Notes on *Sirex juvencus californicus* (Hymenoptera: Siricidae), with a Description of the Male and a Key to the California Species of *Sirex*

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Abstract

For the first time the male of *Sirex juvencus californicus* (Ashmead) (= *Sirex obesus* Bradley, new synonymy) is described; the female is redescribed. Biological notes on this subspecies are included, together with a key to the California species of the genus.

Benson (1962) reduced to subspecific rank under *Sirex juvencus* L. five forms previously treated as separate species, namely, *S. juvencus* L., *S. carinthiacus* Konow, *S. mongolorum* (Semenov & Gussakovskij), *S. ermak* (Semenov), and *S. californicus* (Ashmead). He characterizes these circumboreal subspecies as having ". . . a progressive darkening of the leg colouring eastwards from Europe across Siberia to California", and goes on to suggest that they may be in fact ". . . no more than stages in a cline". *S. juvencus californicus* represents the extreme of darkening, being noted as having "legs all infuscate".

A series of females from Nevada considered to be *S. juvencus californicus* do not have the legs completely infuscated, rather they usually possess a reddish-brown area on the distal portion of each femur. The Arizona-collected type of *S. obesus* Bradley that is synonymized later in this paper under *S. juvencus californicus* is now noted as having legs of red–brown (H. J. Grant, Jr., personal communication, 6 December 1965). The colour factor may or may not be valid for the males. As will be noted below, only the coxae of *S. juvencus californicus* are metallic greenish black, the remainder of the legs being reddish brown. The writer has examined males of only this subspecies, and is not aware of a description of the male of *S. juvencus mongolorum.*

Benson (personal communication, 13 January 1965) has summed up the problem of siricid taxonomy as follows:

> "I feel that there is still a great deal to be found out about the taxonomy of the Siricidae, and the great need is still the accumulation of material for study. I do not think we yet understand the species pattern: how many species there are and where the distinctions between them lie. Many of them are still separated only on colour differences which could be of geographical significance only."

During the summer of 1964, a long series of both sexes of *S. juvencus californicus* was recovered from *Pinus jeffreyi* Murr. This subspecies was originally described as *Paururus californicus* by Ashmead (1904), the rather sketchy description being based on two females. A supplementary description of the female is included in this paper. Until now, the male has been unknown.

As is common with *Sirex* spp., considerable variation in size and colouring was noted in this series of insects. The amount of infuscation of the wings varied from ". . . on the apical margin and across middle" (= *californicus*) to ". . . uniformly dark violaceous (= *obesus*) (Middlekauff 1960). Therefore six females were sent for comparison with the type of *obesus*. In a letter of 6 December 1965, H. J. Grant, Jr., provided the following information:

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> ". . . The females from Incline in variation do not differ significantly from the type. In all points of morphology there is a reasonable similarity. The greatest point of departure is found in coloration. While your series of females have the head, thorax, abdomen and legs metallic blue–black, the following condition is noted in the type: Head and thorax dull brownish-black; abdomen red–brown; legs red–brown. The wings of the type are completely infuscated, the anterior ones show a slight darkening in a broad band adjacent to the costal border. In my considered opinion the females of *S. juvencus californicus* are conspecific with the type of *S. obesus.*"

Grant's comments on colouration are at variance with Bradley's (1913) original description. At that time he described the female as "metallic blue–black, duller on abdomen". It must be supposed, therefore, that in the intervening half-century there has been an unexplained change in colour of the type.

These same six females were then sent to D. R. Smith at the United States National Museum to confirm that they are, in fact, the same as Ashmead had described as *P. californicus.* In a letter of 13 January 1966, after comparing these specimens with Ashmead's type, Smith said, ". . . Although the forewings and most of the antennae are missing from this type, they are similar in all comparable points". Thus the synonymizing of *S. obesus* under *S. juvencus californicus* is in order.

Three of these females, suitably labeled, have been deposited in The Academy of Natural Sciences of Philadelphia, and the other three, similarly labeled, in the British Museum of Natural History.

Sirex juvencus californicus (Ashmead)

Paururus californicus Ashmead, 1904, *Can. Ent.* 36: 64. Female.
Sirex obesus Bradley, 1913, *J. Ent. Zool.* 5: 12–13. Female. New synonymy.

Male. (Previously undescribed.) Incline Village, Washoe County, Nevada, 20.VIII.64, ex *Pinus jeffreyi* Murr. (coll. E. A. Cameron). Length 29.5 mm., forewing 23.0 mm., antennae 18-segmented. Distal segments of antennae, head, thorax, abdominal segments I and II entirely, triangular area on anterior dorsum of III, and coxae, metallic greenish black. Basal 5–6 segments of antennae, remainder of abdomen, and legs reddish brown. Wings hyaline, golden brown, costal and 1st submarginal cells golden yellow; slight infuscation apically on both fore- and hind wings; stigma and veins golden brown. Head, especially frons and lateral margins, thorax, especially mid-ventrally, and to a lesser extent the basal abdominal segments, coxae, trochanters, and femora softly pilose, each hair basally dark, distally fawn-coloured, and 0.5 mm. or more in length. Most of the remainder of the abdomen, legs, and antennae, more sparsely pubescent.

The specimen on which this description is based is deposited in the British Museum of Natural History. Additional specimens from the same series have been sent to the British Museum of Natural History, The Academy of Natural Sciences of Philadelphia, the United States National Museum, the collection of W. W. Middlekauff, University of California, Berkeley, and some have been retained in the author's collection.

In a representative sample of 50 males that were measured, the length varied between 12.5 and 30.0 mm. The number of antennal segments varies from 18 to 21. Some specimens show metallic greenish black in a small area of the anterior dorsum of abdominal segment IV and (or) a mid-ventral streak on abdominal segment III.

The lack of an indistinct reddish-brown postocellar area, presence of metallic greenish-black coxae, distinct or even slightly opened mid-dorsal suture on the first abdominal tergite, and noticeably golden yellow costal and 1st submarginal cells will separate males of *juvencus californicus* from those of *behrensii* (Cresson).

The reddish-brown posterior legs beyond the coxae will separate this subspecies from *cyaneus* Fabricius.

FEMALE. (Redescription.) Incline Village, Washoe County, Nevada, 21.VIII.64, ex *Pinus jeffreyi* Murr. (coll. E. A. Cameron). Length, head to tip of cornus, 25.5 mm., head to tip of abdominal tergite VIII, 20.5 mm.; forewing 19.0 mm.; length of ovipositor 15.0 mm.; length of sawsheath 7.5 mm.; forewing: ovipositor (fw.: ov.) ratio 1.27; ovipositor: sawsheath (ov.: sawsh.) ratio 2.00; antennae 20–21-segmented. Antennae, head, thorax, abdomen, and legs, except as noted, metallic blue–black; usually an area on dorsal distal portion of each femur reddish brown; oblong plates and sawsheath variable, reddish brown to blue–black. Wings hyaline, but with apical margins of both wings and a band across the middle of the forewing infuscate; stigma and veins black or brownish black. Head, especially frons and posterior margins, thorax, coxae, and basal abdominal segments clothed with long grayish pubescence. Antennae and remainder of legs and abdomen less densely pubescent.

In the present series of females there are several that have the wings completely infuscated, and some have only 19 antennal segments. In other respects, though, they agree with the above description. The occasional female has been seen having strikingly white tarsal pads; formerly these were considered to be *S. obesus* (Middlekauff 1960). However, there was no mention of this character in Bradley's (1913) original description.

To the distribution of this subspecies, given by Cameron (1965a) as California, Washington, Oregon, New Mexico (U.S.A.), and British Columbia (Canada), may now be added Nevada and Arizona (U.S.A.). The locality for the Nevada collection is within three miles of the California–Nevada border at an elevation of between 6600 and 6700 feet in the Sierra Nevada. Hosts include *Pinus jeffreyi* Murr., Jeffrey pine; *P. contorta* Dougl. (= *murrayana* Grev. & Balf.), lodgepole pine; *P. ponderosa* Laws., Western yellow (ponderosa) pine; *Cupressus macrocarpa* Hartw., Monterey cypress; and *Pseudotsuga menziesii* (Mirb.) Franco, Douglas-fir (Cameron 1965a).

Table I summarizes measurement data and fw.: ov. and ov.: sawsh. ratios[3] obtained from 40 females selected at random. Benson (1943) indicates that these two ratios ". . . appear to approach a constant value for each race, which is independent of the total size of the insect". From Benson's (1943) tables II and III, and the writer's data, the following can be shown:

	Mean fw.: ov. ratio	Mean ov.: sawsh. ratio	No. measurements
S. juvencus ermak	1.18	2.00	1
S. juvencus californicus	1.27	2.02	40
*S. varipes**	1.29	2.00	1
S. juvencus juvencus	1.34	2.00	9

*Benson (1962) holds this to be *S. juvencus juvencus* × *S. juvencus californicus*. Data are not available for *S. juvencus carinthiacus* or *S. juvencus mongolorum*.

Since 1960, when Middlekauff prepared a "Key to the California species of *Sirex*", the male of *S. longicauda* has been described (Middlekauff 1962), and now the male of *S. juvencus californicus*. The following is a revision and expansion of Middlekauff's key. His parenthetic remark in couplet 1 is still valid. Benson (1962) indicates that the shape of the cornus in the female is quite variable, therefore that character is eliminated from this key.

[3]Benson gives his ratios as "ov.: fw." and "sawsh.: ov.", but has confirmed (personal communication 13 May 1965) that these should be the other way around. Middlekauff (1948) similarly quotes an ovi- [illegible] ratio (= fw.: ov. ratio) in his description of *S. longicauda* Middlekauff.

TABLE I

Measurements of female *Sirex juvencus californicus* (Ashmead) and calculated ratios*,†

	Maximum	Minimum	Mean	σ
Forewing	21.5	10.0	14.88	2.55
Ovipositor	16.0	8.0	11.74	1.92
Sawsheath	8.0	4.0	5.82	1.00
Head to tip of abdominal tergite VIII	21.5	10.0	15.66	2.83
fw.: ov. ratio	1.35	1.17	1.266	0.045
ov.: sawsh. ratio‡	2.13	1.91	2.021	0.057

*Measurements in millimeters to nearest 0.5 mm.
†Total of 40 females measured.
‡23 of 23 ovipositor measurements ending in .0 mm. gave an ov.: sawsh. ratio of 2.00.

Key to the California Species of *Sirex*

1. Females: ovipositor present 2
   Males: ovipositor absent (some species not separable with any degree of certainty) 6

FEMALES

2. Ovipositor as long as the forewing, usually longer 3
   Ovipositor shorter than forewing 4
3. Legs with tibiae and tarsi reddish brown; 25–26 antennal segments; wings slightly infuscated along veins and around the apical margin ..... *longicauda* Middlekauff
   Legs entirely black or blue–black; 20–23 antennal segments; wings completely infuscated ..... *areolatus* (Cresson)
4. Abdomen, except for basal segments, reddish brown; forewing with a transverse fuscous band beneath the stigma and a fuscous apical margin; two basal abdominal segments blue–black ..... *behrensii* (Cresson)
   Abdomen entirely bluish black 5
5. Legs except coxae and trochanters reddish brown; wings usually nearly hyaline except for infuscated apical margin ..... *cyaneus* Fabricius
   Legs metallic blue–black, usually with a reddish-brown area on the dorsal portion of each femur; forewing infuscated on apical margin and across middle to uniformly dark violaceous ..... *juvencus californicus* (Ashmead)

MALES

6. Head, thorax, antennae, basal and apical abdominal segments metallic blue–black; abdominal segments III–VII yellowish orange or reddish brown 7
   Head, thorax, and basal abdominal segments black, blue–black, or metallic greenish black; antennae blue–black, or basally reddish brown or yellowish orange; abdomen reddish brown posteriad from segment III or IV 8
7. Femora, tibiae and tarsi of fore- and mid-legs, and the last two tarsal segments of hind legs reddish brown; most of abdominal segment III, and all of segments IV–VII reddish brown; apex of fore- and hind wings with distinct infuscated band ..... *longicauda* Middlekauff
   Legs metallic blue–black; abdominal segments III–VII yellowish orange; only slight infuscation in apices of wings ..... *areolatus* (Cresson)
8. Fore- and mid-legs beyond the trochanters reddish brown; posterior legs bluish black except distal segment of the trochanter; basal segments of

antennae reddish brown or black; thorax metallic blue or greenish; wings slightly yellow with a faint smoky band around the margins ..... *cyaneus* Fabricius

Legs not as above; basal segments of antennae reddish brown or yellowish orange; wings hyaline 9

9. An indistinct postocellar area reddish brown; coxae dark reddish brown; basal segments of abdomen almost black, remainder of abdomen orangish brown; mid-dorsal suture on 1st abdominal tergite not distinct; hairs on 1st and 2nd abdominal tergites quite as dense as on dorsum of the thorax, 1st submarginal cell of forewing not noticeably yellow ..... *behrensii* (Cresson)

Head unicolourous; coxae and basal segments of the abdomen metallic greenish black; remainder of legs and abdomen reddish brown, rather shiny; mid-dorsal suture on 1st abdominal tergite usually quite distinct, often slightly opened for part or all of its length; density of hairs on 1st and 2nd abdominal tergites, especially medially, not as great as on dorsum of thorax; costal and 1st submarginal cell of forewing noticeably golden yellow ..... *juvencus californicus* (Ashmead)

Notes on *Sirex juvencus californicus* (Ashmead)

About 1961 the hillside area from which the series of *S. juvencus californicus* originated was selectively logged. During these operations a number of trees that were left were scarred to a greater or lesser extent from being hit by the heavy logging equipment and falling trees. Slash was left in piles in the forest. These factors provided a good environment for the build-up of populations of siricids and their parasites.

On 9 August 1964, most of one *Pinus jeffreyi* and several bolts from each of two other trees of the same species were removed from the forest (total volume approximately ½ cord). Each of these trees was dying, two having only a little green foliage near their tops, and the third with all remaining needles brown. During the preceding month repeated visits to this area had yielded a large number of adults of the siricid parasite *Megarhyssa nortoni nortoni* (Cresson) (Hymenoptera: Ichneumonidae), which were shipped to Australia and New Zealand as a part of the biological control campaign against the exotic *S. noctilio* Fabricius (Cameron 1965b). On many occasions, oviposition by *Megarhyssa* was noted in the tree or portions of trees which were later brought into the laboratory. Emergence of *S. juvencus californicus* from these bolts, when confined in screen cages in the laboratory in Fontana, California (laboratory temperature 80° ± 2° F.), commenced 11 August and reached a peak about ten days later. Males and females emerged in almost equal numbers throughout the emergence period.

During the period 20–26 August, 10 newly emerged females were dissected for egg counts. The results are given in Table II. It turned out that the females selected for counting were about one-third larger than the average of the 40 measured. When number of eggs is plotted against length, a rough curve can be drawn that indicates that an "average" female (length 15.66 mm.) might be expected to have approximately 200 eggs.

Chrystal (1928) quotes that Scheidter found by dissection of the ovaries an average of over 1000 eggs in *Urocerus augur* (Klug) and 400 in *S. noctilio*. His own dissections of "large females" of *S. cyaneus* taken at Tubney (near Oxford, England) gave an average of 300–400 eggs. Rawlings (1953) considered 400 an average figure for New Zealand *S. noctilio*, and Coutts (1965) for the same species

TABLE II
Egg counts from dissected females, *Sirex juvencus californicus* (Ashmead)

Number	Left ovary	Right ovary	Total	Length in mm.: head to tip of 8th abdominal tergite
1	167	157	324	—*
2	293	278	571	22.5
3	412	392	804	25.0
4	282	317	599	24.5
5	188	215	403	21.5
6	266	325	591	23.5
7	106	110	216	17.0
8	190	254	444	22.5
9	234	235	469	22.0
10	364	361	725	26.5
Total	2502	2644	5146	—
Mean	250.2	264.4	514.6	22.78
σ	—	—	179.25	2.69

*Abdomen distorted; not measured.

gave averages of from 75 to 250 eggs per female, depending on size. Coutts indicated that subsequent dissections gave larger numbers, especially in the largest size class, but that few had in excess of 400 eggs.

From time to time, both in the field and in the laboratory, females have been observed to have been trapped while ovipositing, presumably by resins in the wood collecting about the ovipositor. One such female was removed from *P. jeffreyi* in the laboratory after she died, and the eggs remaining in her reproductive system were examined. The left ovary contained 76, the right 68, and the ovipositor 3, for a total of 147. The result was determined chiefly by counting, but also partly by estimation, as it was impossible to separate each individual egg. Accuracy is probably within ±10 eggs. From the curve mentioned above, on the basis of her length (24.0 mm.), this female could be expected to have approximately 575 eggs, thus she had laid approximately three-quarters of her complement before death.

Eggs become greatly elongated when passing through the ovipositor; those in the ovipositor were 3.0 mm. long, whereas those in the ovaries were approximately 1.2–1.3 mm. long.

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Influence of Parental Food Quality on the Survival of *Hyphantria cunea*

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Abstract

Larvae of *Hyphantria cunea* Drury were reared on early, mid-season, and late foliage collected from the same apple trees. Survival was significantly lower on late foliage and the fecundity of the moths decreased from 604 in the early series to 128 in the late. Half the filial generation was reared under nutritional stress on a deficient synthetic diet and the other half on a very favorable host, speckled alder. Under both conditions there was a strong transmitted influence of parental food quality on the viability of the eggs and on the ability of first-instar larvae to become established on food. The progeny of the late series did not survive beyond this instar. When the filial generation was subjected to nutritional stress, the influence of parental food was apparent throughout the larval, pupal and adult stages, with progeny of the early series having higher survival than those of the mid-season series. However, when the filial generation had very favorable food, there was no significant difference in survival rates subsequent to the larval establishment period.

The quality of foliage available to univoltine populations of *H. cunea* depends largely on temperature. Thus, in the development of population models for this species, temperature should be treated as a variable having not only direct effects on establishment and survival each season, but also indirect effects on the quality of the progeny in the following season.

Introduction

This is the fifth paper in a series (Morris 1963a, 1963b, 1964; Morris and Bennett 1967) leading to the development of population models for the fall web-