g. taiganus, subsp. n.	(8)	24·0	18·5	1·30	1·85
U. g. tibetanus, subsp. n.	(2)	26·0	20·0	1·30	1·75
U. japonicus, Smith	(5)	22·5	21·0	1·05	1·68
U. multifasciatus, Tak.	(1+1*)	20·5	21·0	0·98	1·60
U. niger, sp. n.	(1)	29·5	28·5	1·04	1·60
U. taxodii, Ashm.	(2)	20·0	22·0	0·90	1·60
U. umbra, Sem.	(2*)	25·5	23·5	1·10	—
U. xanthus, Cam.	(5)	20·0	19·5	1·04	1·49
Xeris himalayensis, Bradley	(1)	21·5	30·5	0·71	1·30
X. morrisoni, Cress.	(1)	16·5	23·5	0·70	1·30
X. spectrum, L.	(13)	17·0	23·5	0·72	1·30
Xoanon mysta, Sem.	(1)	25·0	25·0	1·00	1·60
TREMECINAE—					
Eriotremex formosanus, Mats.	(1)	21·0	17·5	1·20	2·80
E. insignis, F. Smith	(1)	18·5	13·0	1·42	2·90
E. smithi, Cam.	(2)	17·0	13·5	1·24	2·70
Tremex alchymista, Mocs.	(1)	15·5	12·0	1·29	2·05
T. apicalis, Mats.	(1*)	22·5	20·5	1·11	—
T. columba columba, L.	(19)	23·0	20·5	1·15	2·28
T. fuscicornis, F.	(3)	21·5	18·0	1·21	2·36
T. jakovlevi, Sem.	(1*)	22·0	17·0	1·29	—
T. longicollis, Konow	(1)	26·0	21·0	1·24	2·70
T. magus, F.	(1)	21·5	17·5	1·23	2·20
T. simulacrum, Sem.	(1*)	22·5	18·5	1·22	—

ios for those particular specimens
s and not from actual specimens

Mean ovipositor mm.	Mean ov. : fw. ratio (Table II)	Mean sawsh. : ov. ratio (Table III)
21·0	1·00	1·55
18·0	1·19	1·85
21·5	1·07	1·85
13·0	1·47	2·27
11·0	1·18	2·00
15·5	1·29	2·10
15·0	1·34	2·00
11·5	1·54	2·20
13·5	1·47	2·10
13·5	1·15	2·00
14·0	1·29	2·00
15·5	1·44	2·20
15·5	1·19	1·76
22·0	0·96	1·65
24·5	1·03	1·64
22·5	1·13	1·65
14·0	1·27	1·95
15·0	1·41	1·90
20·5	1·00	1·70
18·0	1·25	1·81
20·5	1·11	1·70
18·5	1·30	1·85
20·0	1·30	1·75
21·0	1·05	1·68
21·0	0·98	1·60
28·5	1·04	1·60
22·0	0·90	1·60
23·5	1·10	—
19·5	1·04	1·49
30·5	0·71	1·30
23·5	0·70	1·30
23·5	0·72	1·30
25·0	1·00	1·60
17·5	1·20	2·80
13·0	1·42	2·90
13·5	1·24	2·70
12·0	1·29	2·05
20·5	1·11	—
20·5	1·15	2·28
18·0	1·21	2·36
17·0	1·29	—
21·0	1·24	2·70
17·5	1·23	2·20
18·5	1·22	—

TABLE II.

Ovipositor/Forewing Ratios.

	No.	Mean	Max.	Min.	Standard error
S. nigricornis	(3)	1·54	1·60	1·47	—
S. noctilio	(28)	1·47	1·62	1·35	0·011
S. edwardsi	(3)	1·47	1·52	1·41	—
Siricosoma tremecoides...	(1)	1·44	—	—	—
E. insignis	(1)	1·42	—	—	—
U. fantoma	(3)	1·41	1·47	1·36	—
S. juvencus	(9)	1·34	1·47	1·32	0·020
U. gigas taiganus	(8)	1·30	1·35	1·23	0·014
U. g. tibetanus	(2)	1·30	1·35	1·25	—
S. imperialis	(2)	1·29	1·32	1·25	—
S. varipes	(1)	1·29	—	—	—
T. jakovlevi	(1*)	1·29	—	—	—
T. alchymista	(1)	1·29	—	—	—
U. cressoni	(2)	1·27	1·31	1·22	—
U. gigas flavicornis	(20)	1·26	1·37	1·14	0·012
E. smithi	(2)	1·24	1·25	1·22	—
T. longicollis	(1)	1·24	—	—	—
T. magus	(1)	1·23	—	—	—
T. simulacrum	(1*)	1·22	—	—	—
T. fuscicornis	(3)	1·21	1·29	1·15	—
E. formosanus	(1)	1·20	—	—	—
U. albicornis	(9)	1·19	1·35	1·11	0·025
S. cyaneus	(21)	1·19	1·27	1·10	0·010
S. ermak	(1)	1·18	—	—	—
S. tianshanicus...	(1)	1·15	—	—	—
T. columba columba	(19)	1·15	1·19	1·04	0·009
U. californicus	(4)	1·13	1·17	1·06	—
U. gigas gigas	(27)	1·11	1·17	1·06	0·006
T. apicalis	(1*)	1·11	—	—	—
S. umbra	(2*)	1·08	1·13	1·02	—
S. dux	(1+1*)	1·07	1·09	1·04	—
U. japonicus	(5)	1·05	1·08	1·04	—
U. niger...	(1)	1·04	—	—	—
U. xanthus	(5)	1·04	1·12	0·98	—
U. augur	(6)	1·03	1·14	1·00	—
S. areolatus	(1)	1·00	—	—	—
U. gigas argonautarum	(3)	1·00	1·02	0·98	—
Xoanon mysta	(1)	1·00	—	—	—
U. multifasciatus	(1+1*)	0·98	0·98	0·97	—
U. antennatus	(2)	0·96	0·98	0·93	—
U. taxodii	(2)	0·90	0·94	0·86	—
X. spectrum	(13)	0·72	0·81	0·59	0·017
X. himalayensis	(1)	0·71	—	—	—
X. morrisoni	(1)	0·70	—	—	—

TABLE III.

Sawsheath/Ovipositor Ratios.

	No.	Mean	Max.	Min.	Standard error
E. insignis	(1)	2·90	—	—	—
E. formosanus	(1)	2·80	—	—	—
T. longicollis	(1)	2·70	—	—	—
E. smithi	(2)	2·69	2·70	2·68	—
T. fuscicornis	(3)	2·36	2·43	2·30	—
T. columba columba	(19)	2·28	2·50	2·10	0·027
S. edwardsi	(3)	2·27	2·29	2·15	—
S. nigricornis	(3)	2·20	2·28	2·15	—
Siricosoma tremecoides...	(1)	2·20	—	—	—
T. magus	(1)	2·20	—	—	—
S. noctilio	(28)	2·12	2·30	2·06	0·011
S. imperialis	(2)	2·10	2·15	2·06	—
T. alchymista	(1)	2·07	—	—	—
S. ermak	(1)	2·00	—	—	—
S. juvencus	(9)	2·00	2·00	2·00	—
S. tianshanicus...	(1)	2·00	—	—	—
S. varipes	(1)	2·00	—	—	—
U. cressoni	(2)	1·93	2·00	1·85	—
U. fantoma	(3)	1·89	1·93	1·88	—
S. cyaneus	(21)	1·84	1·93	1·75	0·011
U. gigas taiganus	(8)	1·84	1·88	1·67	0·015
S. dux	(1)	1·83	—	—	—
U. gigas flavicornis	(20)	1·81	1·93	1·74	0·014
U. albicornis	(9)	1·76	1·80	1·71	0·013
U. gigas argonautarum	(3)	1·72	1·73	1·71	—
U. gigas gigas	(27)	1·70	1·78	1·60	0·008
U. japonicus	(5)	1·68	1·72	1·65	—
U. californicus	(4)	1·65	1·70	1·59	—
U. antennatus	(2)	1·64	1·64	1·63	—
U. augur	(6)	1·64	1·68	1·60	—
U. taxodii	(2)	1·61	1·65	1·50	—
Xoanon mysta	(1)	1·60	—	—	—
U. multifasciatus	(1)	1·58	—	—	—
U. niger...	(1)	1·58	—	—	—
S. areolatus	(1)	1·57	—	—	—
U. xanthus	(5)	1·49	1·65	1·30	—
X. spectrum	(13)	1·29	1·36	1·21	0·013
X. himalayensis	(1)	1·28	—	—	—

(c) The Genera.

In the key to the World genera, use has been made of several characters not previously noticed and a new genus is introduced for some of the Oriental species heretofore regarded as belonging to *Tremex*.

The subfamilies SIRICINAE and TREMECINAE seem to be valid groups supported by biological differences; the former, for instance, is, so far as is known, entirely attached to coniferous trees and the latter to angiospermous trees.

The actual host records are still very scanty, but at least the common widely distributed SIRICIDAE seem very tolerant as to the actual genus and species or even family of tree attacked, so long as the wood is in a suitable condition for the growth of the symbiotic fungi (see Francke-Grosmann, 1939).

(d) The Species.

A catalogue of the species of SIRICIDAE of the World appeared recently as part 6 of the *Hymenopterorum Catalogus* edited by H. Hedicke (1938). In this can be found

Max.	Min.	Standard error
—	—	—
—	—	—
—	—	—
2·70	2·68	—
2·43	2·30	—
2·50	2·10	0·027
2·29	2·15	—
2·28	2·15	—
—	—	—
—	—	—
2·30	2·06	0·011
2·15	2·06	—
—	—	—
—	—	—
2·00	2·00	—
—	—	—
—	—	—
2·00	1·85	—
1·93	1·88	—
1·93	1·75	0·011
1·88	1·67	0·015
—	—	—
1·93	1·74	0·014
1·80	1·71	0·013
1·73	1·71	—
1·78	1·60	0·008
1·72	1·65	—
1·70	1·59	—
1·64	1·63	—
1·68	1·60	—
1·65	1·50	—
—	—	—
—	—	—
—	—	—
—	—	—
1·65	1·30	—
1·36	1·21	0·013
—	—	—

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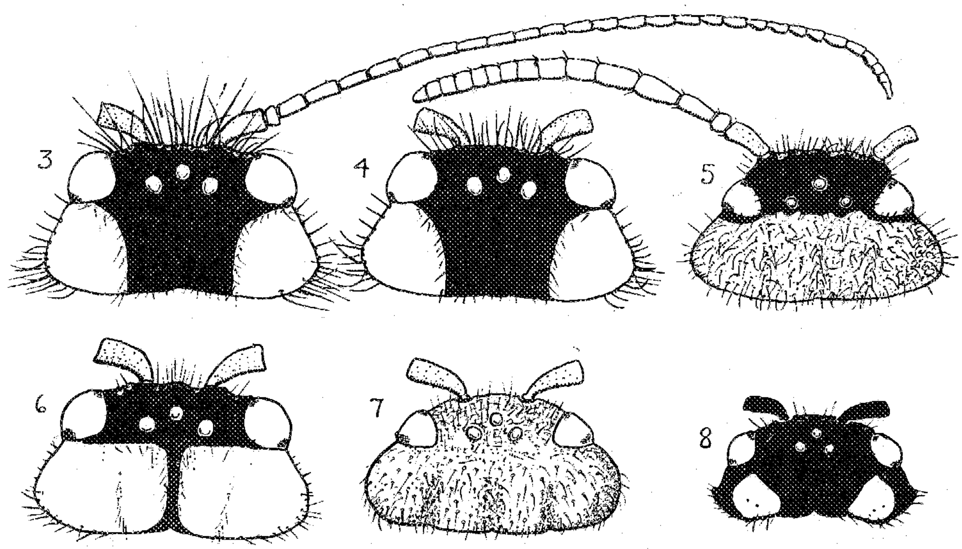
references to many of the species or subspecies dealt with here, but obviously the specimens on which these records are based will have to be re-examined in the light of these new discoveries. Collecting in the less known parts of the world, especially, for instance, in the mountains of central and south-west Asia and the Himalayas, will probably reveal more species (or subspecies) than are known at present.

Unfortunately, in the systematic studies that follow, keys to the males of the species could not be given as so few specimens of them have been available for study. With the help of the present paper, it should now be possible to name correctly females of most SIRICIDAE by using the various faunistic works: keys to the Nearctic species were given by Bradley (1913), to the Palaearctic species by Gussakovskiĭ (1935), while the species of the Japanese Empire were given by Takeuchi (1938). As there are no known native SIRICIDAE in Australia or South America and only *Tremex hyalinatus*, Mocsáry, in the Ethiopian region, the world is fairly well covered by modern revisions except for the Oriental region and the Himalayas; the last section of the present paper is therefore devoted to this area.

KEY TO THE GENERA OF THE WORLD.

1. *Antennae* (fig. 3) *filiform and long* (would reach beyond base of stigma if stretched along forewing from tegula) *and set close together* (except in *Siricosoma*) (so that the distance between them is about $1\frac{1}{2}$ times as great as the distance between one of them and the nearest eye margin); *eyes* (except in *Xoanon*) *not more than $1\frac{1}{2}$ times as broad as long*; *labial palps 3-segmented*; *cerci usually present*; *cenchri about twice as broad as long*; *anal cell of forewing contracted from about the middle* (fig. 11) (except in *Siricosoma*, fig. 12). [Attached to coniferous trees.] (SIRICINAE)..2

   Antennae (fig. 5) *slightly swollen in middle and short* (would not reach as far as base of stigma) *and set very far apart* (so that the distance between them is at least about 3 times as great as the distance between one of them and the nearest eye margin); *eyes at least twice as broad as long*; *labial palps*



Figs. 3–8. Head from above to show general form, colour pattern and pubescence in *Urocerus gigas tibetanus*, subsp. nov., with an antenna (fig. 3), *U. gigas taiganus*, subsp. nov. (fig. 4), *Tremex fuscicornis*, F., with an antenna (fig. 5), *Urocerus augur*, Klug (fig. 6), *Xoanon mysta*, Sem. (fig. 7), and *Xeris spectrum*, L. (fig. 8).

2-segmented; *cerci absent* (except in *Eriotremex*); *cenchri about as long as broad*; *anal cell of forewing contracted only in basal third* (fig. 13). [Attached to angiosperm trees.] (TREMECINAE) 6

2. Head above entirely pale or with at least a pale spot behind each eye (figs. 3, 4, 6, 7 and 8); cornus of female constricted towards base (fig. 14); forewing with 1st transmedian vein represented by at most a stump..............................3

Head without any pale colour above and behind the eyes; cornus of female not constricted towards the base (fig. 15); forewing with the 1st transmedian vein present, but otherwise venation and head structure as in *Urocerus*, Geoffroy. Hind tibia with two apical spurs; eyes about $1\frac{1}{2}$ times broader than long. [Holarctic and Oriental; type: *Sirex juvencus*, L.; ? 19 spp.].................
Sirex, Linnaeus

3. Head without a lateral carina behind the eyes (figs. 3, 4, 6 and 7) and hindwing usually with a closed anal cell; ovipositor at most scarcely longer than forewing; eyes about $1\frac{1}{2}$ times broader than long................................4.

Head with a lateral carina behind the eyes (fig. 8); hindwing without a closed anal cell; ovipositor about $1\frac{1}{2}$ times as long as a forewing; eyes almost round.

[Hind tibia with only one apical spur; head sculpture and venation otherwise as in *Urocerus*, Geoffr.; Holarctic; type: *Ichneumon spectrum*, L.; 4 spp.]
.... **Xeris,** Costa

4. Antennae set far apart (so that they are about 3 times as far apart as either is from the nearest eye-margin); ocelli close together (so that POL : OOL is as about 1 : 1·5); anal cell of forewing contracted only within the basal 3rd (fig. 12); hind tibia with but one apical spur. [Malaya type: *Siricosoma tremecoides*, Fors.; monotypic.]......................**Siricosoma,** Forsius 1934

Antennae set closer together (so that they are only about $1\frac{1}{2}$ times as far apart as either is from the nearest eye-margin); ocelli further apart (POL usually greater than OOL); anal cell of forewing with the basal contraction beginning at about the middle of the cell (fig. 11); hind tibia with two apical spurs......5

5. In the forewing 2nd and 3rd cubital cells (except when fused) each receive a recurrent vein: eyes not more than $1\frac{1}{2}$ times longer than broad; the pale spot on the genae behind the eyes shining with sparse punctures and pubescence (figs. 3, 4 and 6). [Holarctic and Oriental; type: *Ichneumon gigas*, L. ? 18 spp. and subspp.]..
Urocerus, Geoffroy (=*Xanthosirex*, Semenov, **syn. nov.**)

In the forewing the 2nd transverse cubital vein has shifted apicad so that both recurrent veins are received in the 2nd cubital cell; eyes about twice as long as broad; genae behind the eyes dull with dense punctures and pubescence (fig. 7).

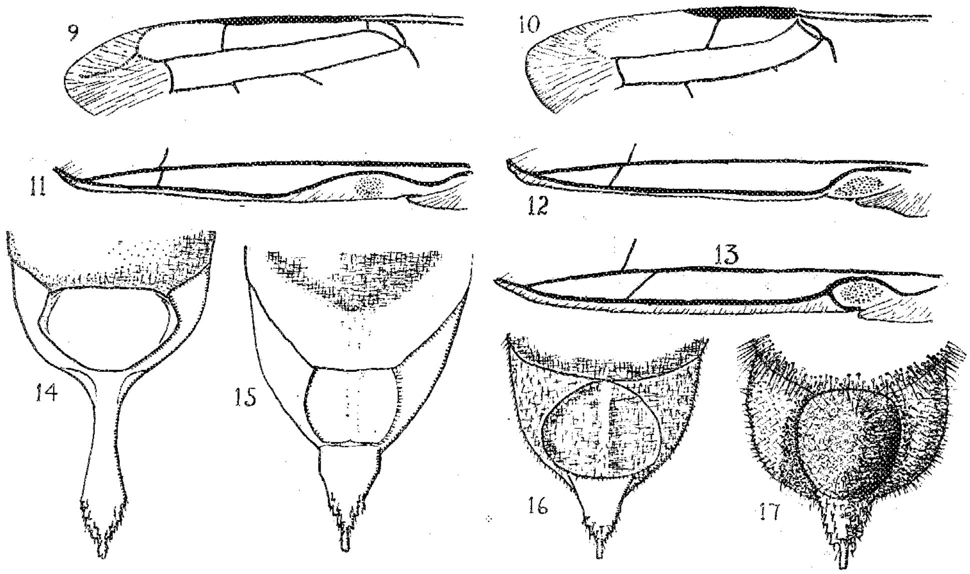
[E. Siberia and Japan; type: *Xoanon mysta*, Sem. 1921. ? 2 spp.—Takeuchi (1938) places this as a synonym of *Sirex matsumurae*, Rohwer 1910 (Japan), which I have not seen. Rohwer says "hair of head and thorax mostly black"; in the specimen before me, from Ussuri, a female as Rohwer's was, a most striking feature is that the pubescence of the whole insect is yellowish-brown not black.]..**Xoanon,** Semenov 1921

6. Flagellum with 14 or more segments; hind legs in both sexes flattened but not greatly dilated; forewing usually with only two transverse cubital veins (figs. 9 and 10)...7

Flagellum reduced to 3 segments; hind legs flattened, the tibiae and tarsi greatly dilated; forewing with three transverse cubital veins. [Not seen; Cuba; type: *Tremex cubensis*, Cress.; monotypic.]..........**Teredon,** Norton

7. Transverse radial divides radial cell of forewing in two almost equal portions or nearer the apex than the base of the cell (fig. 9); ♀ abdomen with depressed disc on 9th tergite flat or longitudinally carinate, with very fine coriaceous surface and, together with tergites 7 and 8, only very finely pubescent (fig. 16); cerci entirely absent.

[*T. hyalinatus*, Mocs., from the Congo and Gabun has the radial cell of the forewing divided as in the following genus (*cf.* Guiglia 1937) and may belong to a distinct genus. Holarctic (but absent from Pacific S.R. of N. America) and Oriental (Manchurian and Indo-Chinese S.R.); type: *Sirex fuscicornis*, F. ? 13 spp.]..**Tremex,** Jurine



Figs. 9–17. Portion of left forewing to show division of radial cell in *Tremex fuscicornis*, F. (fig. 9) and *Eriotremex smithi*, Cam. (fig. 10). Portion of left forewing to show anal cell in *Urocerus gigas*, L. (fig. 11), *Siricosoma tremecoides*, Forsius (fig. 12) and *Tremex fuscicornis*, F. (fig. 13). Apex of female abdomen from above to show form of cornus and disc with pubescence and sculpture in *Urocerus gigas gigas*, L. (fig. 14), *Sirex juvencus*, L. (fig. 15), *Tremex fuscicornis*, F. (fig. 16) and *Eriotremex smithi*, Cam. (fig. 17).

Transverse radial at about the basal 3rd of the radial cell of the forewing (fig. 10); ♀ abdomen with the depressed disc convex in the middle and strongly and coarsely punctured, and, together with the sides of tergites 7 and 8, densely hairy (fig. 17); cerci present in females.

[Oriental (Indo-Chinese and Malayan Subregions to New Guinea); type: *Tremex smithi*, Cam. (holotype); ? 8 spp.]..............**Eriotremex, gen. nov.**

Sirex, L., with a Key to the Females occurring in Europe.

Enslin (1918), trying to use characters suggested by Konow (1905) in the length of the pronotum and colour of the basal segments of the antennae, failed to distinguish more than one species of *Sirex* in Europe. By making use of other characters, particularly the proportions betwe.n the sawsheath and oblong plate, all the female specimens in the British Museum collection were segregated easily into distinct species. Among other striking characters might be mentioned the black apical tarsal segments on all the legs of both sexes of *S. noctilio*; it is astonishing that obvious characters of this sort can so easily be overlooked by worker after worker.

In the males there appear to be fewer characters available for separating the species. All have mainly red abdomens and black hind tibiae and tarsi. *S. cyaneus* and *juvencus* have reddish-yellow hind femora, reddish apical tergites and reddish-yellow apical tarsal segments, but the reddish-yellow bases of the antennae of *S. juvencus* should separate normal specimens of this species from *S. cyaneus*; *S. noctilio* has black hind femora, black apical tergites and a black apical tarsal segment to all legs.

1. Hind legs mostly black..2
   Hind legs mostly reddish-yellow...3
2. Ovipositor about as long as forewing; sawsheath about $1\frac{1}{2}$ times as long as oblong plate; wings dark violaceous. [Occasionally introduced into Britain from N. America.].. *areolatus areolatus*, Cress.
   Ovipositor much shorter than forewing; sawsheath not longer than oblong plate (see Konow 1905, pp. 113–114); wings brownish, paler at bases. [Bavaria, Bohemia & Hungary.]............................ *carinthiacus*, Konow.
3. All legs with the tarsus entirely reddish-yellow; sawsheath as long or longer than the oblong plate; mesopleura in the middle with shining interspaces larger than the punctures; ovipositor would reach from tegula to at least the middle of the radial cell of the forewing; middle tergites less densely wrinkled and shining laterally 4
   All legs with the apical tarsal segment black; sawsheath shorter than the oblong plate (fig. 1*a*); mesopleura so densely punctured that in the middle there are no interspaces larger than the punctures; ovipositor would only reach to base of radial cell of forewing; middle tergites very densely wrinkled and not shining laterally.
   [Ovipositor: forewing as about 1 : 1·47. N. and C. Europe, Siberia, N. Mongolia and Canada. Introduced into New Zealand.]...*noctilio*, F. (? = *atlantidis*, Ghigi 1909)
4. Sawsheath longer than oblong plate (fig. 1*c*); antennae apparently always entirely dark; ovipositor would reach at least almost to apex of radial cell of forewing from tegula..5.
   Sawsheath as long as oblong plate (fig. 1*b*); antennae typically reddish-yellow at base but entirely black in northern races; ovipositor would reach to about middle of radial cell of forewing (ovipositor : forewing as about 1 : 1·34).
   [Typical race N. and C. Europe, Crimea, Caucasus, Siberia, Japan; dark form from N. Europe (including Scotland), Newfoundland and Canada.]...*juvencus*, L. (? = *sucineiceps*, Koornneef 1935)
5. Ovipositor not reaching to apex of radial cell of forewing (ovipositor : forewing as about 1 : 1·19). [N. America, and Europe, ? Asia.]..............*cyaneus*, F.
   Ovipositor reaching beyond apex of radial cell of forewing (ovipositor : forewing as about 1 : 1·07). [E. Transcaucasia.].................................. *dux*, Sem.

Sirex carinthiacus, Konow.

I have not seen any representative of this species, and the characters are taken from Konow 1905, pp. 113–114.

Sirex noctilio, F. (and *atlantidis*, Ghigi 1909).

S. atlantidis, Ghigi 1909, from the Azores, was based on a single dwarf specimen (only 16 mm. long). In such dwarf specimens it is only to be expected that the head would be less swollen behind the eyes. The very short sawsheath and dark apical tarsal segments ("pedibus piceis") indicate *S. noctilio*. Ghigi's description of *S. noctilio* as having the sawsheath "più lunga" than the oblong plate suggests that he had actually specimens of *S. cyaneus* before him to represent this species (see below).

S. noctilio has not previously been recorded from North America (*cf.* Bradley 1913). In the British Museum collection, however, there is a female of this species from Hudson's Bay, St. Martin's Falls, Albany River, G. Barnston (B. M. 1844–17). The proportion of sawsheath to ovipositor for this species is shown in Table III and fig. 1*a*.

Sirex juvencus, L. (and *sucineiceps*, Koornneef 1935).

S. sucineiceps, Koornneef 1935, was described from a single specimen found in Holland and probably derived from *Pinus* wood imported from North Russia. According to the description it differs from *S. juvencus* only in having a semi-transparent and amber coloured head. No indication of size is given but the description suggests an abnormal specimen in which the head is incompletely pigmented. The antennae in *S. juvencus* are normally reddish-yellow coloured at the base, and this has in the past been used as a specific character. The British Museum has several specimens in which the antennae are entirely black; these are actually all from northern localities: Labrador, Newfoundland, Murman Coast and Scotland. As they also have rather paler wings than typical *S. juvencus*, they may represent a distinct northern race belonging to the northern coniferous belt of both the Nearctic and Palaearctic regions and possibly endemic in Scotland. It is not, however, clear that they should receive any taxonomic status, as their nature is unknown. They may, for example, be the direct affects of climatic conditions or result from some gene favoured by such conditions.

At any rate, as no American writers make any mention of "*S. cyaneus*" with pale bases to their antennae, it would appear probable that the conspicuous typical form of *S. juvencus* does not occur in N. America. The following are the specimens I have seen of *S. juvencus* with all-black antennae:

MURMAN COAST, Yukanski, 1♀, 19.vii.1917 (*E. A. Cockayne*, B. M. 1918–9); BRITAIN, 1♀, Stephens Collection (B. M. 1853–46); NEWFOUNDLAND, 1♀, (*J. Milne*) (B. M. 1875–36); LABRADOR, Hopedale, 1♀, 11.ix.1935, (*W. H. Perrett* B. M. 1935–551); SCOTLAND (in the Royal Scottish Museum), Banffshire, 1♀, (1930–144).

In all the specimens of *S. juvencus* which I have examined, the sawsheath is almost exactly as long as the oblong plate (fig. 1*b*) *cf. S. tianshanicus*, Sem. I might here mention that the type of *S. varipes*, Wlk. 1866 (British Columbia) agrees very closely with *S. juvencus* in structure, but differs in having black tibiae to all the legs. It was quite wrongly synonymised with *S. cyaneus* by Konow 1905, and may perhaps be of the same species as *S. californicus*, Ashm. 1904, which I have not been able to see and which is very inadequately described.

Sirex tianshanicus, Semenov.

One female of this species was kindly given to the British Museum in exchange by Dr. V. V. Gussakovskii. The species was described from the mountains of Turkestan and appears to be only distinguishable from the forms of *S. juvencus* with entirely black antennae by its slightly longer ovipositor, which, if stretched along the forewing would reach from the tegula to near the apex of the apical radial cell. The ovipositor forewing ratio estimated from Semenov's figures (1917) (fw. 16–23 mm.; ov. 12–17·5 mm.) would give about 1 : 1·33, this would place it among the species with a very short ovipositor (see Table II). An estimate from the specimen in the British Museum gives 1 : 1·15. There is, therefore, something wrong with Semenov's figures as also with those of his *S. ermak* which give the same ratio.

Sirex cyaneus, F., and *S. dux*, Semenov.

S. cyaneus is very similar to *S. juvencus*, but differs in that the sawsheath is always longer than the oblong plate; the actual proportions are shown in Tables I and III and figure 1*c*. Although long recognised as an established species in Britain, it has heretofore always been regarded as native only to N. America. The description of *S. juvencus* in Konow (1905, pp. 336–7) and Ghigi (1909) show, almost certainly, that they had European specimens of *S. cyaneus* mixed with their representatives of *S. juvencus*; likewise all the Nearctic representatives of this species group have heretofore been called *S. cyaneus*, though actually, as indicated above, both *S. noctilio* and *S. juvencus* also occur there, at least in the Hudson zone.

S. dux, Sem. (represented in the British Museum by a single female given by Dr. V. V. Gussakovskii) differs from *S. cyaneus* only, so far as can be seen, in the slightly longer ovipositor compared to forewing. The forewing ovipositor ratio, as calculated from Semenov's figures (1917) (fw. 23; ov. 21), is 1·09; this agrees closely with the ratio as estimated from the specimen in the British Museum 1·04 (fw. 23; ov. 22). The figures are therefore combined in Table II.

Xeris, Costa.

X. spectrum, L., is a very widely distributed species of the northern coniferous belt and in mountainous regions further south in North America as well as in Eurasia, even in Turkestan, the Caucasus and Atlas Mountains. In spite of its enormous and discontinuous range, it has not yet been possible to define satisfactory geographical races; two other related species, however, occur in North America, and it is replaced in the Himalayas by a fourth species. The significance of it not becoming established in Britain despite its great tolerance of climate, as indicated in its wide distribution, is discussed on p. 44.

According to Francke-Grosmann (1939), *Xeris* is peculiar in that no symbiotic fungi have been found associated with it. Whether this is a primitive or advanced attribute is not clear.

Urocerus, Geoffroy, with a Key to the Females of the Species occurring in Europe.

In the males of the European species, the pale head will separate *U. augur* and *fantoma* from the rest (fig. 6); the former has no black markings on the abdomen and the latter a black apex. Of the others, *U. gigas gigas* and *argonautarum* are distinguished by their reddish 7th tergite—the abdomen being black only from the 8th—and by their entirely yellow antennae. *U. albicornis* and *gigas flavicornis* males are very similar, both having the abdomen black from the 7th tergite and the antennae black at the apex; the former, however, has a hind basitarsus 6·4 to 8·1 times as long as broad and the latter only 4·1 to 5·6 times as long as broad (Peck 1937).

1. Abdomen at least partly red or yellow 2

   Abdomen entirely blue-black with at most lateral pale spots. [Wings smoky; antenna except apex and two or three basal segments, cheeks, sometimes lateral spots on abdomen, bases of tibiae and tarsi white; ovipositor would reach from tegula to middle of radial cell. North America, occasionally introduced into Britain but not established there.] *albicornis albicornis*, F.

2. Head yellow behind the eyes with at most a black longitudinal medial groove with sparse punctures each side (fig. 6) 3

   Head with the yellow spots widely separated by the black post-ocellar region, which is strongly punctured (figs. 3 and 4) [forms of *U. gigas*, L.] 4

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›portions are shown in Tables I
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Species occurring in Europe.

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there.] *albicornis albicornis*, F.

›lack longitudinal medial groove
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›y the black post-ocellar region,
forms of *U. gigas*, L.]............4

3. Hind tibia with basal 2/3rds black ; abdomen with at least tergites 3 to 7 and 9 banded with black above ; claws with large subapical tooth (longer than its basal breadth) ; ovipositor reaching from tegula to beyond the apex of the radial cell of forewing. [Forms of *U. augur*, F.].................................8

   Hind tibia all yellow with at most the extreme apex brown ; abdomen mostly yellow above with only tergites 6 and 7 banded apically with black and sometimes 4 and 5 with lateral spots ; claws with a minute subapical tooth (not longer than its basal breadth) ; ovipositor reaches only to first basal 3rd of the radial cell and is only about 2/3rds as long as the forewing. [Occurs in two widely separated provinces C. and E. Europe and again in W. Siberia.] ....*fantoma*, F. 1781 (=*tardigradus*, Cedj. 1796)

4. 9th tergite at least partly yellow above ; 8th tergite entirely yellow above......5

   9th tergite (excluding cornus) entirely black above and 8th tergite more or less black behind ; 9th sternite and ovipositor sheath entirely black externally.

   [Ovipositor/forewing ratio as about 1 : 1·26. Northern coniferous belt of N. America, occasionally introduced into Britain.]...........*gigas flavicornis*, F.

5. 9th tergite above largely black, with at least the disc mostly black ; ovipositor-sheath dark (black or piceous) and if stretched along forewing (fig. 2*c*) would reach from tegula to a point halfway between the apex of the stigma and the apex of the radial cell (ovipositor/forewing ratio about 1 : 130).................6

   9th tergite mostly yellow, with at least the disc entirely yellow, and, at most, black only on the basal margin ; ovipositor-sheath brown and would reach to apex of radial cell of forewing or beyond (fig. 2*a* and *b*) (ovipositor/forewing ratio as 1 : 1·11 or 1 : 1)...7

6. Hairs on head and thorax exceptionally long ; for instance those between the antennal sockets are longer than the first antennal segment (fig. 3) ; 2nd abdominal tergite mostly black behind. Himalayas. [TIBET : Zayul, Atakawg, 13,000 ft., 1♀ (holotype) 9.viii.1933 (*F. Kingdon Ward & R. J. H. Kaulback*) ; 28°25'N., 97°55'E., 10,000–12,000 ft. 1♀ (paratype), 11.ix.1931 (*F. Kingdon Ward*).] ....*gigas tibetanus*, **subsp. nov.**

   Hairs on head and thorax not abnormally long ; those between the antennal sockets, for instance, are little more than half as long as the first antennal segment (fig. 4) ; 2nd abdominal tergite entirely yellow. Finland, North Russia, Siberia and Japan.

   [FINLAND : 2 ♀♀ (including holotype), Watershed between 70°0'–70°17'N. and 25°50'–26°55'E., 1,000–2,000 ft., 19–20.vii.1938 and 1♀ near Kunes, Coastal area between 70°17'–70°23'N. and 26°40'–26°55'E., 23.vii.1938 (*A. F. O'Farrell*) (B. M. 1938–540). NORTH RUSSIA : Kola Gulf, 1♀, vii.1918 (*A. G. Carment*) (B. M. 1918–127). SIBERIA : 3♀♀, Cameron Coll. (B. M. 1896–76). *S. W. Siberia* : Kolpaslevo, 1♀, 20.vii.1924 (*G. Bei-Bienko*) (B. M. 1924–487). JAPAN : see fig. 23, plate V, Matsumura 1930.]......*gigas taiganus*, **subsp. nov.**

7. Ovipositor about as long as a forewing (fig. 2*a*). [Caucasus, Transcaucasia and Asia Minor (1♀ in B.M. from Amanus Mts.).]...*gigas argonautarum*, Sem. **(comb. nov.)**

   Ovipositor would reach only to about apex of radial cell of forewing from the tegula (ov./fw. ratio as 1 : 1·11) (fig. 2*b*). [C. and S. Europe, and Algeria ; introduced into S. America, Australia, etc.]..........................*gigas gigas*, L.

8. Abdominal tergites 7 entirely and 9 below black ; wings rich amber in colour with clearly defined infuscate margins. [Atlas Mts. (♀♀ in B. M.), Caucasus and Mts. of N. Persia and Turkestan.] ....*augur sah*, Mocs. **(comb. nov.)**

Abdominal tergites 7 with lateral pale band and 9 pale below ; wings yellowish-hyaline without clearly defined infuscate margins. [C. Europe and Asia Minor, occasionally introduced into Britain (Benson 1938).]...*augur augur*, Klug 1803 (= *cedrorum*, Smith 1860) **(syn. nov.)**

Urocerus albicornis, F., and *antennatus*, Marlatt.

Conde (1935, p. 68) suggests that *U. albicornis* of N. America is only a colour form of the East Asian *U. antennatus*. The two are, however, readily distinguished by the ovipositor/forewing and sawsheath/ovipositor ratios. Possibly they are really geographical fragmentations of one species and could be regarded as vicarious subspecies :

U. antennatus, Marl. 1898 : ovipositor longer than forewing (1 : 0·95) E. Asia.

U. albicornis, F. 1781 : ovipositor would only reach from tegula to middle of radial cell of forewing (ov./fw. ratio as 1 : 1·19) N. America.

Urocerus fantoma, F., and *xanthus*, Cameron.

U. fantoma, F. 1781 (= *tardigradus*, Cedj. 1796) occurs in two isolated provinces : C. and E. Europe and E. Siberia. Semenov (1921), solely on the basis of the small tooth it has to its tarsal claws, separates it into a distinct genus *Xanthosirex*, which I do not regard as valid. *U. xanthus*, Cam. 1876 (W. Himalayas) is very similar in colour and structure, but has a much stronger tooth to the claws and a longer ovipositor :

U. fantoma : ov./fw. ratio 1 : 1·41.

U. xanthus : ov./fw. ratio 1 : 1·04.

Urocerus gigas, L., and its subspecies.

Heretofore the two supposed species *U. gigas*, L., and *flavicornis*, F., have been separated only on differences of colour and country of origin. All Palaearctic forms were called *U. gigas* and all Nearctic forms *flavicornis*, the latter being always darker, and strikingly so when compared, as it usually is, with specimens from Central Europe. Bradley (1913) recognised the striking similarity between Nearctic and east Asian forms, and actually identified some forms from east Asia as belonging to the Nearctic species *U. flavicornis*. This appears to have been overlooked by later writers ; Gussakovskiĭ (1935), Conde (1935) and Takeuchi (1938) for example treated the E. Asian form as typical *U. gigas*.

Conde, however, could find no morphological differences between the specimens he called *U. gigas* and those he called *U. flavicornis* ; he therefore suggested that the two should be regarded simply as two colour forms of the same species.

All workers seem to have overlooked the differences in ovipositor length (figs. 2*b* and *c*) ; this is all the more remarkable seeing that Semenov-Tian-Shianskiĭ (1921) drew attention to ovipositor lengths by describing a third species *U. argonautarum* (Caucasus and Transcaucasia) on the basis of its exceptionally long ovipositor (fig. 2*a*). The proportional differences of the ovipositor/forewing ratio between *argonautarum* and *gigas* are actually less than between *gigas* and *taiganus* (the ov./fw. ratios in these three forms being 1 : 1, 1 : 1·11, and 1 : 1·30) ; *taiganus* is very similar to *flavicornis* in structure but has less developed dark markings, while *tibetanus* differs from *taiganus* only in the longer hairs on its head (fig. 3). These forms are obviously closely related to each other and are better regarded as subspecies of one species, with a tendency to darker pigmentation towards the east and a longer ovipositor in more southern climates.

Through the carriage of timber between different parts of Europe and N. America there appear to be a certain number of intermediates, especially in the areas where *taiganus* and *gigas* meet—in Britain and north-east Europe (see p. 46). In computing the ov./fw. ratios of these two forms, British specimens were therefore excluded, as also were any continental specimens showing intermediate colour pattern.

The different lengths of ovipositors in these forms are correlated naturally with a very different general facies. In the forms with a longer ovipositor, the apex of the abdomen is much sharper and the basal sternites are more crowded together, with the effect that the apex of the hind femora will reach to the base of the ovipositor; in the forms with a shorter ovipositor, the apex of the abdomen is more obtuse and the hind femora do not reach as far as the base of the ovipositor.

Urocerus augur, Klug.

U. augur, Klug, is here regarded as consisting of two subspecies. *U. cedrorum*, Smith (Asia Minor) is not distinguished from the European *U. augur augur*, and it is difficult to understand why Konow, in his haste to be rid of it, should have placed it as a synonym of *U. fantoma*, F., a very different species. *U. sah*, Mocs. (on the basis of specimens so named by Gussakovskii) differs only in colour from typical *U. augur* and is relegated to the position of a subspecies. *U. japonicus*, Smith (holotype examined) is superficially very similar to typical *U. augur* and may be of the same stock, but, as pointed out by Takeuchi (1938), it differs from all other known SIRICIDAE in having no barbs on the apex of the ovipositor sheath.

The mean ovipositor/forewing ratio of the few specimens of *U. augur* examined is as 1 : 1·03; insufficient material was available to tell whether significant differences exist between the two races. In *U. japonicus*, Smith, the figure is approximately the same (1 : 1·05).

Tremex, Jurine, with a Key to the Males and Females of the Species occurring in Europe.

Unfortunately I have had only extremely limited Palaearctic material of this genus to work with. The most widespread species, *T. fuscicornis*, F., appears to be very closely related to the Nearctic *T. columba*, L., being somewhat intermediate in body colour between the dark *T. columba columba* (Bradley 1913) of the Central and Eastern States of U.S.A. and the paler bodied subspp., *sericea*, Say (Southern States) and *aurea*, Bradley (Rocky Mountains). West of the Rocky Mountains and in the northern zone *T. columba* does not apparently occur, owing presumably to the scarcity of hardwood trees, so that *T. columba* is widely separated geographically from the eastern limits of the present range of *T. fuscicornis* in Asia. Structurally the two species, on the basis of the limited material before me, can be separated as follows:—

T. columba, L. 1763: ocelli closer together, so that POL : OOL is less than 1 : 1·5; Nearctic.

T. fuscicornis, F. 1787: ocelli further apart, so that POL : OOL is nearly 1 : 2; Palaearctic.

T. magus, F., is not represented in the British Museum at all, but I have examined a pair in the Hope Department at Oxford; of *T. alchymista*, Mocs., there is a single male and female in the British Museum. To this genus, as restricted above, belong:— *T. alchymista*, Mocs. ♂♀ (Europe), *apicalis*, Mats. ♂♀ (Japan), *atratus*, Mocs. ♀ (Tonkin), *chujoi*, Sonan ♀ (Formosa), *columba*, L. ♂♀ (N. America), *fuscicornis*, F. ♂♀ (Europe and Siberia), *insularis*, Smith ♀ (Malay, holotype examined), *longicollis*, Konow ♀ (Japan), *jakovlevi*, Sem. ♀ (Transcaucasia), *magus*, F. ♂♀ (Europe) and possibly also *T. flavicollis*, Cam. ♀ (but see under *Eriotremex*); in addition the following were described only from males and may later be correlated with known females: *pandora*, Westw. ♂ (E. India and China), *satanas*, Sem. ♂ (Transbaikal and Ussuri) and *nigra*, Sonan ♂ (Formosa).

Tremex rugicollis, Westw. ♂ (Philippines) and *T. viridiceps*, Cam. ♂ (Borneo) were also described only from males: of these *T. viridiceps* is dealt with under *Eriotremex* where it may belong, but *T. rugicollis* (the type of which I have not seen) would appear from its long setiform antennae and two-spurred middle tibiae (Westwood 1874, plate 20, fig. 9) not to belong to the TREMECINAE at all. Konow (1905, p. 342) mentions that the left forewing of the figure of the type has four cubital cells and the right only three; this is not so in the copy of Westwood in the Tring Museum—both wings being figured here as having but three cubital cells.

T. hyalinatus, Mocs. (W. Africa: Congo and Gabun) has the transverse radial vein near the base of the radial cell, as in *Teredon*, Norton, and *Eriotremex*, gen. nov., and possibly represents still another genus, but no specimens have been available for study.

Key to European Tremex *Jurine* (*Males and Females*).

1. Antenna black, either with white apex (♀) or with entirely black legs (♂); wings at apices, or entirely, dark brown; hind ocelli close together (POL= OOL approximately) 2

   Antenna brown, more or less infuscate at apex (♀), if entirely black (♂) legs are partly brown; wings yellowish; hind ocelli far apart (POL greater than $1\frac{1}{2}$ OOL); tarsal claws with large sub-basal tooth. [Europe and E. Siberia.] ♂♀ *fuscicornis*, F.

2. Wings entirely dark brown; abdomen black, in ♀ with only the middle sternites white-flecked, in ♂ with pale lateral margins to segments; tarsal claws with an obsolete sub-basal tooth, much shorter than its basal breadth. [Hungary.] ♂♀ *alchymista*, Mocsáry

   Wings only dark brown at their apices; abdomen black, in ♀ generally richly flecked with white above, but in ♂ entirely black; tarsal claws with a large sub-basal tooth longer than its basal breadth. [C. and S. Europe, S. Russia and Crimea.] .... ♂♀ *magus*, F.

Eriotremex gen. nov. with a Key to its Females.

♂♀. *Head* without lateral carina behind the eyes; labial palps 2-segmented; antenna swollen in middle and short (would not reach as far as base of stigma if stretched along the forewing from the tegula) and set very far apart (so that the distance between the antennal sockets is about three times as great as the distance between one of them and the nearest eye-margin); flagellum with more than 14 segments. *Forewing* with only two transverse cubital veins and with the transverse radial vein near the base of the radial cell (fig. 10) (the apical portion of the radial cell is about twice as long as the basal portion); anal vein at about half way from the base of the anal cell with a short projecting branch to the wing margin (as in *Tremex*, *Teredon* and *Xeris*, *cf.* fig. 13). *Cenchri* pear-shaped and scarcely broader than long. ♀ *Abdomen* with depressed disc on 9th tergite convex in the middle and (except in *T. flavicollis*, Cam., which may not belong here) strongly and coarsely punctured (fig. 17); small cerci present in ♀. *Pubescence* in ♀ very long and dense; on lower face it is longer than the 3rd antennal segment; on the abdomen it is developed more on the apical than basal segments, the sides of tergites 7 and 8 being clothed in long dense hairs.

Type: *Tremex smithi*, Cameron (holotype ♀) (E. India).

To this genus also belong *Tremex formosanus*, Mats. ♀ (Formosa and Indo-China), *T. insignis*, Smith ♀ (Aru), *T. konowi*, Lange ♀ (New Guinea), *Eriotremex malayanus*, sp. nov. ♂, ? *Tremex flavicollis*, Cam., ♀ (Assam), and ? *T. viridiceps*, Cam., ♂ (Borneo).

In the following key to females, *Tremex flavicollis*, Cam., is included because of its close superficial similarity to *E. formosanus*, Mats., although there is nothing else in its original description to indicate that it belongs to *Eriotremex*. *Tremex viridiceps*, Cam. ♂ (Borneo) had to be omitted as its female has not been described (at any rate under this name) and its original description is entirely inadequate even to show its relationships—it is mentioned here as possibly a species of *Eriotremex* mostly for geographical reasons (but note that the Malayan *Tremex insularis*, Smith, has forewings of typical *Tremex*, but unfortunately the abdomen of the unique type in the Hope Department is missing). I have indicated above that the type of *Tremex viridiceps* is a male; this is not in accordance with the original description which describes it as female. A male labelled as type in Cameron's handwriting came to the British Museum from Cameron's collection (1914–110); the size, colour-pattern of abdomen and other data (" Kuching, Oct. 1906, J. H.") agree with the original description of the unique type. At the same time it seems almost incredible that a male Siricid could be mistaken for a female. That the mistake was not simply a wrongly placed " ♀ " sign is shown by the description of the produced hypopygium as " ovipositor short, narrow." Unfortunately the specimen is now in very bad condition, and has no forewings left, so that it cannot be placed generically. Its tarsal claws are without a sub-basal tooth, and this, with its pale pronotum, suggests a possible relationship with *E. malayanus*, sp. nov.

Key to Eriotremex **gen. nov.** *Females.*

1. Tarsal claws with a well-developed sub-basal tooth in addition to a slight basal lobe 2

   Tarsal claws without a sub-basal tooth [♀ not known, but ♂ has pronotum yellow above and wings smoky at least apically]....*viridiceps*, Cam. (Borneo) and *malayanus*, sp. nov. (Malay)

2. All pubescence yellow, so also are pronotum, tibiae and basitarsi (except at their apices), wings and at least three complete bands on dorsum of abdomen...3

   Pubescence on lower face and underside black, and either black or silvery white elsewhere; pronotum black; legs piceous; wings hyaline and/or smoky; dorsum of abdomen with at most one complete yellow band....................4

3. Abdomen with yellow bands narrow on bases of tergites 2 and 3, broad on tergite 5; scutellum smooth and shining; disc on apical tergite smooth and unpunctured; frons with a short tooth above the antennae. [Not seen. Assam. ? belongs to *Tremex*.] ....*flavicollis*, Cam.

   Abdomen with broad yellow bands on bases of tergites 2 and 8 and with narrow bands on bases of tergites 3 and 7; scutellum dull with close fine punctures as rest of mesonotum and profusely pubescent; disc on apical tergite dull with dense coarse punctures; frons without tooth above antennae. [Formosa and Indo-China.]....................*formosanus*, Takeuchi

4. Pronotum with a large smooth shining area each side; wings uniformly smoky; abdomen with tergites 5 to 9 smooth shining and almost impunctate and but sparsely pubescent above; all pubescence black.

   [The three forms placed here may prove to be no more than colour forms of one species.]....................5

   Pronotum dull all over with coarse warts and rugae; wings with at least hind pair largely hyaline; abdomen above dull all over with fine punctures and microsculpture and densely pubescent apically; pubescence black on lower face and underside generally but silvery white on upper face and dorsum of abdomen.

   [Abdomen all dark metallic blue or purple, or (type) with lateral basal pale marks more or less developed, especially on terga 2, 3, 7 and 8. Type and one other specimen in British Museum. Indo-Chinese subregion.]...*smithi*, Cam.

5. Abdomen with some of the basal tergites white-marked..............................6

Abdomen without pale markings. [Malay (Westwood 1874); N. Borneo (Forsius 1934 as "*Tremex insignis*, Smith"); not seen.]...*purpureipennis*, Westw. 1874.

6. 1st tergite of abdomen with a narrow transverse fascia in the middle and the 2nd very narrowly white at the base. [Type in Hope Department seen. Aru.]..*insignis*, Smith 1859.

1st tergite of abdomen immaculate; 2nd tergite with lateral basal broad white marks; tergites 4 to 6 with basal medial triangular white masks. [Not seen. N. Guinea.]..*konowi*, Lange 1909.

Eriotremex malayanus, **sp. nov.**

This species was described by Forsius 1934, *Bull. Raffles Mus.* **5** pp. 172–173, following his note on "*Tremex insularis*, Smith." Unfortunately the name heading his new species was omitted! Among the type specimens from this collection, that came to the British Museum, is the one here described as it bears a manuscript label in Forsius's handwriting "*Tremex malayana n. Holotypus. det.*" Hedicke (1938) unfortunately has already taken the description to refer to the male of *T. insularis*, Smith. This is manifestly impossible from the text, for had this been Forsius's view he would have scarcely described the male as "*holotypus*" and mentioned that the female was unknown.

In the key above, I have drawn attention to a rather important character, not mentioned by Forsius, the fact that the tarsal claws of this new species have no sub-basal tooth; a character which, together with a pale pronotum, it shares with *Tremex viridiceps*, Cam., ♂ (which may also belong to *Eriotremex*). *T. viridiceps* can easily be distinguished by the pale markings on the abdomen. It might here be mentioned that *Tremex alchymista* (but not *magus*; see under *Tremex* above) and *T. pandora* (Westwood's type ♂ in the Hope Department) also have claws without a sub-basal tooth.

Eriotremex formosanus, Matsumura.

A single female in the British Museum collected by R. V. de Salvaza in Indo-China, Haut Mekong, Vien Poukha, 11.v.1918, agrees closely with the redescription and figure of this species given by Sonan 1938 (pp. 93–94 and fig. 3).

It would appear, therefore, that this species is not limited to Formosa, but has a wider oriental distribution.

In colour the species appears to be rather similar to *Tremex flavicollis*, Cam. (Assam), but the very different sculpture suggests that the latter does not belong to *Eriotremex* at all.

British Siricidae.

(a) Recorded British Species.

Waterston (in Chrystal 1928) regarded *Urocerus gigas*, L., *Sirex cyaneus*, F., ? *S. juvencus*, L., and *S. noctilio*, F., as established British species. Species occurring occasionally but not apparently established he lists as: *U. albicornis*, F. (Nearctic), *U. flavicornis*, F. (Nearctic) and ? *augur*, Klug (C. Europe). *U. augur*, Klug (=*cedrorum*, Smith) is confirmed by Benson 1938. To these must be added *Xeris spectrum*, L. (Roebuck 1906 and Saunt 1925) and *Sirex areolatus*, Cresson (Saunt 1925).

(b) Is there a Native Siricid Element in Britain?

Waterston and others have assumed that none of these species was truly native in Britain. At the same time it must be remembered that the old Caledonian forest is simply an extension of the great circumpolar northern coniferous belt, the taiga, and that where the forest could spread so probably could the SIRICIDAE, and that two or three species are able to flourish in our climate to-day.

There seems no reason why we should necessarily assume that any post-glacial native element would have been exterminated with the great destruction of the ancient forests in Scotland, Ireland or even in England. For even in England conifers were being planted before the end of the 17th century (Tansley 1939, pp. 181–189); that is to say before the native conifer forests in England were entirely destroyed. If our plantations are so readily infected, as has been assumed, by SIRICIDAE emerging from imported timber, could they not have been infected by native SIRICIDAE from the old forest relics ? Admittedly timber was being imported in quantity into north-east Britain from north Europe by the 13th and 14th centuries, and our species may easily have been brought in then. But, if this is so, why of all the species brought in should the common *Xeris spectrum*, L., with the widest geographical distribution, and therefore presumably the greatest tolerance, never have succeeded in establishing itself, though known to have been introduced ?

(c) Is there a native British Form of Urocerus ?

Among the British *Urocerus* in the British Museum there is one specimen from Perthshire, Murthly, 15.vii.1909, with an ovipositor/forewing ratio of 1 : 1·24, that is to say within the known range of *U. gigas taiganus*, but coloured as in normal *U. gigas*. In the Royal Scottish Museum Collection I was able to find two more specimens with a short ovipositor, one labelled " Aberdeen 1925–134 " and the other " Whittingham, E. Lothian "; in both these the ovipositor/forewing ratio is 1 : 1·23 and, furthermore, they approach *taiganus* in colour, both having the 9th tergite broadly black at the base and the ovipositor black. Similar specimens occur in the British Museum from other northern localities, Norway, Lapland, etc. Because of these specimens, British and pale northern forms were excluded from the statistics in Table II, as it was thought they might indicate hybridisation between the two sub-species.

Such a possibility is further suggested when specimens from Scotland, England and Central Europe are treated separately for ovipositor/forewing ratios :—

	No.	Mean	Max.	Min.	Standard error
(*a*) Scotland	16	1·16	1·24	1·05	0·012
(*b*) England	28	1·13	1·19	1·07	0·007
(*c*) Central Europe	27	1·11	1·17	1·06	0·006

Between samples (*a*) and (*b*) this difference is significant when the appropriate tests are applied ($P = 0{\cdot}01$) ; between (*b*) and (*c*), however, the significance is less certain ($P = 0{\cdot}056$ to $0{\cdot}02$).

If, furthermore, we examine the colour, taking, for example, the colour of the ovipositor sheaths, we find it is black to dark brown in all specimens of *U. gigas taiganus* and brown in typical *U. gigas gigas*, but that dwarf specimens of *U. gigas gigas* (with forewing length of less than 16 mm.) have a dark sheath and approach *taiganus* generally in colour.

If now we divide the above specimens according to whether the ovipositor sheath is black to dark brown or dark brown to brown (omitting dwarfs), we get :—

	Total	Sheath dark
Scotland	16	8 = 50%
England	26	0 = 0%
C. Europe	23	4 = 17·4%

When the ovipositor/forewing ratios were compared between the eight dark and eight light Scotch specimens both gave the same mean result: 1·16! This suggests that there is no evidence of correlation between short sheath and dark sheath.

From the above it is clear that there is a significantly larger proportion of darker specimens and specimens with shorter ovipositors in samples from Scotland than in samples from England and Central Europe. This may be the direct result of climatic conditions in Scotland, within historic times, favouring the survival there of individuals showing these tendencies in imported stocks of *U. gigas gigas*, or it may indicate the presence in Scotland of a different race. Such a race may have survived as an endemic element in the northern British coniferous forests; alternatively, a *taiganus* or *flavicornis* element may have been established from importations of North European or American origin, and have been able to survive more readily in our northern forests than *U. gigas* introduced from a more southern latitude.

Unfortunately I have not been able to examine any SIRICIDAE known to have been captured in any Caledonian forest relic. Any such specimens would naturally be of very great interest in this connection.

(d) Is the dark Form of Sirex juvencus native in Britain?

As indicated above, *Sirex juvencus*, though normally having brownish-yellow bases to the antennae, occurs in the extreme north (Murman Coast, Labrador and Newfoundland) in a form in which the antennae are entirely black. In the Royal Scottish Museum there is a similar specimen from Banffshire.

Of the typical form of *S. juvencus* I have seen no Scotch specimens, the only British ones being from Southern England.

W. Evans (1922) had likewise seen no typical *S. juvencus* when he discussed the distribution of SIRICIDAE in Scotland. Waterston (1928) doubted whether "*S. juvencus*" was established in Britain. A re-examination of the material in collections is now called for, as, even in the British Museum collections, all the specimens of *S. juvencus* with dark antennae had been placed by previous workers as *S. cyaneus* or *S. noctilio*. Further British specimens of the dark form of *S. juvencus* may well exist in collections and their discovery might throw more light on its possible significance.

THE SIRICIDAE WERE NOT DERIVED FROM THE JURASSIC PSEUDOSIRICIDAE.

In the SIRICIDAE, as in some other orthandrious sawflies, the more generalised forms (SIRICINAE) are attached to coniferous trees and the more specialised (TREMECINAE) to angiosperm trees. The SIRICINAE are spoken of as more generalised because, in their antennae, mouth-parts, venation and cerci, they differ from the TREMECINAE by being less reduced and thus more like the earliest known fossil insects.

With the help of Dr. F. E. Zeuner, I examined the type of *Megapterites mirabilis*, Cockerell (Eocene); here also the cross veins are evidently reduced, though, beyond part of the forewings, nothing is preserved to indicate that the insect was even Siricoid. When we come, therefore, to the PSEUDOSIRICIDAE (an extinct fossil family common in the Upper Jurassic of Solenhafen, Bavaria) we are surprised to find that, though they are remarkably similar to SIRICIDAE in general form, the cross-veins in the forewings have been in some respects, even here, further reduced than in modern *Tremex* (*cf.* Tillyard 1927, figs. 1 & 2).

Now it is unlikely that the cross-veins, after being lost in the Jurassic PSEUDOSIRICIDAE, would have been regained in modern sawflies. That these cross-veins are (contrary to Tillyard's view) of great antiquity, is suggested in comparing the wings of modern Megaloptera with modern XYELIDAE (as was done by Ross 1936) or with Martynov's figure of the forewing of *Liadoxyela* (Lower Jurassic) (Martynov 1937)—the earliest known Hymenopteron: not only the number but also even the positions of these cross-veins are shown to be almost identical!

This leads to the conclusion that the PSEUDOSIRICIDAE (U. Jurassic) and *Megapterites* (Eocene) were not in the direct line of any modern sawfly group and could not have been the progenitors of the SIRICIDAE.

HIMALAYAN AND ORIENTAL SIRICIDAE.

Sonan (1938) describes some species known to him in Formosa; any of these Formosan species (see *Eriotremex formosanus*, Mats., above, and *Urocerus multifasciatus*, Takeuchi, below) may be widespread Oriental species.

Urocerus koshuna, Sonan (apparently close to *U. multifasciatus*).

U. niitakana, Sonan, with its var. *tsutsujiyamana* (may be forms of *U. japonicus*, Smith—a species rather variable in colour but distinguished from all other *Urocerus* by the absence of barbs near the apex of the sawsheath).

Tremex chujoi, Sonan (? related to *T. longicollis*, Konow, of Japan).

T. nigra, Sonan (? male of *T. chujoi*).

Apart from *Siricosoma*, *Tremex* and *Eriotremex*, which have been dealt with above, the following Oriental and Himalayan SIRICIDAE are represented in the British Museum:—

Xeris himalayensis, Bradley 1934.

This species was described from a single pair taken at about 9,000 ft. in the United Province. In the British Museum there is a female from Kashmir, near Gulmerg, 5,000–9,000 ft. (*J. E. T. Aitchison*) (B. M. 1896–255). Takeuchi (1938) records the widespread *X. spectrum*, L., from Formosa.

Urocerus xanthus, Cameron 1876.

In addition to the holotype from "North India" the British Museum contains specimens taken from 5,000–9,000 ft. in Kashmir and in Punjab. For comparison with *U. fantoma* see discussion above under that species.

U. gigas tibetanus, **subsp. nov.**

This form from Tibet is closely allied to the northern-coniferous-belt *U. gigas taiganus*, subsp. nov., and is included for this reason in the key above to the European *Urocerus*.

U. multifasciatus, Takeuchi 1938.

In the British Museum there is a single female (from North Burma, Adung Valley, 12,000 ft., 23.viii.1931, *F. Kingdon Ward*), which agrees very closely with Takeuchi's description of the single specimen (from Formosa) which he made the basis of this species. The colour pattern is the same except that the Burma specimen has the mesonotum in the middle, the scutellum and the upper part of the mesopleura brown; as the ovipositor/forewing ratio is also approximately the same (0·98 : 0·97) the two specimens are probably conspecific.

Unfortunately in Takeuchi's figure of his specimen (1938, p. 190, fig. 4) the ovipositor has been drawn much too long. My reason for saying this is that it does not agree with two independent measurements he gives :—

(i) He says that the ovipositor projects by 8 mm. beyond the tip of the cornus, which is 5 mm. long ;

(ii) He says that the ovipositor extends " a little less than twice the length of the cornus beyond tip of the latter."

In his figure the ovipositor is drawn as extending more than three times the length of the cornus beyond the apex of the latter.

Urocerus niger, **sp. nov.**

♀. *Colour* : black with the following parts yellowish-white ; head behind the eyes (except for the frons and a longitudinal vertical stripe about as wide as an eye) ; antennal segments 3 to 11 and the bases of 12 and 14 ; basal 2/5ths of front tibia ; basal 1/3rd of front basitarsus ; basal 3/4ths of middle and hind tibiae and basitarsi, and extreme bases of 2nd and 3rd tarsal segments of same. *Wings* fuscohyaline with black venation. *Size* : forewing 29·5 mm. ; ovipositor 28·5 mm. ; sawsheath 18 mm. ; antenna 19·5 mm. ; ov. : fw. ratio 1 : 1·04 ; sawsheath : ov. ratio 1 : 1·60. *Sculpture* : head with pale parts shining, almost impunctate and naked as in *U. augur* ; rest of head and thorax dull and irregularly punctured ; coarse on the hind parts of the mesonotum and on the mesopleura ; very coarse on the pronotum above. Abdomen with terga 1 and 9 to 10 shining and almost impunctate ; terga 2 to 8 dull with dense transverse rugulae, less developed on the apical 3rd of the terga and the whole of tergum 8. *Head* with a very deep medial vertical furrow ; antenna 24 segmented ; eyes small so that in dorsal view the length of the eye is about as long as half the length of the head behind the eye (in all other *Urocerus* spp. it is 2/3rds to 3/4ths this length). *Mesonotum* with a slight but distinct medial longitudinal furrow. Otherwise in structure including pubescence and wing-venation as in *Urocerus gigas gigas*.

S.E. Tibet, Zayul, 1♀, 7,000–12,000 ft., summer 1935 (*R. J. H. Kaulback*) (B. M. 1937–547).

In colour this species is apparently rather similar to the eastern Palaearctic *Urocerus umbra*, Sem., and in the ovipositor/forewing ratio it agrees closely with this species (1 : 1·04 and 1 : 1·08). It differs, according to the description, in the following points : the antennae are black instead of pale at the apex ; the venation is all black instead of being white at the base of the forewing ; the wing membrane is fuscohyaline instead of brownish-yellow ; the abdomen is entirely black instead of being yellow-flecked on the sides of terga 5 and 6.

The small eyes separate it from all other *Urocerus* spp. that I have examined (but I have not seen any *U. umbra*, Sem.). The rather similarly coloured *U. antennatus*, Marl. (Japan), *albicornis*, F. (N. America) and *taxodii*, Ashm. (N. America) differ, in addition, by having the pale naked spots on the head widely separated on the vertex.

Sirex imperialis, Kirby.

This species is represented in the British Museum by two specimens : the ♀ holotype from " N. India " and a ♀ from Punjab, Kangra Valley, 4,500 ft., June 1899 (*G. C. Dudgeon*).

Structurally it is very close to *S. noctilio* but differs in its entirely black legs, more strongly infuscated wings and less densely punctured mesopleura—punctured as in *S. juvencus*. It has a shorter sawsheath than the similarly coloured *S. ermak*, Sem. (China, Sze-tschuan) and *S. varipes*, Wlk. (British Columbia) ; from *S. carinthiacus*, Konow (W. Europe), *S. nitobei*, Mats. (Japan) and *S. mongolorum*, Sem. & Guss. (N. Mongolia), whose sawsheaths I have not had an opportunity of measuring, it differs by having all its legs entirely black. It is apparently closely related to *S. vates*, Mocs. (China, Sze-tschuan), but this is described as having a dull black, not metallic abdomen. The Nearctic *S. edwardsi*, Brullé, has an even shorter sawsheath and together with *S. obesus*, Bradley, has a clearly shouldered cornus (Bradley 1913).

Summary.

1. These studies were originally intended to form the basis of a world monograph of the SIRICIDAE ; such a work cannot be completed under present circumstances.

2. Two ratios are introduced as useful characters for separating species : the ovipositor/forewing ratio and the sawsheath/ovipositor ratio. These ratios were obtained from all specimens of all the species represented in the British Museum collections and the results are tabulated. They were found not to vary with the size of the insects.

The former ratio is specially useful in the genus *Urocerus*, which has a long ovipositor, and the latter ratio in the genus *Sirex*, which has a shorter ovipositor.

3. Keys are given to the genera of the world. Of Semenov's new genera, *Xoanon* is accepted but not *Xanthosirex*. A new genus *Eriotremex* is erected for certain Indo-Malayan species previously included in *Tremex*.

4. Keys are given to the European species, which are compared critically with related species from other parts of the world. A key to the species of *Eriotremex*, gen. nov., is also given.

5. *Sirex noctilio*, F., and *S. juvencus*, L., are recorded for the first time from North America and *S. cyaneus*, F., from the continent of Europe. The common *Urocerus* of the northern Palaearctic region is shown to be more closely related to the Nearctic *U. gigas flavicornis*, F., than to the central European *U. gigas gigas*, L., and is treated as a new subspecies—*U. gigas taiganus*, subsp. nov. *U. gigas tibetanus*, subsp. nov., is described from the Himalayas. *U. sah*, Mocsáry, is treated as a subspecies of *U. augur*, Klug, and *U. cedrorum*, Smith, as a synonym of *U. augur augur*, Klug.

6. The British SIRICIDAE are discussed, and it is suggested that *U. gigas taiganus*, subsp. nov., and the form of *S. juvencus*, L., with entirely black antennae may be native in the Caledonian forest.

7. It is argued that modern SIRICIDAE could not have been derived from the Jurassic PSEUDOSIRICIDAE.

8. The known Oriental and Himalayan SIRICIDAE are listed and discussed. *Urocerus multifasciatus*, Takeuchi, and *Eriotremex formosanus*, Matsumura, are mentioned as two species originally described from Formosa but shown also to occur on the mainland. *Urocerus niger*, sp. nov., is described from the Himalayan region, and the name *Eriotremex malayanus*, sp. nov., is given to a form described without a name by Forsius from Malaya.

9. Several errors in previous work on SIRICIDAE are corrected.

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