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# *SYMPETRUM JANEAE* SPEC. NOV. FROM EASTERN NORTH AMERICA, WITH A KEY TO NEARCTIC *SYMPETRUM* (ANISOPTERA: LIBELLULIDAE)

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The new sp. is described from adult and larval material (holotype ♂, allotype ♀: marsh along Carle's Pond, Somerset Co., NJ, USA; 25-VIII-1984; deposited at USNM, Washington) and its affinities are discussed. *Kalosympetrum* subg.n. (type sp.: *Libellula rubicundula* Say) is introduced. Adult and larval keys to nearctic *Sympetrum* are provided along with a summary of known distributions.

## INTRODUCTION

The original version of this publication was included as Appendix VI in CARLE (1982). Originally primary concern was placed on separating the new species from *Sympetrum rubicundulum* (Say), a species with which it had been confused by J.G. Needham, E.M. Walker, and several other workers. Obvious adult and larval differences between *S. internum* Montgomery and the new species originally obscured the need for a detailed diagnosis between the two. However, it was noted that these species were apparently allopatric and that *S. internum* from eastern Michigan and southern Ontario often lacked the bright yellow costa typical of the species. In addition, several apparent hybrids between related species were known indicating the need for further study, the results of which are presented here in an updated version of the original manuscript.

While determining specimens of *Sympetrum* collected in Vermont and New Jersey it became apparent that taxonomic problems continued to exist in the genus. Utilizing the keys provided by NEEDHAM & WESTFALL (1955) the

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males and females of pairs taken in tandem often keyed to *S. rubicundulum* (Say) and *S. obtrusum* (Hagen), respectively. Following the publication of new keys presented in WALKER & CORBET (1975) the specimens were redetermined; the males as *S. internum* Montgomery, and the females again as *S. obtrusum*. CARLE (1978) reported the problem and found that Dr H.B. White and Mr Clark Shiffer had also noticed the "intermediate" specimens which according to WILLIAMSON (1933) did not exist. Several additional *Sympetrum* were collected in tandem and in copulation throughout eastern North America and it was determined that the aberrant specimens represented an undescribed species.

The larvae of the new species were also discovered and are similar to those of *S. obtrusum* and *S. rubicundulum*, perhaps explaining the inability of NEEDHAM & WESTFALL (1955) to distinguish the larvae of these species.

The new species is known to be sympatric with *S. obtrusum* throughout its range, sympatric with *S. internum* along southeastern Canada, and sympatric with *S. rubicundulum* in Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Ontario, Pennsylvania, Quebec, Rhode Island, Virginia, and West Virginia.

## TAXONOMIC HISTORY

The taxonomic history of *S. rubicundulum* and related species has been confusing. SAY (1839) described *Libellula rubicundula* from "many individuals" collected in Indiana and Massachusetts, but unfortunately Say's types are lost and "neotypes" at the Museum of Comparative Zoology (MCZ), mentioned by MUTTKOWSKI (1910), have not been designated as such. Say also described a variety of his species with the "ferruginous tinge" of the wings extended to the nodus. UHLER (1857) described *L. assimilata* from three Nebraska specimens which had the wings tinged with yellow along the base and humeral margin.

HAGEN (1861) redescribed *Diplax rubicundula* and *D. assimilata* from specimens in part determined by Uhler. A study of the specimens grouped under the heading *S. rubicundulum* at the MCZ revealed seven species, of which the following material was utilized by HAGEN (1861) in his description of *D. rubicundula*: *S. rubicundulum*: 1 ♂ and 1 ♀ from Maryland (determined as *L. rubicundula* by UHLER, 1858, and likely the "neotypes" mentioned by Muttkowski and here so designated), 1 ♂ from Washington D.C. (Osten Sacken); – *S. obtrusum*: 2 ♀ from Chicago (Osten Sacken, the ♂ type of *S. obtrusum* was originally also included here); – and the new species: a ♂ from Maryland (labelled as *L. rubicundula* by Uhler in 1858), 2 ♀ from Bergin Hill, New Jersey (Guex), 1 ♀ from New York (Osten Sacken), and a ♂ from Philadelphia (Osten Sacken).

It is evident that neither Say, Uhler, nor Hagen differentiated *S. obtrusum* or the new species from clear winged specimens of *S. rubicundulum*. However,

HAGEN (1861) had noted differences in a male specimen from Chicago which was of the then undescribed *S. obtrusum*.

WALSH (1862) correctly considered Say's *L. rubicundula* and Uhler's *L. assimilata* synonymous, but incorrectly considered Hagen's composite redescription of *D. rubicundula* to be of *L. ambigua* Rambur. Walsh's specimens, which he identified as the *D. rubicundula* of Hagen, were clearly the *D. obtrusa* later described by HAGEN (1867).

SCUDDER (1866) also considered *L. rubicundula* and *L. assimilata* synonymous, but his New Hampshire specimens which he identified as the *D. rubicundula* of Hagen were the new species.

An undescribed species from Yellowstone, closely related to *D. rubicundula*, was mentioned by HAGEN (1873) and considered probably the same as specimens from Fort Hill, Colorado, used in his description of *D. decisa* HAGEN (1874). The distinctness of *D. decisa* and *D. obtrusa* was questioned by HAGEN (1875) and later by Calvert (CURRIE, 1905).

Also in 1875, HAGEN referred to specimens labeled *D. interna*, which were collected in "Saskatchewan, southern Lake Winnipeg, British America". However, 2 males from this lot were found under the heading *S. rubicundulum* at the MCZ and were apparently the specimens from "British America" included in the description of *D. rubicundula* by HAGEN (1890). RIS (1911) considered Hagen's *D. decisa* a subspecies of *S. rubicundulum*, and WILLIAMSON (1917, 1933) considered it a distinct species; Williamson also confirmed the synonymy of *S. assimilatum* with *S. rubicundulum*.

After studying the types of Hagen's *D. decisa*, MONTGOMERY (1943) correctly synonymized Hagen's types with *S. obtrusum*, although Hagen's statement "veins reddish, the costa and some transversals near the base yellowish" is problematic in that it could refer to the entire costa as being yellow. Montgomery proposed the name *S. internum* for the species referred to by Hagen under the nomen nudum *D. interna* and called *S. decisum* by RIS (1911) and later workers. Montgomery designated as types Hagen's specimens found under the manuscript name "interna"; type locality "Saskat. Scudder F. C. Gray's Fund", but cited as "Saskatchewan, Southern Lake Winnipeg, British America" (HAGEN, 1875).

NEEDHAM & WESTFALL (1955) incorrectly listed *S. decisum* a synonym of *S. internum*, and the large series of the new species at Cornell determined as *S. rubicundulum* by J.G. Needham suggest that figure 309H on page 536 in NEEDHAM & WESTFALL (1955) may be of the new species.

KORMONDY (1960), and WALKER & CORBET (1975) reported specimens of the new species as *S. rubicundulum* from Prince Edward Island, Canada.

## *SYMPETRUM JANEAE* SPEC. NOV.

Figures 1a, 2a, 3a, 4a, 5a, 6a

Material. – **Holotype** ♂: UNITED STATES: New Jersey, Somerset Co., marsh along Carle's Pond, 25-VIII-1984, F.L. Carle leg., deposited USNM, Washington. – **Allotype** ♀: same as for holotype. – **Paratypes**: Connecticut: Fairfield, Hartford, Litchfield, New Haven, & Tolland Counties: 11 ♂, 9 ♀; 30-VI/23-IX; – Delaware: New Castle Co.; 2 ♂; 20/21-VI; – Maine: Androscoggin, Cumberland, Hancock, Lincoln, Penobscot, & York Counties; 102 ♂, 60 ♀; 21-VI/1-IX; – Maryland: Frederick, Montgomery, & Prince Georges Counties; 4 ♂, 3 ♀; 25-VIII/13-IX; – Massachusetts: Barnstable, Berkshire, Dukes, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, & Worcester Counties; 119 ♂, 62 ♀; 8-VI/24-X; – New Hampshire: Carroll, Cheshire, Coos, Grafton, & Hillsboro Counties; 38 ♂, 7 ♀; 7-VII/20-IX; – New Jersey: Bergen, Burlington, Cape May, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, Union, & Warren Counties; 45 ♂, 43 ♀; 10-VI/22-IX; – New York: Albany, Bronx, Chenango, Clinton, Cortland, Dutchess, Broome, Cattaraugus, Essex, Franklin, Hamilton, Herkimer, Jefferson, New York, Oneida, Orange, Oswego, Putnam, Queens, Richmond, St. Lawrence, Schuyler, Seneca, Steuben, Suffolk, Sullivan, Tompkins, Ulster, Warren, Westchester, & Yates Counties; 152 ♂, 78 ♀; 11-VI/5-X; – Pennsylvania: Allegheny, Bradford, Centre, Chess, Crawford, Delaware, Mercer, Mifflin, Montgomery, Pike, & Susquehanna Counties; 83 ♂, 33 ♀; 19-VI/15-X; – Rhode Island: Providence, & Washington Counties; 3 ♂, 2 ♀; 18-VII/11-X; – Vermont: Addison, Bennington, Caledonia, Chittenden, Essex, Grand Isle, Franklin, Lamoille, Rutland, Washington, Windham, & Windsor Counties; 207 ♂, 67 ♀, 2 larvae, 26 exuviae; 19-VI/18-X; – Virginia: City of Suffolk; 1 ♂; 20-IX-1978; – West Virginia: Berkeley Co.; 1 ♂; 2-VIII-1982; – CANADA: New Brunswick: Charlotte, Gloucester, Kent, Queens, & York Counties; 21 ♂, 5 ♀; 5-VII/16-IX; – Nova Scotia: Colchester, Guysborough, Halifax, Inverness, Pictou, Shelburne, Victoria, & Yarmouth Counties; 12 ♂, 1 ♀; 15-VII/2-IX; – Ontario: Carleton, Leeds, & Renfrew Counties; 3 ♂, 2 ♀; 2-VII/11-XIII; – Prince Edward Island: Queens Co.; 5 ♂; 24-VII/3-VIII; – Quebec: Chateauguay, & Missisquoi Counties; 12 ♂, 1 ♀; 5/18-VII. – Complete collection information is available from the author.

Etymology. – *S. janeae* [jane'ae], English given name Jane; N. L. gen. noun *janeae* "Jane's", in honor of my wife.

MALE – Total length 30.0-36.5 mm, abdomen including cerci 21.0-25.0 mm, cerci 1.4-1.6 mm, hind femora 4.5-5.8 mm, hind wings 24.0-28.0 mm, pterostigmata 2.1-2.5/2.1-2.5 mm.

Head. – Labium yellowish white, prementum with medial distally widened brown line; maxillae and mandibles yellowish white, brown apically; labrum yellowish white; genae, anteclypeus, and postclypeus white, antefrons white, tinged with yellow anteriorly, basal 1/5 of dorsal surface brown; antennae brown; vertex (postfrons) light brown with dark brown bands around lateral ocelli; ocellar ridge inflated-conical, somewhat bilobed apically; occiput (dorsal portion) brown; posterior surface of head yellow, dark brown ventrally, with well developed transverse lateral ridges and medial tubercle.

Thorax. – Prothorax reddish brown, posterior margin directed dorsally with distinct medial cleft. Pterothorax reddish brown (pale yellow in immature males), mesanepisterna and terga primarily red, metanepimera with ventrolateral portion pinkish red at maturity; dorsolateral carinae of mesanepimera brown; sternum yellow-brown; metasternum sparsely covered with short hair.

L e g s. – Coxae and trochanters yellow-brown; femora black, with internal surface of front and generally middle femur brownish yellow; tibiae and tarsi black.

W i n g s. – Venation brown, yellow proximal to cubital-anal crossvein; costa brown with black spines; pterostigmata red, white proximally and distally, veins along anterior and posterior margins thickened, black; membrane hyaline, fore wing transparent saffron at extreme base, hind wing transparent saffron proximal to cubital-anal crossvein, membranule white. Antenodal crossveins 6-8, 6-8/5-8, 5-7 (5-62%, 6-38%); postnodal crossveins 6-9/6-11, supratriangles and hind wing triangle 1-celled (occasionally 2-celled), subtriangles 3-celled, fore wing triangle 2-celled; 1 or rarely 2 bridge crossveins; radial and median planates subtend 1 cell row; crossveins under pterostigmata 1-2/1-2; anal loop 16-24-celled.

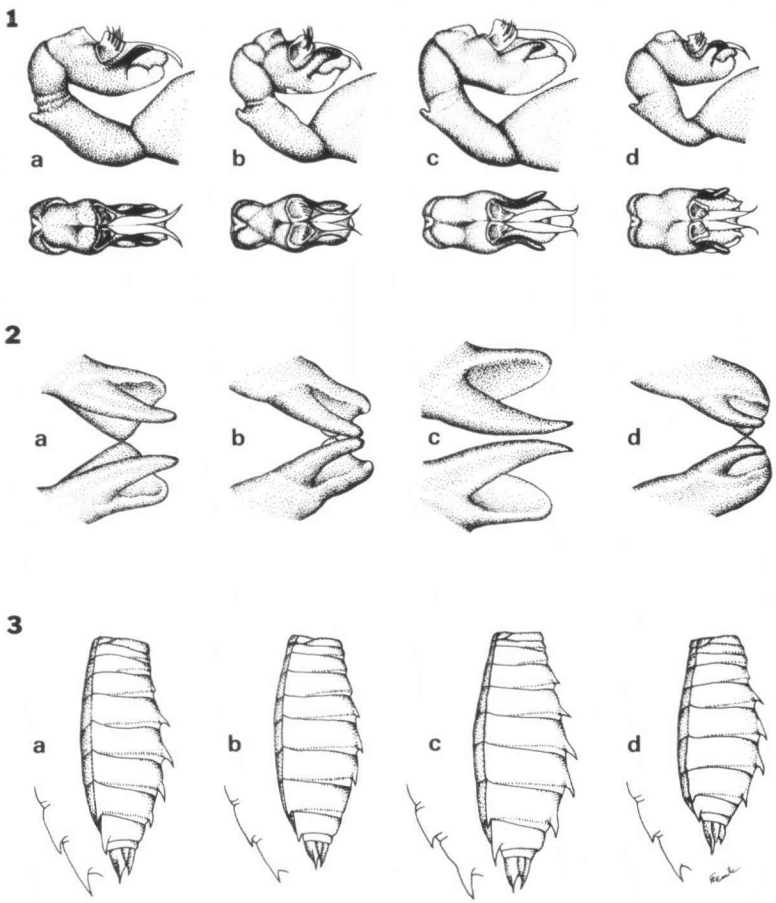
A b d o m e n. – Red marked with black, pale yellow and black in immature males; terga 1-3 red, generally with black area along lateral carinae of tergum 3; terga 4-8 red dorsally with full length triangular lateral black areas, black areas widened distally, extended dorsally to ca 1/2 length of posterodorsal carinae (ca. 1/2 of tergum 5 covered by black in lateral view), ventrally black areas extended slightly below lateral carinae; ventral surface of terga 4-10 yellowish brown; tergum 9 dorsally red with lateral black band; terga 8 and 9 occasionally with black dorsal area on posterior half; tergum 10 red often with lateral black area; sternum 4-9 black, sternum 10 yellowish brown. Cerci yellowish red to red with ventral denticles and often apex black, dorsal surface concave in lateral view, ventral tooth at ca 1/2 length; epiproct yellowish brown to reddish brown extended beyond ventral tooth of cerci with slight apical cleft; paraprocts reddish brown.

G e n i t a l i a. – Posterior hamuli brownish yellow, forked for ca. 3/10 length, ventromedial hook extended posteriorly beyond triangular dorsolateral lobe, hooks slightly shorter than genital lobe and with apices widely separated in natural position; in ventral view dorsolateral lobe with distinct inner lobe, inner surface somewhat shelflike. Penile segment 1 globose, light brown, ca 1.1 mm long; segment 2 gently curved, retractor spine located at ca 2/3 length, ca 1.1 mm long; segments 3 and 4 ca 1.0 mm long excluding flagella, medial lobe with lateral setal tufts, flagella forked, lanceolate, with apices decurved, and ca 0.7 mm long; lateral lobes black, attenuate apically, and extended to ca. middle of flagella; internal lobes white, decurved apically, extended to ca 2/3 length of flagella; posterior lobe robust, curved ventrally at apex, extended to ca 2/3 length of flagella.

FEMALE – Total length 29.5-35.0 mm, abdomen including cerci 20.0-24.5 mm, cerci 0.9-1.1 mm, hind femora 4.4-5.5 mm, hind wings 22.0-27.5 mm, pterostigmata 2.1-2.5/2.1-2.5 mm.

H e a d. – As in male.

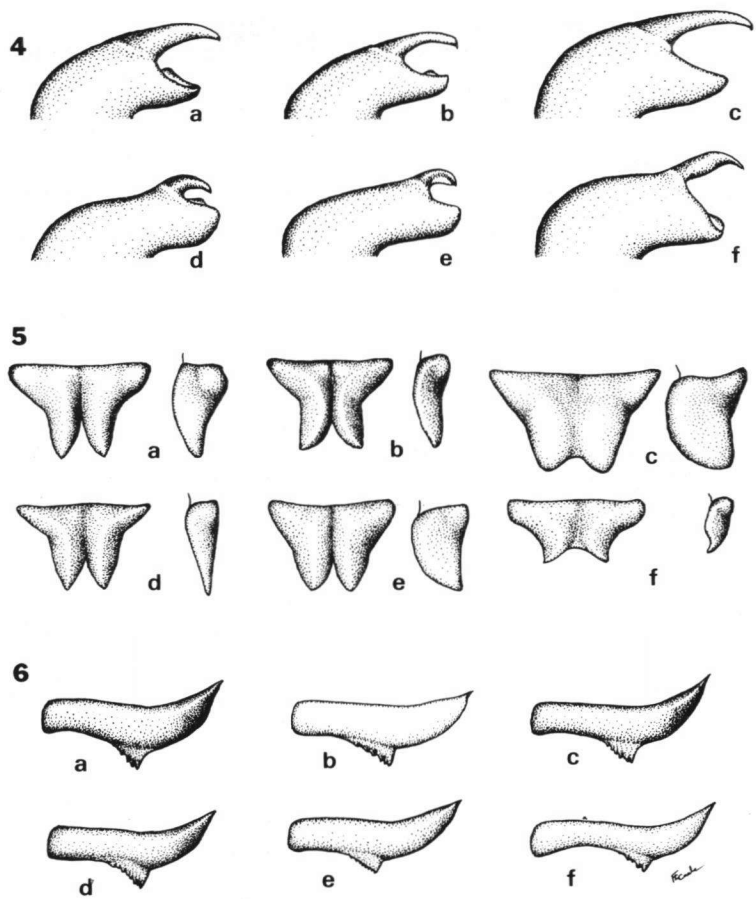
T h o r a x. – As in immature male with lateral portions yellowish white, occasionally as in mature male.




Figs 1-3. Structural features of selected *Kalosympetrum* species: (1) lateral and ventral views of penis; – (2) ventral view of posterior hamuli; – (3) lateral view of larval abdomen. – [a: *S. janeae*, – b: *S. internum*, – c: *S. rubicundulum*, – d: *S. obtrusum*].

L e g s. – As in male with inner surface of hind femora often predominantly yellowish brown.

W i n g s. – Venation brown, yellow proximal to cubital-anal crossvein; costa brown with medial yellow streak; pterostigmata red, proximally and distally yellowish red dorsally and white ventrally, veins along anterior and posterior margins thickened, black; membrane hyaline, fore wing transparent saffron at extreme base, hind wing transparent saffron proximal to cubital-anal crossvein; membranule white. Antenodal crossveins 6-8, 6-8/4-6, 4-6 (5-77%, 6-23%), postnodal crossveins 5-8/6-10, supratriangles and hind wing triangle 1-celled (occasionally




Figs 4-6. Structural features of American *Kalosympetrum*: (4) lateral view of posterior hamuli; – (5) ventral and lateral views of vulvar lamina; – (6) lateral view of male cerci. – [a: *S. janeae*, – b: *S. internum*, – c: *S. rubicundulum*, – d: *S. obtrusum*, – e: *S. pallipes*, – f: *S. ambiguum*].

2-celled), subtriangles 3-celled, fore wing triangle 2-celled; 1 or rarely 2 bridge crossveins; radial and median planates subtend 1 cell row; crossveins under pterostigmata 1-2/1-2; anal loop 16-22-celled.

A b d o m e n. – Golden yellow marked with black (mature females occasionally colored as in male), black lateral triangular areas largely separated from black line along lateral carinae on segments 3-5 to 3-7, black triangular areas 2/3 to as long as respective terga. Terminalia yellowish brown.

G e n i t a l i a. – Vulvar lamina bilobate, ca 3/8 as long as sternum 8 (ca 0.5 mm long), in ventral view with apices directed posteriorly, in lateral view ca

1/2 as high as long with apices subacute and directed posterodorsally.

LARVA (exuviae) – Total length 13.5-15.5 mm, abdomen 8.6-9.8 mm, hind femora 3.5-4.1 mm, prementum 4.5 mm.

H e a d. – Palpal setae 10 (end hook not included), premental setae 11-13.

T h o r a x. – Hind femora extended to ca middle of segment 7.

A b d o m e n. – Long-ovoid in shape, widest at segments 5 and 6; dorsal spines on abdominal segments 4 or 5-8, that on 4 generally vestigial, that on 6 largest; lateral spines present on segments 8 and 9, that of 8 ca 1/8 as long as lateral margin of segment (spine included), that of 9 ca 1/4 as long as lateral margin of segment; epiproct ca 7/8 length of paraprocts, cerci ca 4/7 length of paraprocts.

## AFFINITIES

*Sympetrum janeae* sp.n. is closely related to *S. rubicundulum*, *S. internum*, and *S. obtrusum* (Figs 1-6). The ranges of *S. janeae* and *S. obtrusum* overlap in the Mid-Atlantic and New England states with *S. obtrusum* becoming increasingly more abundant northward until at the latitude of northern Maine all known occurrences of *Kalosympetrum* are *S. obtrusum*. However, further south in Virginia *S. janeae* is found along the coast and *S. obtrusum* is restricted to high elevation bog ponds. The range of the new species overlaps that of *S. internum* across south-eastern Canada and that of *S. rubicundulum* in a U-shaped band extending from southern Quebec and Ontario through western New York south to Virginia and along the coast north to Cape Cod (Fig. 7). The almost mutually exclusive distributions of the latter species suggest that hybridization may be occurring. However, the distinctiveness of these taxa along such extensive fronts seems to preclude the recognition of subspecies.

Mixed pairs are actually quite common in *Sympetrum* and have been comprised of such distantly related species as *S. danae* and *S. obtrusum* and *S. costiferum* and *S. internum*. *S. obtrusum* and *S. rubicundulum* are often captured in tandem, but no mixed pairs of *S. rubicundulum*, *S. internum*, or *S. obtrusum* with *S. janeae* are yet known. However, apparent hybrids between all these species are known.

In addition to the characteristics mentioned in the key a few aspects of color pattern will generally help distinguish *S. janeae* sp.n. from its nearer relatives. The face of *S. janeae* is typically white with a tinge of yellow, in *S. rubicundulum* it is predominantly yellow, in *S. internum* it is reddish yellow and in *S. obtrusum* it is white. The femora of *S. janeae* are black with typically the inner surfaces of the fore and middle femora pale yellow, in *S. rubicundulum* the femora are often predominantly yellow, and in *S. internum* and *S. obtrusum* they are black with generally only the inner surfaces of the front femora pale yellow. The abdominal color pattern in *S. janeae*, *S. internum* and *S. obtrusum* is composed of a series of lateral black triangles which are generally confluent with the black

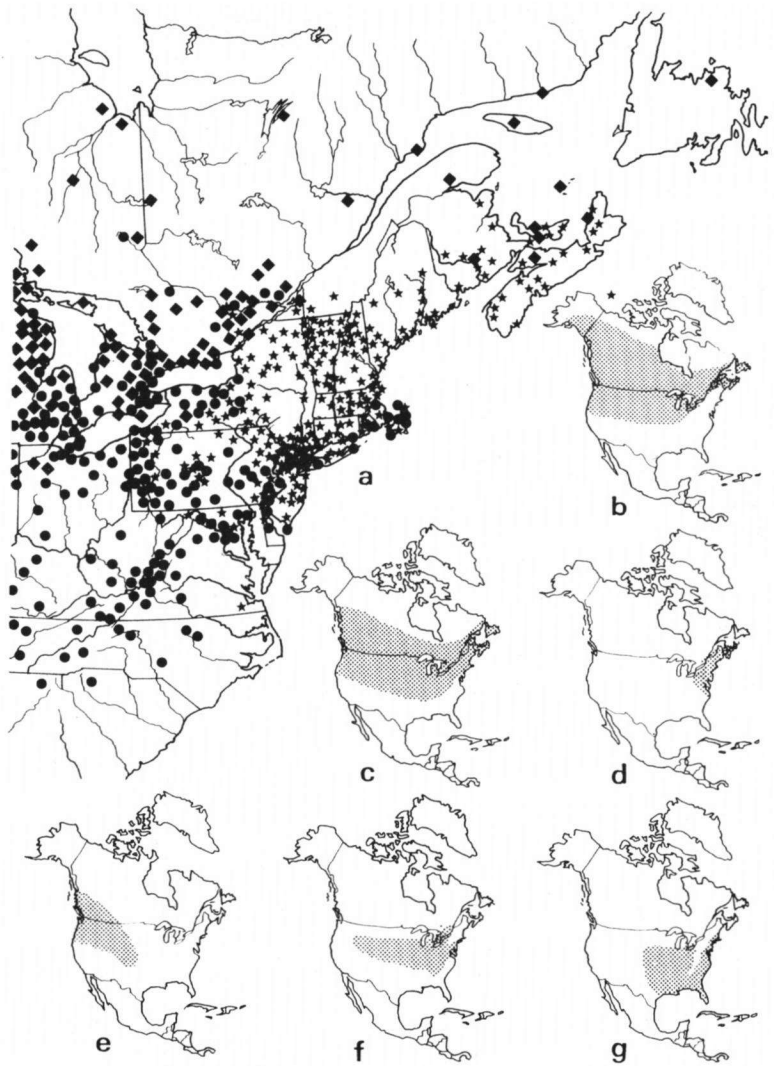



Fig. 7. Distribution of American *Kalosympetrum*: (a) eastern North American occurrences of *S. janeae* ★, *S. rubicundulum* ●, and *S. internum* ◆; – (b) *S. internum*; – (c) *S. obtrusum*; – (d) *S janeae*; – (e) *S. pallipes*; – (f) *S. rubicundulum*; – (g) *S. ambiguum*.

lateral carinae of each segment for its entire length. In *S. rubicundulum* the lateral black triangles are smaller (about ½ length of segments) and often separated anteriorly from the black band along the lateral carinae. In addition, the cerci of *S. internum* are typically yellow whereas in related species they are typically

reddish with brown apices. The size of the four species also differs with *S. rubicundulum* averaging largest but ranging from 31-40 mm, and *S. internum* and *S. obtrusum* averaging smallest but ranging from 30-38 mm.

The larva of *S. janeae* sp.n. is distinguished from that of related species by having a vestigial dorsal hook on abdominal segment 4, by having a well-developed dorsal hook on segment 8, and by having the lateral spine of segment 9 ca. ¼ the length of segment 9 including the spine.

NEEDHAM & FISHER (1936) established *Tarnetrum* which was distinguished from *Sympetrum* by the absence of dorsal abdominal spines in the larva, and the presence of an additional transverse carina of abdominal segment 4 in the adult. BORROR (1945) listed the following species in *Tarnetrum*: *illotum* (Hagen), *corruptum* (Hagen), *nigrocreatum* (Calvert), *virgulum* (Selys), and *gilvum* (Hagen). Based on similarities in genitalia and color pattern *S. villosum* Ris and *S. roraimae* DeMarmels can also be placed in *Tarnetrum*. Although NEEDHAM & WESTFALL (1955) attributed generic rank to *Tarnetrum* this status has not been supported by KORMONDY (1958, 1960), GLOYD & WRIGHT (1959), WALKER & CORBET (1975), or CANNINGS (1981). The latter authors also placed *S. mandidum* in the subgenus *Tarnetrum* based on the double row of cells subtended by the radial planate, similarity of the genitalia, and the lack of middorsal abdominal spines in the larvae; the larva described by NEEDHAM (1904) which had middorsal spines was shown to be incorrectly associated with the adult of *S. mandidum* by CANNINGS (1981). In addition, it is noted that female *S. mandidum* have a subbasal transverse carina on abdominal segment four. Although American *Tarnetrum* comprise a large distinctive and apparently monophyletic group, similarities to the *fonscolombei* group of the eastern hemisphere suggest that both groups should be included within *Tarnetrum*. These similarities include: male genital lobe, hamules, and penis relatively small; penile flagella level and arising from midlevel of apical segment; vulvar lamina a short thick bilobate ridge; pterothorax typically with lateral spots; abdomen robust; and larva with reduced lateral and without dorsal abdominal spines. Two cell rows subtended by the radial planate does not appear to be a reliable subgeneric character; for example, one cell row is often subtended in *S. illotum* and *S. fonscolombei* (Selys), and two cell rows subtended in the palearctic *S. uniforme* (Selys), *S. infuscatum* (Selys), *S. pedemontanum* (Allioni), and *S. baccha* (Selys), none of which belong in *Tarnetrum*.

American *Kalosympetrum* subgen. n. (type species: *Libellula rubicundula* Say) also form a large monophyletic group distinguished from other *Sympetrum* in couplet one of the key, the group is actually more distinctive than other genera of the Sympetrini, (e.g. *Leptothemis-Erythemis*, *Erythrodiplax* s.str.-*Uracis*). However, the palearctic *Kalosympetrum* are far less distinctive, being primarily distinguished by the midventral tooth of the male cerci, ventrolateral origin of penile flagella, typically saclike dorsal lobe of the hamule, and long, flattened,

bilobate vulvar lamina. These character states are apparently the basic synapomorphies of *Kalosympetrum*. However, the typically multispined apex of the male cerci, somewhat tubelike penile segment 3, and form of the vulvar lamina indicate that the palearctic *Kalosympetrum* are not paraphyletic but form a monophyletic group. In addition, many of the similarities in male and female genitalia between *Tarnetrum* and *Kalosympetrum* are unique suggesting that they are sister groups. The saclike form of the dorsal hamular lobe in *S. mandidum* is evidently a convergence to the condition found in Asian *Kalosympetrum*, *S. palipes* and *S. obtrusum*. Penis and hamular structure also support a sister group relationship between *Sympetrum* s.str. and *Nesogonia*, both have the ventral hamular hook erect and have the flagella arising dorsally and curving ventrally into the hamular notch. To avoid paraphyletic or polyphyletic groupings all four groups should be given equivalent rank, here all are considered to be subgenera of *Sympetrum*.

### BIOLOGY

Location of exuviae and oviposition sites indicate the preferred habitat of *S. janeae* sp.n. to be the temporary pools of marsh areas. *S. obtrusum* and *S. internum* seem to prefer slightly more boggy situations with the larvae of *S. internum* adapted to a more sedentary mode of life than related species. In contrast the related *S. rubicundulum* seems to prefer the stands of emergent vegetation along ponds, lakes, and slow streams; this preference apparently explains its northward range extension along the Great Lakes. During the period following emergence the adults are commonly found in open fields generally within a hundred meters of the larval habitat. Female *Kalosympetrum* often do not oviposit in tandem as is typical in *Sympetrum* s.str. Instead of flicking or tapping a cluster of eggs directly into the water, American *Kalosympetrum* typically release eggs singly or at most two at a time over damp mud or wet vegetation. The eggs are not sticky and bounce and roll into cracks and crevices. However, the scooplike vulvar lamina of Asian *Kalosympetrum* suggests that in this group the eggs may be released in a clump over water. Species of *Sympetrum* commonly associated with the new species include *vicinum*, *costiferum*, *obtrusum*, *rubicundulum*, and *internum*. However, either ecologic competition or reproductive interference apparently dictates that only one species of *Kalosympetrum* will be dominant at any one locality. In New England *S. janeae* appears to be the most common species of Anisoptera.

## DISTRIBUTION OF AND KEY TO NEARCTIC *SYMPETRUM*

### DISTRIBUTION

Of the fourteen Nearctic *Sympetrum* six have a transcontinental distribution,

four are limited to western North America, and four are centered in eastern North America. The known distributions of nearctic *Sympetrum* are as follows: *ambiguum*: U.S.A.: AL, AR, DE, FL, GA, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, NE, NJ, NC, OH, OK, PA, SC, TN, TX, VA; Canada: ON; – *corruptum*: U.S.A.: AL, AZ, AR, CA, CO, FL, GA, ID, IL, IN, IA, KS, LA, MI, MN, MS, MO, MT, NE, NV, NJ, NM, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, WA, WI, WY; Canada: AB, BC, MB, ON, SK; also Mexico, Honduras, Asia, and Sea of Okhotsk; – *costiferum*: U.S.A.: CA, CT, ID, IA, ME, MA, MI, MO, MT, NE, NV, NH, NY, OH, OR, PA, RI, SD, UT, VT, WA, WI, WY; Canada: AB, BC, MB, NB, NF, NW, NS, ON, QU, SK; – *danae*: U.S.A.: AK, CA, CO, KY, IL, ME, MI, NV, NH, NY, OH, OR, UT, VT, WY; Canada: AB, BC, MB, NB, NF, NW, ON, QU, SK; also Europe and Asia; – *illotum*: U.S.A.: CA, NV, OR, WA, WY; Canada: BC; also south to Mexico and Argentina; – *internum*: U.S.A.: AK, CA, CO, ID, IL, IN, IA, KS, KY(?), MI, MN, MO, MT, NE, NV, ND, OK, OR, SD, UT, WA, WI, WY; Canada: AB, BC, PE, MB, NB, NS, NW, NF, ON, QU, SK, YK; – *janeae*: U.S.A.: CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, VA, WV; Canada: PE, NB, NS, ON, QU; – *madidum*: U.S.A.: CA, CO, MO, MT, NV, OR, WA, WY; Canada: AB, BC, MB, NW, SK; – *obtrusum*: U.S.A.: CA, CO, ID, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MT, NE, NH, NJ, NY, NC, ND, OH, OR, PA, RI, SD, UT, VT, VA, WA, WV, WI, WY; Canada: AB, BC, MB, NB, NS, NW, ON, PE, QU, SK; – *occidentale*: U.S.A.: CA, ID, NV, OR, UT, WA, WY; Canada: AB, BC; – *pallipes*: U.S.A.: CA, CO, MT, NE, NV, OR, TX, UT, WA, WY; Canada: AB, BC; – *rubicundulum*: U.S.A.: CO, CT, DC, DE, GA, ID, IL, IN, IA, KS, KY, MD, MA, MI, MN, MO, NE, NV, NJ, NY, NC, OH, PA, RI, SC, SD, TN, UT, VA, WV, WI, WY; Canada: MB(?), ON, QU; – *semicinctum*: U.S.A.: CT, DC, IL, IN, IA, KY, ME, MD, MA, MI, MN(?), NH, NJ, NY, NC, OH, PA, RI, TN, VT, VA, WV, WI; Canada: NB, NS, ON, QU; – *vicinum*: AL, AR, CO, CT, DC, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, NE, NH, NJ, NY, NC, OH, OK, PA, RI, SC, TN, TX, VT, VA, WA, WV, WI, WY; Canada: BC, NB, NS, ON, QU.

## SPECIES KEY TO THE ADULTS

1 Head typically with posterior median and submedian ridges; male cerci concave dorsally in lateral view and with prominent midventral tooth; genital lobes triangular, directed posteriorly, and widely separated; hamuli directed posteriorly, hook movement ventral-dorsal; lateral penile lobes elongate, penile flagella distally approximate and curved dorsally; vulvar lamina present, bilobate ..... ***Kalosympetrum*** subgen.n. 4

– Head without posterior ridges; male cerci convex dorsally in lateral view and with small subapical ventral tooth; genital lobes spatulate, directed posteroventrally, and approximate; hamuli directed ventrally, hook movement medial-lateral; lateral penile lobes not elongate, penile flagella distally not approximate and curved dorsally; vulvar lamina apparently absent, represented by posteroventrally directed emarginate or entire margin of sternum 8 ..... 2

2 Abdominal tergum 4 with subbasal transverse carina in both sexes or in female only; forewing radial planate typically subtends 2 cell rows; hamular hook distinctly appressed and shorter than lateral hamular lobe; lateral penile lobes not sheathlike, apices of penile flagella not curved ventrally into hamular notches; vulvar lamina a thick bilobate ridge ..... ***Tarnetrum*** 9

– Abdominal tergum 4 without subbasal transverse carina; forewing radial planate typically subtends 1 cell row; hamular hook erect and about as long as lateral hamular lobe; lateral penile lobes sheathlike, apices of penile flagella curved ventrally into hamular notch; vulvar lamina not a thick bilobate ridge ..... 3

3 Abdomen with lateral carinae vestigial; CuP in hind wing arises from discal brace; fore wing antenodal crossveins 10-11; hind wing triangle typically 2-celled ..... ***Nesogonia blackburni*** (McLachlan)

– Abdomen with lateral carinae well developed; CuP in hind wing arises from discal nodus; fore wing antenodal crossveins typically 6-9; hind wing triangle typically 1-celled ..... ***Sympetrum*** 11

4 Abdominal segments 4-9 with black apical annulations; posterior surface of head without ridges; hamuli with dorsolateral lobe shelflike internally and broadly rounded distally in ventral view; vulvar lamina ca 4 times as wide as long ..... ***ambiguum*** (Rambur)

– Abdominal segments 4-9 without black apical annulations; posterior surface of head with ridges; hamuli without dorsolateral lobe shelflike internally and broadly rounded distally in ventral view; vulvar lamina ca as wide as long ..... 5

5 Pterothorax with lateral pale stripes; abdominal terga 4-9 without posteriorly widened black lateral spots; external surface of tibiae yellow or brown; penile segment 3 without well developed ventrolateral setal tufts ..... ***pallipes*** (Hagen)

– Pterothorax without lateral pale stripes; abdominal terga 4-9 with posteriorly widened black lateral spots; external surface of tibiae black; penile segment 3 with well developed ventrolateral setal tufts ..... 6

6 Metasternum and anterior lamina densely hairy; costa typically yellow; tornus often with extra cell row; cerci light yellow with apex slightly upcurved; hamuli in lateral view with dorsolateral lobe truncate and longer than wide, with apices tuberclelike, and with ventromedial hooks contiguous at apices; vulvar lamina with ventral ridges curved posterolaterally ..... ***internum*** Montgomery

– Metasternum and anterior lamina not densely hairy; costa predominantly brown; tornus without extra cell row; cerci red with brown apices strongly upcurved; hamuli not as above, vulvar lamina with ventral ridges directed posteriorly ..... 7

7 Face white; metafemora black; hamuli in lateral view with dorsolateral lobe truncate and wider than long, with apices ridgelike ventromedially, and with distal notch ca 2/10 length of hamuli; vulvar lamina in lateral view ca 3 times as long as high and flatly tapered to acute posteriorly directed apices ..... ***obtrusum*** (Hagen)

– Face yellowish white to red, internal surface of metafemora typically brown; hamuli in lateral view with dorsolateral lobe pointed and longer than wide, with apices shelflike ventromedially, and with distal notch 3/10-1/3 length of hamuli; vulvar lamina in lateral view less than 2.5 times as long as high and convexly curved to blunt posterodorsally directed apices ..... 8

8 Face and hind femora typically predominantly yellow; posterior hamuli with small subbasal dorsomedial lobe, dorsolateral lobe internally concave and facing ventromedially, distal notch ca 1/3 hamular length, and with ventromedial hooks approximate for ca 1/2 length; vulvar lamina inflated, fused medially for more than 1/2 length, and in lateral view ca as high as long ..... ***rubicundulum*** (Say)

– Face and hind femora not typically predominantly yellow; posterior hamuli with large dorsomedial lobe, dorsolateral lobe internally level and facing ventrally, distal notch ca 3/10 hamular length, and with ventromedial hooks widely separated in natural position; vulvar lamina not inflated, fused medially for less than 1/2 length, and in lateral view ca 1/2 as high as long ..... ***janeae*** sp.n.

9 Pterothorax with two inconspicuous whitish stripes on each side; male abdominal tergum 4 without subbasal transverse carina; hamuli with lateral lobe saccular; penile flagella widely separated with apices curved dorsally ..... ***madidum*** (Hagen)
– Pterothorax with two conspicuous yellow spots margined with black ventrally on each side; male abdominal tergum 4 with subbasal transverse carina; hamuli with lateral lobe conical; penile flagella not widely separated or curved dorsally ..... 10
10 Wing venation pinkish with membrane hyaline; antenodal crossveins 7/5; legs black with extensor surfaces yellow; lateral abdominal carinae black; male cerci without subapical ventral angulation; penile flagella vestigial ..... ***corruptum*** (Hagen)
– Wing venation yellowish with opaque brown areas at wing base; antenodal crossveins 8-9/6-7; legs yellowish brown; lateral abdominal carinae not black; male cerci with subapical ventral angulation; penile flagella represented by paired short flat lobes ..... ***illotum*** (Hagen)
11 Hind wings predominantly transparent saffron over basal half; abdominal segment 9 with lateral carinae ..... 12
– Hind wings predominantly hyaline over basal half; abdominal segment 9 without lateral carinae ..... 13
12 Pterothorax with upper portions of pleural sulci and lower portion of intersegmental interface black; face whitish yellow; genital lobe obovate, strongly constricted basally; female with posterior margin of sternum 8 entire ..... ***occidentale*** Bartenev
– Pterothorax without upper portions of pleural sulci and lower portion of intersegmental interface black; face yellowish brown; genital lobe elongate, slightly constricted basally; female with posterior margin of sternum 8 emarginate ..... ***semicinctum*** (Say)
13 Lateral abdominal carinae not black; legs predominantly yellow; genital lobe more than 2 times as long as wide; female with posterior margin of sternum 8 in lateral view ca. as long as segment ..... ***vicinum*** (Hagen)
– Lateral abdominal carinae black; legs predominantly black; genital lobe less than 2 times as long as wide; female with posterior margin of sternum 8 in lateral view shorter than segment ..... 14
14 Pterostigma yellow or red dorsally; metanepisterna without transverse black area above spiracles; posterior 1/3 of abdominal terga 8 and 9 not black; hamuli with medial hook shorter than lateral lobe; posterior margin of sternum 8 in lateral view ca as long as segment 10 ..... ***costiferum*** (Hagen)
– Pterostigma brown or black dorsally; metanepisterna with transverse black area above spiracles; posterior 1/3 of abdominal terga 8 and 9 black; hamuli with medial hook ca as long as lateral lobe; posterior margin of sternum 8 in lateral view ca. as long as segment 9 .. ***danae*** (Sulzer)

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