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Symbiocladius equitans (Diptera: Chironomidae), an Ectoparasite of Ephemeroptera in the Martin River, Northwest Territories, Canada

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Symbiocladius equitans (CLAASSEN 1922) was found in the Martin River, Northwest Territories, Canada (61°53'N; 121°37'W) on *Rhithrogena* EATON 1881, *Heptagenia maculipennis* WALSH 1863 and *Heptagenia* WALSH 1863. *S. equitans* appears to be bivoltine with two generations per year, the winter generation infesting *Rhithrogena* nymphae and the summer generation infesting *Heptagenia* nymphae. Occurrence of the midge in the Martin River is a first Canadian record and is a considerable extension of its range.

1. Introduction

A number of relationships including symphoresis, commensalism and parasitism exist between larvae of Chironomidae and other aquatic Invertebrata (STEFFAN 1967; ARVY & PETERS 1973). The occurrence of *Symbiocladius* KIEFFER 1925, a genus of Orthocladiinae, on species of Ephemeroptera is an example of ectoparasitism.

Table 1, adapted from CODREANU and BALCESCU-CODREANU (1975), summarizes the distribution of *Symbiocladius* and its ephemeropteran host species. At least three species of *Symbiocladius* are known to exist: S. *(Acletius) wygodzinskyi* from South America; S. *equitans* from North America; and S. *rhithrogenae* from Europe. The status of a second species from Europe, S. *microcephalus,* is unclear (Table 1). Additionally, UENO (1930) reported the occurrence of a chironomid resembling *Symbiocladius* on a species of *Ecdyonurus* EATON 1868 in Japan.

The species found in this study, S. *equitans,* is strictly North American and has been found in California, Utah, Colorado, Vermont and North Carolina (CLAASSEN 1922; ROBACK 1953, 1966). During our investigation of aquatic ecosystems in the Mackenzie and Porcupine River watersheds (BRUNSKILL et al. 1973) we found *Symbiocladius equitans* infesting at least three species of Heptageniidae in the Martin River, Northwest Territories.

2. Materials and Methods

The Martin River is a brown water river draining the Martin Hills, Antoine Lake and low-lying areas of muskeg 65 km southwest of Fort Simpson, Northwest Territories. Six sampling locations (Fig. 1) were established in the lower 9 km of the river before its confluence with

Table 1: Ectoparasitic species of the Genus *Symbiocladius* KIEFFER 1925 [Diptera: Chironomidae] and their hosts from the insect order Ephemeroptera[a].

Species of *Symbiocladius*	Species of Ephemeroptera	Location
S. (Acletius) wygodzinskyi ROBACK 1965	*Meridialaris* PETERS 1972	Argentina
S. equitans (CLAASSEN 1922)	*Epeorus (Iron) vitrea* (WALKER 1853)	United States
	Rhithrogena doddsi (MCDUNNOUGH 1923)	United States
S. rhithrogenae (ZAVŘEL 1924)[b]	*Ecdyonurus dispar* (CURTIS 1834)	Czechoslovakia
	E. fluminum (PICTET 1844)	Czechoslovakia
	E. forcipula (PICTET 1844)	France
	E. (= Heptagenia) lateralis (CURTIS 1834)	Roumania, France, Germany
	E. subalpinus KLAPALEK 1905	Czechoslovakia
	E. torrentis KIMMINS 1942	Czechoslovakia
	E. venosus (FABRICIUS 1775)	France
	Heptagenia sulphurea (MÜLLER 1776)	France
	Rhithrogena alpestris EATON 1885	France
	R. diaphana NAVAS 1916	France
	R. semicolorata (CURTIS 1834)	France, Czechoslovakia, Roumania
Symbiocladius sp.	*Thraulodes speciosus* TRAVER 1934	United States

[a] Adapted from CODREANU & CODREANU-BALCESCU (1975).

[b] Includes, at least for *E. fluminum, S. microcephalus* which according to the description by ZAVŘEL (ŠULC & ZAVŘEL 1924) appears to be a distinct species (see also ROBACK 1953, p. 2).

the Mackenzie River as part of a monitoring program on the effects of a highway crossing on the Martin River (BRUNSKILL et al. 1973, ROSENBERG & SNOW 1975). All sites were located in riffle-pool sequences and had water velocities 0.4 to 1.0 m sec^{-1}. The substrates of the riffles were cobble and boulders 0.1 to 0.5 m in diameter with an admixture of fine gravel, sand and silt in the interstices.

From 1971 to 1974 macrobenthos were collected at the 6 stations using artificial substrates (ANDERSON & MASON 1968). In addition, Surber samples were taken at stations 4 and 6 in 1973, and the total number of Ephemeroptera infested by *S. equitans* estimated at each station. Drift net collections were made at stations 1, 4, 5 and 6 (BRUNSKILL et al. 1973). Larval specimens were preserved in 70% ethyl alcohol. All *S. equitans* were removed from their hosts and mounted in Euparal or Canada Balsam in our Winnipeg laboratory using the method described in SAETHER (1969).

3. Results

During the period of sampling, 105 larvae of *S. equitans* were found attached to 103 nymphae of Heptageniidae. The larvae were identified as *S. equitans* on the basis of one large and three fine mandibular teeth in mature specimens (JOHANNSEN 1937). The mentum of mature Martin River larvae had four lateral teeth that were slightly stronger than those illustrated by ROBACK (1965) but positioned similarly.

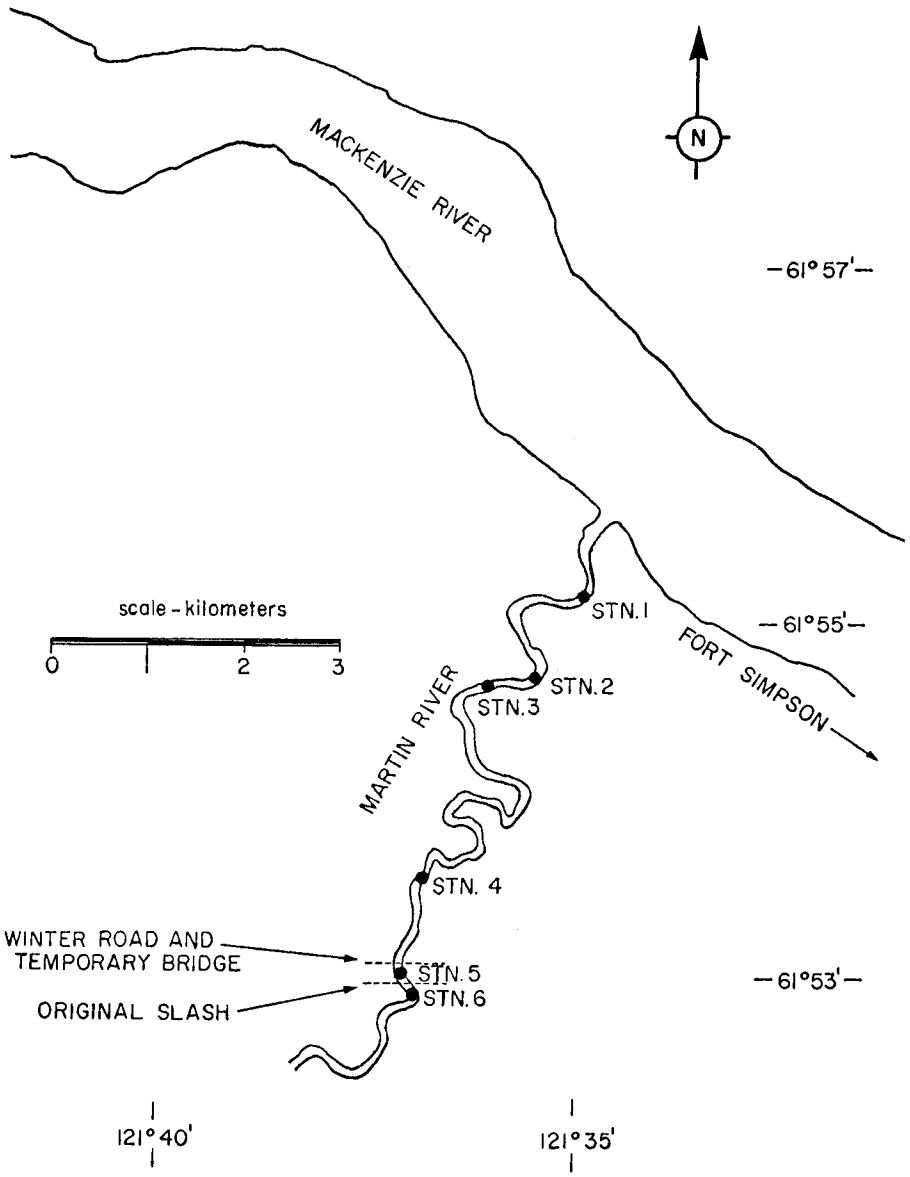

Fig. 1: Sampling sites on the Martin River, Northwest Territories, Canada, for larvae of *Symbiocladius equitans* CLAASSEN 1922 (Diptera: Chironomidae) (from BRUNSKILL et al. 1973).

The hosts were identified as *Heptagenia maculipennis* WALSH 1863 and possibly *H. flavescens* (WALSH 1862); and one unidentified species of *Rhithrogena* EATON 1881. Damaged and immature specimens prevented species identifications of many nymphs.

The smallest *Symbiocladius* larvae infesting the heptageniids closely resembled first instars of *S. rhithrogenae*. They were 0.55–0.57 mm long, had well developed eyespots

and parapedes, four papillae anales, and procerci bearing six setae. The caput was 1.45 times as long as broad and tapered to a point anteriorly. Each mandibula consisted of a single long hook without accessory teeth. Most first instar larvae and all later instar larvae and pupae were enclosed in a sheath secreted beneath the wing pads of their hosts, as described by CLAASSEN (1922).

CODREANU (1939) noted that a major reduction in sense organs and body structures occurs in *S. rhithrogenae* during larval development. The length : width ratio of the head capsule is reduced, antennae are shortened, eyes and procerci are reduced or lost and the parapedes and papillae anales become much less prominent. Similar changes occur in *S. equitans*. The greatest change occurs during the first moult, and although we did not rear first instars from the egg we were able to associate first and second instars from head capsules retained in the secreted larval sheath.

Two specimens of *Rhithrogena* had a double infestation. One specimen had two first instars, each attached to an opposite side of the metathorax, with its head under the nearest wing pad. The other nympha had one first instar beneath the left wing pad and one attached to the fibrilliform portion of gill number 5.

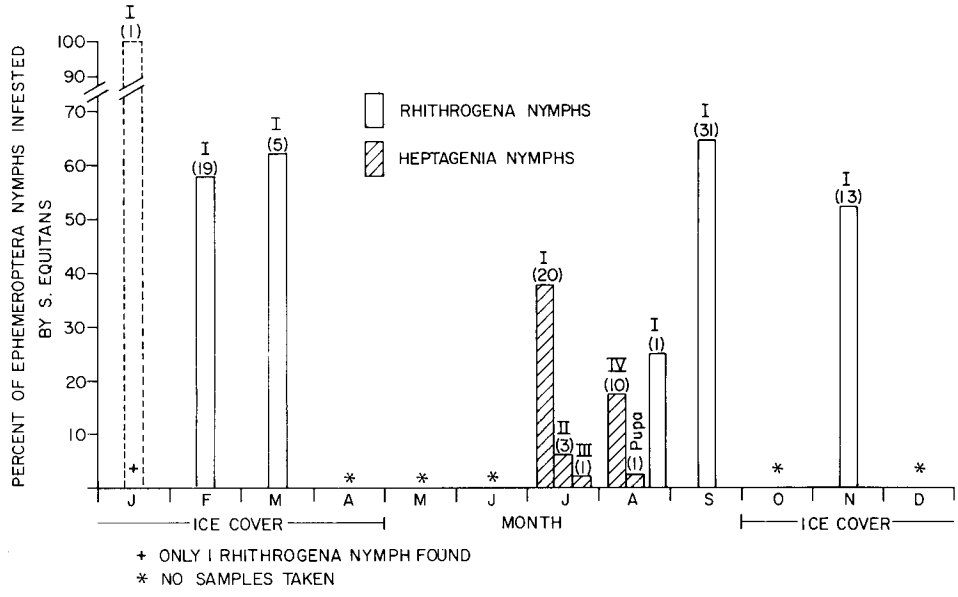

Fig. 2: Percent infestation of *Heptagenia* spp. and *Rhitrogena* sp. nymphae (Ephemeroptera) by instars of *S. equitans* CLAASSEN 1922 (Diptera: Chironomidae) from 1971 to 1974 in the Martin River, Northwest Territories, Canada. (Total numbers of larvae are given in parenthesis. Instars are given by Roman numeral. Collections having been made approximately at mid-month, the data from 1971 to 1974 are pooled monthly).

Fig. 2 shows the percent of *Heptagenia* and *Rhithrogena* nymphae infested by instars of *S. equitans* during a year. The totals of larvae for each month represent a combination of data over the period of 1971 to 1974. Collections, when made, were usually in mid-month. It also shows the apparent alternation of hosts, *Heptagenia* being parasitized in summer and *Rhithrogena* in winter. The majority of infested *Rhithrogena* nymphae were

found during the winter months from September through March, during which time the percentage of infested nymphae changed very little, ranging from 52.7 to 65.0%. Although *Rhithrogena* was never found in July, 4 nymphae were found in August, one of which was parasitized. All of the larvae found on *Rhithrogena* were first instars. This, however, is not unusual as CODREANU (1939) found that first instars of *S. rhithrogenae* from eggs laid in autumn have the longest duration, and develop slowly during the winter. Instars I to IV and pupae were found on *Heptagenia* during the summer months, but no larvae were found on 98 *Heptagenia* nymphae taken between September and March. *Heptagenia* had a 45.3% nymphal infestation in July, composed of instars I, II, and III. In August the percentage of infestation was 19.3% and only instar IV and pupae were found. From August 5 to 17, six *Heptagenia* nymphae were found carrying empty cocoons from which the pupae of *S. equitans* had emerged.

Numbers of *Heptagenia* nymphae infested by *S. equitans* in the entire riffle areas of stations 4 and 6 ranged from 576 to 4592 during the summer of 1973 (Table 2). The number of nymphae collected per m^2 was similar (range: 57.4 to 89.7) but the number infested per m^2 was highly variable (range: 3.6 to 28.7) (Table 2). Other estimates of the numbers per m^2 or numbers for an entire riffle area of Ephemeroptera infested by species of *Symbiocladius,* to which the Martin River results can be compared, are not available in the literature.

Table 2: Estimated number of nymphae of *Heptagenia* species [Ephemeroptera: Heptageniidae] infested during the summer of 1973 by larvae of *Symbiocladius equitans* (CLAASSEN 1922) [Diptera: Chironomidae] at stations 4 and 6 on the Martin River[a], Northwest Territories, Canada.

Sampling date	Nymphae per m^2	Numbers Infested per m^2	Estimated Number Infested for Entire Riffle area
Station 4			
July 19	68.2	3.6	1080
August 16	89.7	7.2	2160
Station 6			
July 19	82.5	28.7	4592
August 16	57.4	3.6	576

[a] The areas of stations 4 and 6 were approximately 300 m^2 and 160 m^2, respectively.

No correlation existed between the sex of the host and the presence of *S. equitans.* Of 14 parasitized *Heptagenia,* 6 were ♂♂ and 8 were ♀♀; of 19 *Rhithrogena,* 10 were ♂♂ and 9 were ♀♀. Most of the other Ephemeroptera were too small to be reliably sexed.

4. Discussion

Although there is a large variability in the number of nymphae infested by *S. equitans* in the Martin River (Table 2), the percentages of infestation (Fig. 2) are substantially lower than the 90% recorded by CLAASSEN (1922) for *Rhithrogena* in the Big Thompson

River in Colorado. Infestation levels by Martin River larvae are more comparable to those shown for *S. rhithrogena* in Roumania by CODREANU (1939) who found that 28 to 64% of the *Rhithrogena* nymphae and 18 to 69% of the *Heptagenia* nymphae were infested by *S. rhithrogenae*. This is nearly identical to the 25 to 65% infestation of *Rhithrogena* and the 5.3 to 45.3% on *Heptagenia* in the Martin River. The relatively constant percentages of *Rhithrogena* infested in the Martin River may indicate that mortality of infested nymphae is insignificant during the winter.

No life history information is available for *S. equitans* other than the original paper of CLAASSEN (1922) which states the time of emergence of *S. equitans* as August 7 in Colorado, and ROBACK'S (1953) paper stating that pupae were found in California and Colorado in August. Despite shortcomings in our study (1. we were unable to sample the Martin River during the spring high water period of late March to late June; 2. insufficient numbers of larvae were collected for instar analysis; and 3. no adults were collected) we are able to provide some life history information and suggest that *S. equitans* is bivoltine with 2 generations per year.

The following life cycle for *S. equitans* in the Martin River seems likely:

1. Adults of larvae parasitizing *Heptagenia* emerge in August, mate and lay eggs which produce the fall generation of larvae. The first instar larvae actively seek out *Rhithrogena* nymphae of 4 to 5 mm length and attach beneath their wing pads.
2. The first instar larvae infesting *Rhithrogena* grow slowly but do not moult from September to late March.
3. Between late March and early July the larvae moult, pupate, emerge, and produce the spring generation of larvae which seek out the only available host, *Heptagenia*.
4. The larvae grow during July, then pupate and emerge from *Heptagenia* in August to renew the infestation of *Rhithrogena*.

Two other life cycles are possible:

(a) Two species of *Symbiocladius* are present, one infesting *Heptagenia*, the other infesting *Rhithrogena*. Although identification to species is difficult for instar I, our morphological observations preclude the possibility of two species of *Symbiocladius* in the Martin River. First instars found on the two hosts were identical, and all of the later instars found on *Heptagenia* were *S. equitans*. Moreover, ROBACK (1953) found that *Epeorus (Iron) vitrea* replaces *Rhithrogena* sp. as a host species for *S. equitans* in the eastern United States, showing that the chironomid is apparently not host-specific and will attach to any suitable host. In addition, the closely related *S. rhithrogenae* parasitizes three genera of Ephemeroptera in Europe: *Heptagenia*, *Rhithrogena* and *Ecdyonurus* (CODREANU 1939, ARVY & PETERS 1973). Thus it is likely that *S. equitans* infests both genera in the Martin River.

(b) *S. equitans* is univoltine, with one generation per year involving a transference of first instars from *Rhithrogena* to *Heptagenia* during the period March to July. However, CODREANU (1939) states that *S. rhithrogenae*, a species closely related to *S. equitans*, is free-living only during the early first instar when it is actively seeking a host, and he found no evidence of host transference during its normal life cycle. He also found that *S. rhithrogenae* has three generations per year in France, a winter generation of 7 months and two summer cycles of 32 to 53 days each. He noted that the overwintering first instars develop rapidly in spring with final [pupal] metamorphosis in the second half of May or early June. Thus, it is unlikely that *S. equitans* would be univoltine and switch hosts during its life cycle.

Seasonal hosts are necessary for Martin River *S. equitans* since *Rhithrogena is not* available for parasitism during the summer months (Fig. 2). *Rhithrogena* species generally emerge in spring and early summer (LEONARD & LEONARD 1962) and the early instars are probably too small to be parasitized during July and early August. *Heptagenia*, however, is present and of suitable size during these months.

We have never found *S. equitans* in rivers other than the Martin in the Ft. Simpson area. This is likely due to the presence of relatively high numbers of both host genera in

the Martin River (i.e.: ranges of 20 to 90 *Heptagenia* m^{-2} and 7 to 18 *Rhithrogena* m^{-2}) compared to adjacent rivers such as the Trail, Harris, Rabbitskin, and Jean Marie which have lesser occurrences of one or both hosts (ranges: 4 to 29 *Heptagenia* m^{-2} and 0 to 4 *Rhithrogena* m^{-2}) (D. M. ROSENBERG – unpublished data).

Previously, the most northerly record of *S. equitans* was from Colorado (CLAASSEN 1922). Our report is the first Canadian record of *S. equitans* and extends its northern range by 2500 km.

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