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THE LARVA OF *SOMATOCHLORA SAHLBERGI* TRYBÔM, WITH NOTES ON THE SPECIES IN THE YUKON TERRITORY, CANADA (ANISOPTERA: CORDULIIDAE)

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The final instar larva of *S. sahlbergi* is redescribed using material collected in the Yukon Territory, Canada. Differences between this larva and those of its closest Nearctic relatives, *S. albicincta* and *S. hudsonica*, are outlined and a key to the larvae of the *alpestris* group of *Somatochlora* is provided. *S. sahlbergi* is an amphi-Beringian species, distributed across northern Asia in a band near the northern limit of trees, but in North America is found only in the extreme northwest. It is usually found in deep, cold, mossy ponds. Examination of larval morphometrics indicates a four to five year maturation period. In the northern Yukon and adjacent Northwest Territories, *S. sahlbergi* hybridizes with *S. albicincta* and *S. hudsonica*.

INTRODUCTION

Somatochlora sahlbergi Trybŏm is a dragonfly of the far north; in fact, the southern limits of its range are probably farther north than those of any other odonate. It is found at or near the Arctic treeline from Finland east to the Mackenzie River Delta of Canada (Fig. 1). With the exception of a possibly disjunct population near Lake Baikal it does not occur south of 60°N, and only in western Alaska (and possibly in extreme eastern Siberia) does it follow the treeline south of 65°N. Because most of its range is very difficult to reach, its biology remains poorly known. VALLE (1931) discovered the larva at Parkkina, in what is now Soviet Lapland and described it on the basis of four specimens. In his paper, he stated that three of the larvae were full-grown and the other was smaller, but upon examining three of his specimens we find that two are definitely

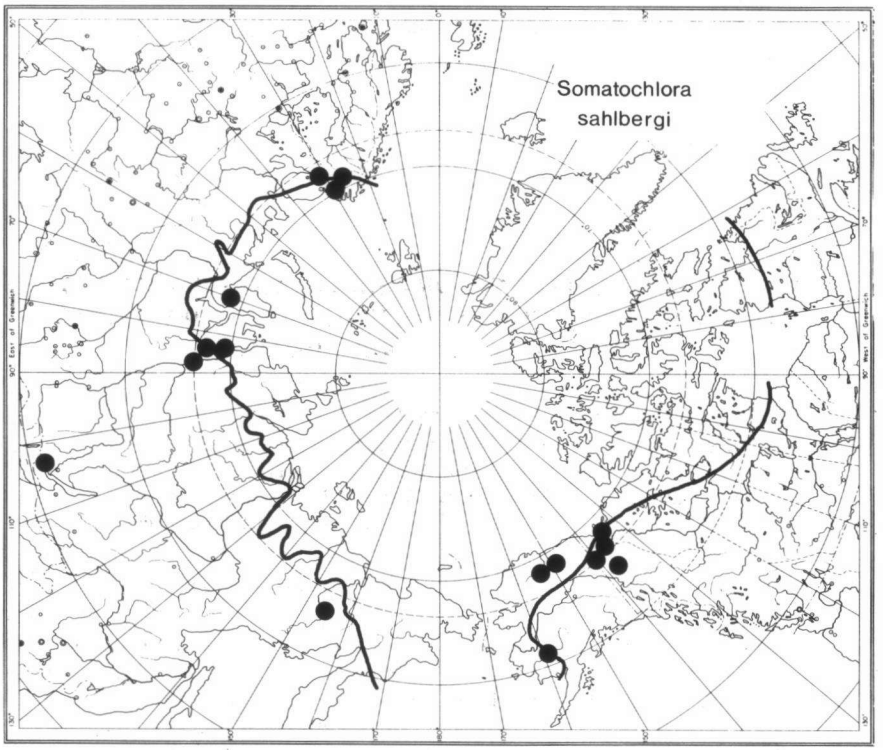


Fig. 1. Distribution of *Somatochlora sahlbergi*. Solid line represents approximate northern limit of trees. Distribution data include both adult and larval collections, taken from VALTONEN (1980), BELYSHEV et al. (1978), WALKER & CORBET (1975), BELYSHEV (1968) and VALLE (1952), as well as additional specimens in the Canadian National Collection (Ottawa), the Spencer Entomological Museum, University of British Columbia (Vancouver), the British Columbia Provincial Museum (Victoria) and the Royal Ontario Museum (Toronto).

less than full-grown and the largest is probably the penultimate, rather than the ultimate, instar. Until recently, these unassociated specimens remained the only larvae of *S. sahlbergi* known.

In 1979, on a collecting trip to the northern Yukon Territory, one of us (SGC) collected a *Somatochlora* larva at a pond in the Richardson Mountains. Although it was initially identified as *S. albicincta* (Burm.), we later concluded that it might be *S. sahlbergi*. So, when we returned to the Yukon in 1982, we made a special effort to find emerging *S. sahlbergi* and were successful in collecting two emerging adults and eight additional exuviae. Subsequently, thirteen larvae (five of them final instar) were discovered in the collection of the Royal Ontario Museum. These were collected in 1980 at two sites in the northern Yukon — one

the same pond that we had visited, the other a pond along the Ogilvie River, 180 km to the southwest.

With this sample of fifteen final instar larvae and exuviae in hand, we thought it would be valuable to expand on Valle's description. A comparison of his specimens and description with the larvae from the Yukon follows the redescription.

REDESCRIPTION

Material examined — USSR: Parkkina, Petsamo [near Pechenga, Murmansk], 3 larvae (none final instar, 2.VII.1929, K. Valle (University of Turku), 1 larva (not final instar), 12.VIII.1929, K. Valle (UT). — CANADA: Yukon: Dempster Highway, km 148, 65°05′N 138°08′W, 1 exuviae (not final instar), 30.VI.1982, S.G. Cannings (University of British Columbia); Dempster Highway, km 216, 65°28′N 138°13′W, 6 larvae (2 final instars), 20.VII.1980, ROM field party (Royal Ontario Museum, UBC); Dempster Highway, km 450, 66°56′N 136°14′W, 1 larva (not final instar), 30.VI.1979, S.G. Cannings (UBC); 7 larvae (3 final instars), ibid., 18.VII.1980, ROM field party (ROM); 8 exuviae (2 associated with emerging adults), ibid., 3.VII. 1982, S.G. Cannings, R.A. Moore (UBC); 2 exuviae, ibid., 6.VII.1982, S.G. Cannings (UBC).

The final instar larva is shown in Figure 2. Coloration is described from larvae fixed in Kahle's solution and preserved in 70% ethanol. Overall body colour a uniform orange-brown; some larvae coated in a dark film which gives them a dusky red-brown colour. Total length 22.8-25.0 mm (23.8 ± 0.19 mm) (range with mean and standard error in parentheses; n=15, unless otherwise noted).

Head 6.2-6.5 mm (6.3 ± 0.06 mm, n=5) wide. Antenna with the two basal segments light to medium brown, the more distal segments pale yellow-brown; segments 5 and 6 sometimes with a broad, brown, transverse band; acute tip of seventh segment dark brown. Antenna with segments 1-7 having mean lengths of 0.54, 0.65, 0.75, 0.41, 0.55, 0.82 and 0.75 mm respectively (n=12). Eyes prominent and convex. Occiput with bands of dark brown hairs in the usual position. Labium large, the folded prementum extending posteriorly to the middle of the mesocoxae; underside of folded prementum about as broad as long; 5.0-5.1 mm (5.0 ± 0.02 mm) wide at widest point (n=5; many of the exuviae had slightly distorted prementa, so none of these were included in this measurement), 1.5-1.7 mm (1.6 ± 0.02 mm) wide at base (n=15), 4.9-5.1 mm (4.99 ± 0.02 mm) long (n=15). Prementum and labial palps light yellow-brown with scattered brown or black spots of variable size; these spots more numerous on the palps, where they often merge to form irregular streaks or blotches. Premental setae 11-14, usually 12 or 13 (12.6 ± 0.16, n=30); the fifth or sixth from the outside longest, the inner 3 or 4 very short. Palpal setae 8 or 9 (8.7 ± 0.08, n=30) (Fig. 3). Medial border of palps with 7-8 deeply rounded crenulations, the middle crenulations bearing 3 (occasionally 4) setae, the outer ones often with only 1 or 2 setae (Fig. 4).

Thorax similar to head in colour, but slightly lighter. Prothoracic processes not very prominent, with wiry brown hairs. Femora with two dark bands, lighter

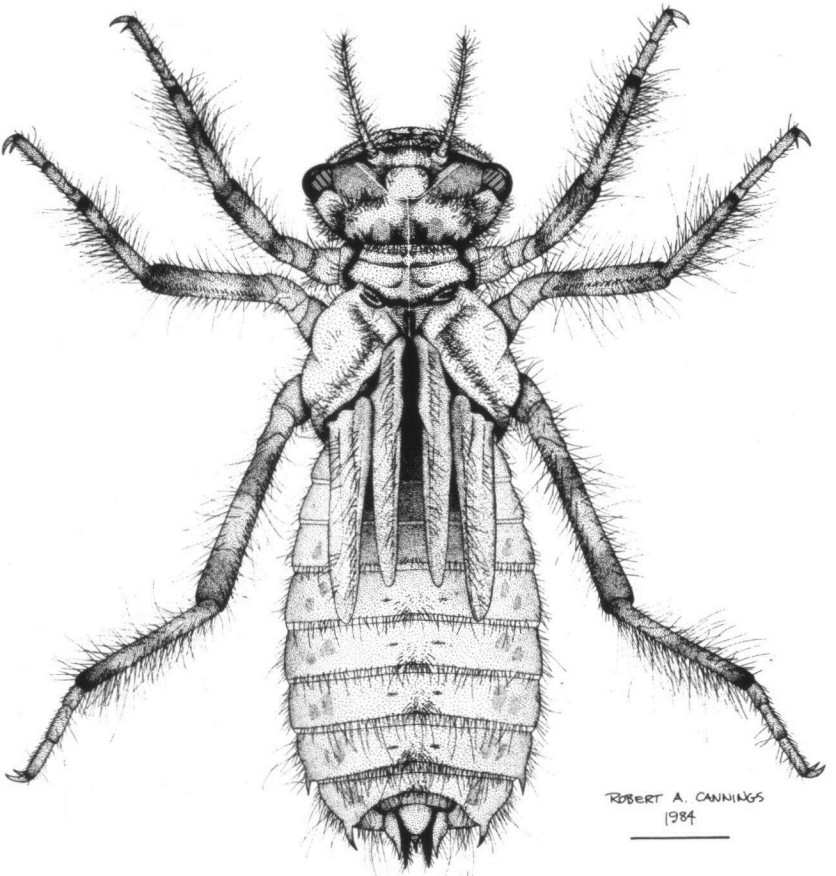


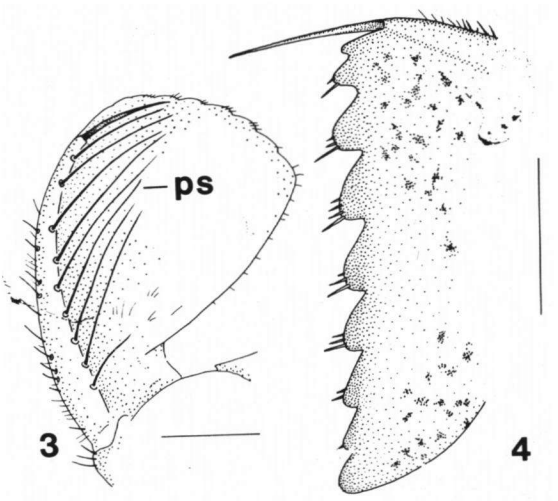
Fig. 2. *Somatochlora sahlbergi*, final instar male larva, dorsal view. Scale line = 3 mm.

on the metafemur, and with the distal band lighter than the proximal one. Femora moderately hairy but tibiae densely haired. Most of the setae on the metatibia about three times the width of the tibia, some more than five times this width. Metafemur 6.7-7.4 mm long (7.1 ± 0.05 mm). Hindwing sheaths 7.4-8.0 mm (7.7 ± 0.05 mm).

Abdomen 12.7-15.1 mm long (13.5 ± 0.17 mm), 6.7-7.6 mm wide (7.2 ± 0.08 mm), widest at 6 or 7; covered fairly evenly on the dorsal surface with minute setae with a few longer hairs scattered among them. These longer hairs more common near the lateral margins, the margins with a distinct fringe consisting of both the short setae and the longer hairs. The fringe on tergum 9 consists of distinctly longer and stouter hairs than on the previous segments. The posterior

margin of each segment is lined with a row of short brown setae mixed with longer, wiry hairs. The number and length of the long hairs increase from the anterior to the posterior segments. These long hairs also increase in density near the midline, forming median tufts with other hairs on the posterior dorsum of each segment. The largest tuft is on tergum 8, where some of the hairs extend to the posterior border of tergum 10. Dorsal hooks absent.

Divergent lateral spines on abdominal segments 8 and 9, those on 8 about 1/5 to 1/3 (0.22-0.32; 0.27 ± 0.009) the lateral length of the segment excluding the spine and those on 9 about 1/3 to 1/2 (0.34-0.48; 0.43 ± 0.009) the lateral length of the segment excluding the spine (Fig. 5). Epiproct somewhat longer than broad, slightly shorter than the cerci, which are distinctly shorter than the paraprocts. Epiproct extending the same length posteriorly as the cerci in many exuviae, where the cerci are angled medially rather than pointing directly caudad. Epiproct 1.23-1.43 mm (1.36 ± 0.013 mm) long, paraprocts 1.43-1.93 mm (1.63 ± 0.040 mm) long, cerci 1.30-1.50 mm (1.42 ± 0.018 mm) long (Fig. 5).



Figs 3-4. *Somatochlora sahlbergi*, left labial palp of larva: (3) dorsal view: ps-palpal seta; — (4) left lateral view of apex showing crenulations and associated spines. Scale lines = 1 mm.

COMPARISON WITH PALAEARCTIC MATERIAL

The large ("ausgewachsene") larvae used by VALLE (1931) in his original description are mounted on cards and pinned. Although it is dry, the largest specimen does not seem to have shrunk to any extent. However, the ratios of the lengths of its hind wing and metafemur to its head width are only 0.98 and 1.09 respectively, whereas these ratios in the Yukon specimens are on average 1.26 and 1.16. The low ratios of the Valle specimen and its overall smaller size (Tab. I) suggest that it is not fully grown and is more likely the penultimate instar.

In other features, however, it is virtually identical to its North American counterparts. It is a much lighter colour, but this is undoubtedly the result of a difference in preservation. The lateral spines on abdominal segments 8 and 9 are

Table I

Morphometric comparisons of *Somatochlora albicincta, S. hudsonica,* and *S. sahlbergi* larvae from the Yukon Territory, Canada and VALLE's (1931) specimen from Soviet Lapland — (All length measurements are in millimeters; setae are presented as counts on one side of the labium. For the former two species, n=10 except where noted; for the latter n=15 except where noted)

Character	*albicincta* range	*albicincta* x±SE	*hudsonica* range	*hudsonica* x±SE	*sahlbergi* range	*sahlbergi* x±SE	Valle specimen
Total length	21.3-24.4	23.1±0.37	23.9-27.3	25.9±0.31	23.3-25.5	24.3±0.19	18.6
Abdomen length	11.2-14.1	12.9±0.32	13.5-16.3	14.7±0.24	13.0-15.4	13.5±0.17	11.3
Abdomen width	6.4-7.5	7.1±0.12	6.7-8.2	7.4±0.14	6.8-7.7	7.3±0.08	6.5
Head width	5.9-6.2	6.0±0.04	6.3-6.6	6.5±0.04[1]	6.3-6.6	6.4±0.06[2]	5.8
Hindwing	6.3-6.8	6.6±0.06	7.1-7.5	7.3±0.05	7.5-8.2	7.9±0.05	5.7
Metafemur	6.0-6.6	6.3±0.07	6.8-7.3	7.0±0.05	6.8-7.5	7.2±0.05	6.3
Metatibia	6.7-7.5	7.0±0.07	7.6-8.5	8.1±0.07	7.6-8.3	7.9±0.05	7.0
Palpal setae[3]	6-9[4]	7.1±0.11	6-8	7.1±0.14	8-9	8.7±0.08	9&9
Premental setae[3]	11-14	12.9±0.22	11-14	12.8±0.25	11-14	12.6±0.16	14&11
Ratio lateral spine/seg. 8[5]	0.18-0.28	0.22±0.01	0.10-0.18	0.15±0.01	0.22-0.32	0.27±0.01	0.36
Ratio lateral spine/seg. 9[5]	0.23-0.33	0.29±0.01	0.11-0.18	0.16±0.01	0.34-0.48	0.43±0.01	0.46
Epiproct	1.53-1.70	1.59±0.02	1.60-1.84	1.70±0.03	1.25-1.46	1.38±0.01	1.22
Paraproct	1.87-2.04	1.93±0.02	1.81-2.14	1.95±0.04	1.46-1.97	1.66±0.04	1.53
Cerci	1.25-1.43	1.34±0.02	1.43-1.63	1.51±0.02	1.33-1.53	1.45±0.02	1.30

[1]n=6; — [2]n=5; — [3]n=20 for *albicincta* and *hudsonica*, n=30 for *sahlbergi*; — [4]almost always 7; WALKER & CORBET (1975) give a range of 5-7 (rarely 6 or 9); — [5]length of lateral edge of segment not including spine.

quite long, the relative length of those on segment 8 being outside the range of North American specimens (Tab. I).

In his description, VALLE (1931) did make one notable error which has been repeated elsewhere (WALKER & CORBET, 1975; BELYSHEV, 1973). Although he reported (and portrayed in his fig. 6c, p. 48) that the palpal crenulations bore only one or two setae each, those on his large specimen bear three (except for the outermost ones), and are therefore similar to other closely related species in this regard (Fig. 4).

COMPARISON WITH RELATED SPECIES

In Eurasia, the larva of *S. sahlbergi* can be readily distinguished from that of the related *S. alpestris* (Sel.) by the presence of prominent lateral spines on abdominal segments 8 and 9 in the former; these are absent in *S. alpestris.* In North America the situation is complex, and *S. sahlbergi* could be confused with *S. hudsonica* (Sel.), *S. albicincta* or *S. cingulata* (Sel.).

Table I compares many features of *S. sahlbergi* and its two close relatives in extreme northwestern North America — *S. hudsonica* and *albicincta.* The larva of *S. sahlbergi* is moderately large and its mean length lies between that of *S. albicincta* and *S. hudsonica.* It is moderately hairy, similar in this regard to *S. albicincta,* but less bristly than *S. hudsonica.*

The number of palpal setae is large for *Somatochlora;* no other member of the *alpestris* group regularly possesses 9, and even 8 is rare for *S. albicincta.*

For its size, the larva of *S. sahlbergi* has long appendages, a feature which is carried over into the adult stage (WALKER & CORBET, 1975, p. 117). The metafemur is consistently longer than that of *S. albicincta* and its mean length is greater than that of *S. hudsonica.* The hindwing sheaths are long as well, showing only minimal overlap in length with those of *S. hudsonica.* The banded femora also distinguish *S. sahlbergi* from *S. alpestris, S. hudsonica,* and *S. albicincta.*

The lateral spines on abdominal segments 8 and 9 are the longest of any species in the *alpestris* group, although in some specimens relative spine lengths on segment 8 overlap with those of *S. albicincta.*

One of the most striking differences between *S. sahlbergi* and the other two species is its short epiproct, which appears as short as or shorter than the cerci, whereas in the others it is noticeably longer than the cerci. The paraprocts are also short, although they project farther than the epiproct and cerci (Fig. 5).

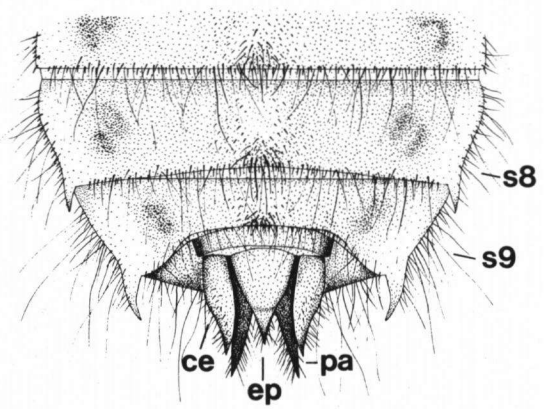


Fig. 5. *Somatochlora sahlbergi,* apex of abdomen of larva, dorsal view: ce-cercus, ep-epiproct, pa-paraproct, s8-abdominal segment 8, s9-abdominal segment 9. Scale line = 1 mm.

KEY TO THE LARVAE OF THE *ALPESTRIS* GROUP OF THE GENUS *SOMATOCHLORA*
(brevicincta unknown)

The *alpestris* group can be separated from other *Somatochlora* by the combination of absence of dorsal abdominal hooks and either presence of lateral spines on abdominal segments 8 and 9 or complete absence of these spines.

1a Lateral spines present on abdominal segment 8 and 9 4
1b Lateral spines absent 2
2a Palaearctic ..... ***alpestris*** **(Sel.)**
2b Nearctic 3

3a Premental setae 9 or 10; palpal setae 6 or 7 ..... *whitehousei* **Wlk.**
3b Premental setae 11 to 13; palpal setae 8 ..... *septentrionalis* **(Hag.)**
4a Epiproct short, slightly less than the length of the cerci; lateral spines on abdominal segment 9 long, 1/3 to 1/2 the length of the segment excluding the spine; palpal setae 8 or 9; Holarctic ..... *sahlbergi* **Trybom**
4b Epiproct distinctly longer than the cerci; lateral spines on segment 9 shorter, 1/3 or less the length of the segment excluding the spine, palpal setae usually 5 to 7, occasionally 8, rarely 9; Nearctic 5
5a Metafemur long, usually greater than 7.3 mm; abdomen with a median series of slightly elevated dorsal prominences; epiproct of male with a distinct knob on each side ..... *cingulata* **(Sel.)**
5b Metafemur less than 7.3 mm; abdomen without median dorsal prominences; epiproct of male without lateral knobs 6
6a Lateral spines on segment 9 greater than 1/5 the length of the segment excluding the spine; metafemur usually less than 6.6 mm ..... *albicincta* **(Burm.)**
6b Lateral spines on segment 9 less than 1/5 the length of the segment excluding the spine; metafemur usually greater than 6.6 mm ..... *hudsonica* **(Sel.)**

ECOLOGY AND BEHAVIOUR

DISTRIBUTION

VALLE (1932) points out that this is a species of the Arctic treeline, and this observation is borne out by our experience. In the Yukon *S. sahlbergi* is invariably found within 100 km or so of the latitudinal treeline and is usually within 300 m of the altitudinal treeline. It is very common in the valleys of the Ogilvie River and its tributaries in the Ogilvie Mountains, but is not found in subalpine areas south of this mountain barrier. In the Engineer Creek valley, a southern fork of the Ogilvie River, *S. sahlbergi* is without doubt the most abundant corduliid of the valley's numerous deep peaty ponds, since at this latitude its two close relatives *S. albicincta* and *S. hudsonica* are very rare or absent in these higher forests. BELYSHEV (1973), discussing its status in Siberia, states that "generally this species is rare and even in the northern part it could not be considered as common".

HABITAT

In Fennoscandia, VALLE (1932) found *S. sahlbergi* larvae in bog ponds and pools at the edge of the shrub tundra. These ponds were surrounded by *Sphagnum* and sedges, the only shelter for the adults being the small dwarf birches. BELYSHEV (1973) states that *S. sahlbergi* is found in clear and cold, slowly moving waters, usually surrounded by coniferous forest.

In the Yukon, *S. sahlbergi* inhabits a variety of ponds and bog pools, from narrow roadside ditches and pools in low-centre polygons to small (150 m diameter) moss-margined lakes. Both minerotrophic (fens) and ombrotrophic (bogs) waters are represented. We have never found this species in slowly moving

waters, except in one fen pond where there was a perceptible current through the saturated moss and sedges. There seem to be two main characteristics that unite all the sites — the occurrence of an aquatic moss as the dominant vegetation and deep, cold water.

The moss is not necessarily *Sphagnum* — for example, in a pond in a low-centre polygon fen near Old Crow, Yukon the dominant moss was *Scorpidium scorpioides* (Hedw.) Limpr., accompanied by *Drepanocladus fluitans* (Hedw.) Warnst. The former usually occurs on wet peat or grows submerged or floating at the margins of pools and has been cited as an "indicator" species of rich fen; some authorities regard it as decidedly calciphile. The latter is most common in deep pools and probably prefers acid habitats (CRUM & ANDERSON, 1981; WATSON, 1981). At the small boggy lake at km 450 of the Dempster Highway, the dominant moss was the aquatic form of *Sphagnum lindbergii* Schimp. ex Lindb., a moss usually associated with ombrotrophic or weakly minerotrophic waters (ANDRUS, 1980). Here the larvae were crawling out of the moss onto sedges that grew in occasional clumps at the water's edge. Permafrost lay beneath the moss, only 20 to 50 cm below the surface of the water.

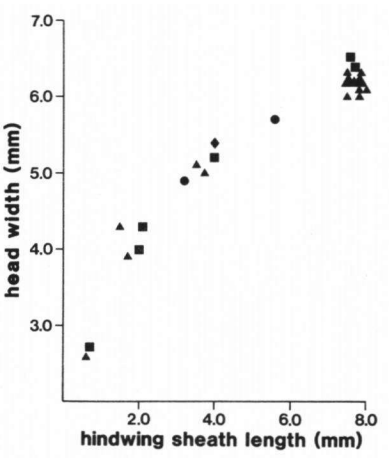


Fig. 6. Hindwing sheath length versus head width in *Somatochlora sahlbergi* larvae and exuviae. Collection localities indicated by symbols: triangles-km 450, Dempster Highway, Yukon (small = 1 specimen, large = 2 specimens); squares-km 216, Dempster Highway, Yukon; diamonds-km 148, Dempster Highway, Yukon; circles--Petsamo, U.S.S.R.

The preference for relatively deep ponds dominated by aquatic moss separates *S. sahlbergi* somewhat from *S. hudsonica* and *S. albicincta*. *S. hudsonica* is one of the dominant dragonflies of deep, rich sedge marshes in the Yukon whereas *S. albicincta* is most common in sparsely vegetated ponds, bogs and shallow lakes.

In the northern Yukon, *S. sahlbergi* is usually found flying with at least some of the following dragonflies: *Coenagrion interrogatum* (Hag.), *C. resolutum* (Hag.), *Enallagma boreale* Sel., *Aeshna eremita* Scudder, *A. juncea* (L.), *A. septentrionalis* Burm., *Cordulia shurtleffi* Scudder, *Somatochlora albicincta, S. hudsonica, Leucorrhinia hudsonica* Selys and *L. patricia* Wlk. If the pond has shallow, flooded margins, *Aeshna sitchensis* Hag., *Somatochlora franklini* Sel., *S. kennedyi* Wlk., *S. whitehousei* Wlk. and *Sympetrum danae* (Sulz.) can be common.

LARVAL GROWTH AND EMERGENCE

When the head widths and hindwing lengths of all of the larvae are measured, they can be sorted into five distinct groups (Fig.6). If the head widths (converted to logarithms) are graphed against hypothetical instars and forced onto a straight line, the figure suggests that these groups represent the final instar F and the F-1, F-2, F-4, F-8 and F-11 instars (Fig. 7). If these groups correspond to yearly cohorts, it would indicate that the larvae take five years to mature. Cohort splitting, however, may complicate the picture; perhaps some larvae can mature in four years.

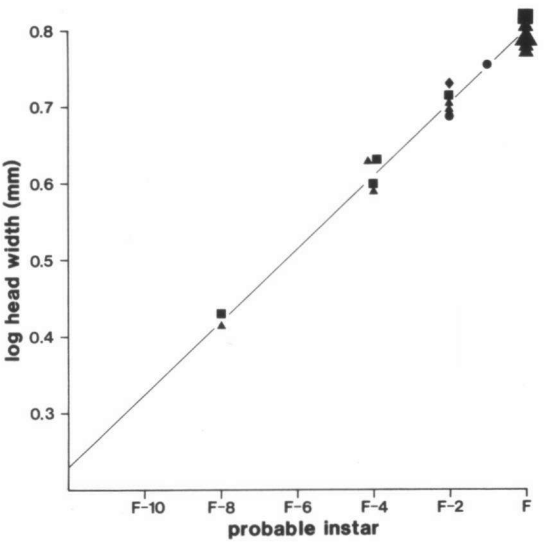


Fig. 7. Log of head width versus probable instar of *Somatochlora sahlbergi* larvae and exuviae. Symbols as in Figure 6 (small squares and triangles = 1 specimen, medium squares and triangles = 2 specimens, large triangle = 5 specimens). F = final instar, F-1 = penultimate instar, etc.

VALLE (1938) never observed emergence, but estimated that in "early" years *S. sahlbergi* could emerge in the second half of June and in "late" years in the beginning of July. The earliest record he knew of was 19 June 1883 at Jekostroff, a village south of Petsamo in the interior of Lapland. The earliest record at Petsamo, at the head of a fjord of the Arctic Ocean, was 8 July 1930. In the Yukon, the only date of emergence recorded is 3 July 1982, at a cool, windswept pond at timberline in the Richardson Mountains. At the same time, however, mature adult males were actively patrolling the pond and three days later the emergence appeared to be over. On 30 June 1979 no adults were flying at this pond. In 1982, adults were mating and ovipositing on 30 June in the Engineer Creek valley, 200 km to the south.

BEHAVIOUR

Although both VALLE (1931) and HÄMÄLÄINEN (1967) report that males patrolled the edges of ponds, it is our experience, as well as that of others (R.J. Cannings, D.M. Wood, pers. comm.) that *S. sahlbergi* males usually patrol at

least one metre offshore. At small ponds they tend to stay out over open water, often criss-crossing over the surface rather than following the contour of the shoreline. This habit, very frustrating to the collector, contrasts with the shore--hugging behaviour of male *S. albicincta* and *S. hudsonica.* In this respect, *S. sahlbergi* more closely resembles the lake-inhabiting *S. cingulata.*

When females appear at the ponds to oviposit they stay away from the shoreline sedges, dropping their eggs into open water underlain by aquatic moss. At two sites where the depth was measured the moss was 30 cm below the surface. Oviposition has been observed from 1200 h to 1600 h PDT; the true sun time would be almost two hours earlier.

We have only observed copulation twice. Both of these occurred at the same locality within a few minutes of each other about 1200 h PDT. In both cases the male quickly grabbed an ovipositing female and the pair flew off rapidly into the spruce woods.

HYBRIDIZATION

In the low valleys of the northern Yukon, *S. sahlbergi, S. albicincta* and *S. hudsonica* are sympatric. At ponds which combine the habitat preferences of the dragonflies, two (or occasionally all three) of the species can be found together. In these situations, hybrids are relatively common between *S. sahlbergi* and its North American congeners. These hybrid swarms will be the subject of a future paper.

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