[The Great Lakes Entomologist](https://scholar.valpo.edu/tgle)

Volume 25
Number 1 - Spring 1992 *Number 1 - Spring 1992*

Article 5

April 1992

Observations on the Nesting of *Crabro Tenuis* (Hymenoptera: Sphecidae)

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OBSERVATIONS ON THE NESTING OF *CRABRO TENUIS* (HYMENOPTERA: SPHECIDAE)

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ABSTRACT

Three nests of *Crabro tenuis* were studied during June 1971–1972 in Oswego County, New York. Females constructed shallow but lengthy, multicelled nests in sand with the cells being built in clusters, sometimes in series. Females plugged the entrances with damp sand and occupied the burrows during midday. Paralyzed prey were stored head inward at the end of the burrow. The deeper cells in a cluster were excavated and provisioned first and the shallower cells built and stored later, as determined by the developmental stages of the wasps within the cells. From four to seven paralyzed, adult male flies were placed in a fully provisioned cell with their venters toward the center. Such a cell usually held only one species of fly. Provisions consisted of the suborders Brachycera and Cyclorrhapha and comprised the families Rhagionidae, Anthomyiidae and Tachinidae. An egg was affixed about equally to the left or right side of the neck of a fly and this prey was placed against or near the wall of the cell. The nesting traits of *C. tenuis* were compared with those of other members of the *Cribrarius* group, *C. advena* of the *Advena* group, *C. venator* of the *Tumidus* group and species in the *Hilaris* group.

The nesting behaviors of the Nearctic species of *Crabro* have been studied somewhat intensively during the past three decades (Evans 1960, 1964; Pechuman 1963, Kurczewski and Acciavatti 1968, Kurczewski *et al.* 1969, Miller and Kurczewski 1976, Barrows *et al.* 1978, Matthews *et al.* 1979, Evans *et al.* 1980, O'Brien and Kurczewski 1980, Alcock 1982, Wcislo 1984, Wcislo *et al.* 1985). These studies have disclosed species-specific differences in nesting habitat, communal activities, prey selection and, sometimes, number and size of prey. Species that inhabit firm soil tend to demonstrate a basic nest structure that differs from that of species that inhabit loose sand, specifically in tumulus shape, burrow slope and design and depth of cells. In the vast majority of species, the more recently built cells in a cell cluster within a nest are constructed nearer the ground surface and the older cells in the cluster are deeper. All species of *Crabro* provision with adult, often male flies (Krombein 1979).

Our study on *C. tenuis* Fox was undertaken in order to compare components of its nesting behavior, which were heretofore unknown, with those from published studies on other Nearctic species in the genus. *Crabro tenuis* is a member of the *Cribrarius* group (Bohart 1976) and should illustrate common nesting traits with other species in the group such as *C. argusinus* R. Bohart, *C.*

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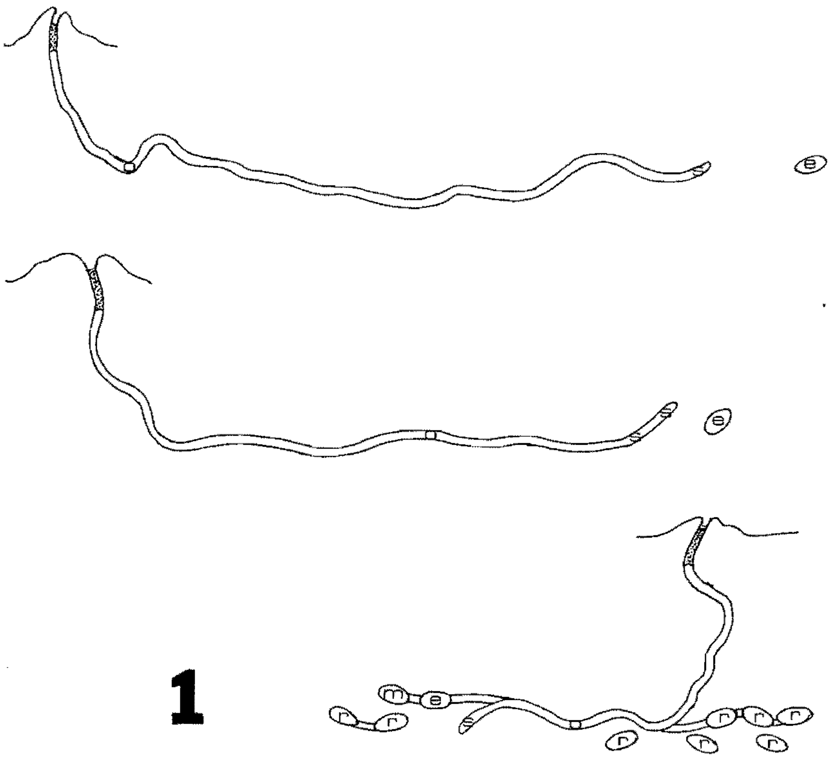

Figure 1. Nests of *Crabro tenuis*, as viewed from the side. Cell contents are as follows: e, egg; r, larva; m, maggots. Females in burrows are indicated by o, prey storage areas by s. Sand plugs near entrances are stippled. Structures are drawn to scale.

cribrellifer (Packard), *C. largior* Fox, *C. latipes* Smith and *C. monticola* (Packard). *Crabro tenuis* occurs transcontinentally in North America, ranging from Washington and Utah to Alberta, Quebec and Georgia (Bohart 1976).

We excavated three nests of *C. tenuis* on 10 June 1971 and on 13 and 14 June 1972 at Selkirk Shores State Park, Oswego County, New York. They were located in flat, bare or lightly vegetated, moist sand at the interface of a man-made sand pit and a sandy field. Predominant vegetation surrounding the nesting site included various grasses, *Rubus* spp. and *Rhus typhina*. Species of Pompilidae and Sphecidae nesting in close proximity to *C. tenuis* included *Episyron quinquenotatus* (Say), *Tachysphex terminatus* (Smith), *Crabro advena* Smith, *C. monticola* (Packard), *Oxybelus bipunctatus* Olivier, *O. emarginatus* Say and *Philanthus politus* Say. Two of the nests (10 June 1971, 13 June 1972) were in an early stage of development, when excavated, and each contained only a single cell (Fig. 1). The third nest (14 June 1972) held 10 fully provisioned cells (Fig. 1). All three nests were plugged with damp sand at the entrance, had wasps within the burrows positioned head outward and had paralyzed flies stored at the end of the tunnel. Recently constructed tumuli surrounding the entrances to these nests were 4.5, 5.0 and 7.0 cm wide and 1.5, 1.8 and 2.0 cm high, respectively. The burrows entered the sand at an angle nearly perpendicular to the horizon, were 4.5–5.0 mm in diameter, plunged downward nearly vertically for 8–10 ($\bar{x}$=9.0) cm and then coursed laterally for 15–28 ($\bar{x}$=23.0) cm before ending blindly 5.5, 6.0 and 9.0 cm, respectively, beneath the surface.

In the two recently built nests, fully provisioned cells were unearthed 2.5 and 4.0 cm, respectively, from the burrow terminus. In the oldest nest, the 10 cells were constructed in two distinct clusters with some of the cells in series. One of the shallowest cells in this nest, 8.0 cm deep, was the most recently stocked and contained an egg, 2.5 mm long, affixed to one of the prey. Two other shallow, recently stocked cells, 8.0 and 9.0 cm deep, each contained a newly hatched larva, 3.5 mm long, feeding on one of the prey. Six cells, 8.5–10.0 cm ($\bar{x}$=9.4) cm deep, held older larvae, 4.5–11.0 mm long, with the two deepest cells, 10.0 cm deep, containing the largest and, presumably, oldest larvae. Another cell in this nest, 8.0 cm deep, contained three maggots that were reared to *Senotainia trilineata* (Van der Wulp) (Sarcophagidae). The cells in this nest were 7–8 ($\bar{x}$=7.5; N=10) mm high and 12–15 ($\bar{x}$=13.6; N=10) mm long. One cell in one of the recently built nests was 7 cm deep, 6 mm high and 12 mm long. Many of the cells were sloped upward at a 15°–20° angle with the horizon, the front being higher than the back end.

Crabro tenuis females stored their burrows and provisioned their cells with adult, male flies belonging to the suborders Brachycera and Cyclorrhapha. A representative sampling of these flies included 17 *Symphoromyia* sp. (Rhagionidae), 3 *Hydrophoria conica* (Wiedemann) (Anthomyiidae), and 16 *Eulasiona comstocki* Townsend and 14 *Cryptomeigenia* sp. (Tachinidae). Nine of the cells each contained only a single species of fly and two each contained both *Hydrophoria conica* and *Cryptomeigenia* sp.

The three nesting wasps weighed (wet) 19, 21 and 23 mg. One fully provisioned cell in a newly constructed nest contained seven paralyzed flies that weighed (wet) a total of 68 (individual wgts., 3–19) mg. The 10 fully provisioned cells in the oldest nest held four to six ($\bar{x}$=4.9) paralyzed flies per cell. The aggregate prey weights of the five most recently provisioned cells in this nest ranged from 46 to 59 ($\bar{x}$=49.8) mg, with individual flies weighing 5–21 ($\bar{x}$=10.7; N=29) mg. In this nest individual flies to which were affixed the wasp's eggs weighed 5–10 ($\bar{x}$=9.0; N=5) mg and were the heaviest (10 mg), second heaviest (10 mg), second lightest (l0 mg) or lightest (10, 5 mg) prey in the cells. The egg-bearing fly in one of the recently built nests was the second heaviest prey in the cell and weighed 11 mg.

Eggs or recently hatched larvae of *C. tenuis* were affixed to the left (3) or right (2) sides of the ventral side of the neck of the fly in the typical *Crabro* position (Fig. 2). The wing to the opposite side of the egg affixation point was extended laterally to accommodate this affixation site in some individuals. The flies were placed in a cell with their heads toward the back end and venters toward the center, as indicated in Fig. 2. The egg-bearing fly was often placed against or near the wall of the cell, usually near the top.

DISCUSSION

Evans (1960) provided the initial notes on comparative nesting behavior of the Nearctic species of *Crabro*. He reported species-specific differences in prey type, habitat (including soil type), nest depth (as related to soil type and size of wasp) and manner of provisioning flight for *C. advenus* Smith (=*C. advena*), *C. argus* (Packard) (=*C. argusinus*) and *C. monticola*. He noted similarities in prey transport, nest entry, burrow storage and oviposition site for the three

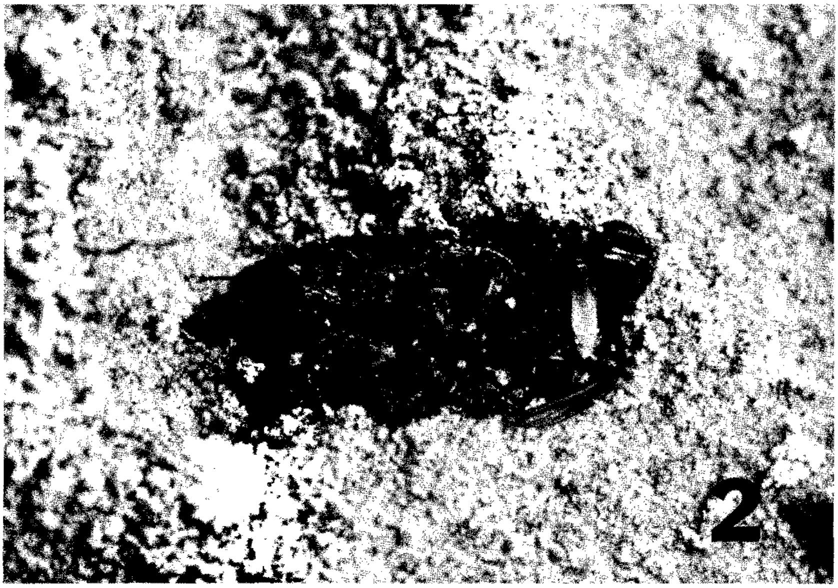

Figure 2. Cell of *Crabro tenuis*, as seen in top view. Paralyzed flies are placed head inward with their venters toward the center of the cell. Note wasp's egg affixed to neck of one of the flies.

species. Kurczewski and Acciavatti (1968), in reviewing the nesting behaviors of the Nearctic species of *Crabro*, reinforced Evans' species-specific behavioral differences and similarities for members of this genus. In addition they indicated that number of prey per cell and size of prey (often related to wasp size) were discriminating behaviors at the species level, but they assumed incorrectly that nesting in banks versus flat soil could be used to differentiate between species. These authors overemphasized species-specific differences between *C. advenus* (=*C. advena*) and *C. latipes* in attempting to derive subgeneric correlatives. Miller and Kurczewski (1976), Matthews *et al.* (1979) and O'Brien and Kurczewski (1980) presented information to enhance the notion of much intraspecific variation in some species of the genus, which serves only to make more difficult the formulation of clear-cut species-specific behavioral differences. Miller and Kurczewski (1976) summarized data from over 30 large nests of two presumed sibling species, *C. rufibasis* (Banks) and *C. arcadiensis* Miller, that included an analysis of a considerable amount of quantitative information and the generic and specific identification of approximately 1,150 prey flies. They concluded the similarity in some aspects of the nesting behavior necessitated species separation based upon statistical averages. Matthews *et al.*'s (1979) study highlighted differences in nesting behavior between two geographically separated, but synchronic populations of *C. argusinus* and associated these differences with biotic and abiotic variation. O'Brien and Kurczewski's (1980) observations on *C. advena* expanded the range of behavior for this species for cell depth, number of prey per cell and size and kind of prey. They reviewed and systematized generic and specific identifications for 11 families of *C. advena* prey.

Evans *et al.* (1980) provided detailed information, including hundreds of prey records, for seven species of *Crabro*. Their study concluded that differences in nesting behavior "remain to be demonstrated" to substantiate species' placement in Bohart's (1976) species group assemblages. They noted that there is a large amount of intraspecific variation but less adaptive radiation in nesting behavior within this genus than commonly occurs among sphecid wasps. These authors believed that nest structure and prey selection were two of the more plastic traits within the genus. Our study of the nesting behavior of *C. tenuis* does not contradict their beliefs.

As indicated in the introductory remarks, *C. tenuis* and several other common Nearctic species are members of Bohart's (1976) *Cribrarius* group. Based on an evaluation of the known nesting behaviors of some of these species, e.g., *C. latipes*, and, now, *C. tenuis*, no set pattern of components can be used to distinguish between them, *C. advena* in the *Advena* group and *C. venator* (Rohwer) in the *Tumidus* group. In fact, the nesting behaviors of *C. latipes* and *C. tenuis* resemble more those of *C. advena* and *C. venator* than they do those of other members of the *Cribrarius* group such as *C. argusinus*, *C. cribrellifer*, *C. largior* and *C. monticola*! All four species nest in sandy soils, build relatively shallow multicellular nests, the cells occurring in dense or diffuse clusters, and prey upon many families of flies (Evans 1960, 1964, Kurczewski and Acciavatti 1968, Kurczewski *et al.* 1969, Evans *et al.* 1980, O'Brien and Kurczewski 1980). *C. advena* selects more stockily-bodied flies, primarily Anthomyiidae, Muscidae and Calliphoridae, for use as prey (Evans *et al.* 1980, O'Brien and Kurczewski 1980) while *C. latipes* preys upon a wide variety of flies, including members of the suborders Brachycera, Cyclorrhapha and even Nematocera (Kurczewski *et al.* 1969, Evans *et al.* 1980). Evans (1964) reported that fully-provisioned cells of *C. venator* contained from 30 to 36 apparently small flies belonging to the families Empididae, Anthomyiidae, Muscidae and Sarcophagidae. Our brief study of *C. tenuis* revealed species of both Brachycera and Cyclorrhapha as prey. Interestingly, there was more variation between populations of *C. advena* nesting during different times of the year and at different localities than between populations of *C. advena* and *C. latipes* nesting synchronously at the same locality (Kurczewski *et al.* 1969).

In contrast to *C. latipes* and *C. tenuis*, other species in the *Cribrarius* group are easy to categorize behaviorally. *C. argusinus* inhabits areas of loose sand, often constructs sloping burrows in dunes and banks, preys upon small flies frequently belonging to the families Drosophilidae and Ephydridae and has a characteristic quavering, side-to-side flight (Evans 1960, Evans *et al.* 1980). *C. cribrellifer* nests in shaded, compacted soil in and at the edges of woodlands, constructs shallow but lengthy nests with cells often built in series and preys exclusively upon Asilidae (Barrows *et al.* 1978, Evans *et al.* 1980). *C. largior* and *C. monticola* construct lengthy, but not overly deep nests in sandy soil and provision predominantly with Tabanidae (*C. largior*, *C. monticola*) or Therevidae (*C. monticola*). Both *C. largior* and *C. monticola* hunt for prey in early morning and late afternoon (Evans *et al.* 1980). *C. cribrellifer* and *C. monticola* females usurp nests, occupy the same nests sequentially and nest communally (Alcock 1982, Wcislo *et al.* 1985).

Whereas behavioral distinctions between certain species in the *Advena*, *Cribrarius* and *Tumidus* groups cannot be drawn clearly, members of the *Hilaris* group can be readily delineated behaviorally from species in these three groups. Two species in the *Hilaris* group, *C. rufibasis* and *C. arcadiensis*, construct deep cells from a relatively straight, vertical burrow and prey predominantly upon small Brachycera (Miller and Kurczewski 1976). *C. hilaris*, another member of this group, captures small Brachycera and Cyclorrhapha equally and places the paralyzed flies in deep cells surrounding a vertical burrow (Matthews *et al.* 1979).

Viewed collectively, species of *Crabro* share several common nesting behavior components such as prey transport, nest entry, burrow storage and oviposition site and prey only upon adult Diptera. Differences in nest design and dimensions within and between species groups seem to be related to soil type (friability) and size and shape of wasp. The rigid prey selection exhibited by some of the species, such as *C. cribrellifer* (Asilidae) and *C. monticola* (mostly Tabanidae and Therevidae), as opposed to broad prey selection, as exemplified by *C. advena* and *C. latipes*, is difficult to interpret ecologically and evolutionarily but does not seem to be related to habitat at least in *C. monticola* and the last two species as they often nest together with *C. tenuis* at the same locality. Hunting for potential prey early in the morning and late in the afternoon in some *Crabro* species may be related to fly availability and their use of polarized light for feeding or reproductive activities at these times of day. The fact that recent publications (Alcock 1982, Wcislo 1984, Wcislo *et al.* 1985) have implicated certain species of *Crabro* in nest usurpation and reutilization and communal nesting makes this genus attractive for detailed studies of individual wasps and their intraspecific interactions. Further observations on the nesting behaviors and prey selection of other species of *Crabro* are needed to support or contradict Bohart's (1976) species group assemblages.

ACKNOWLEDGMENTS

We are indebted to R. M. Bohart, University of California-Davis, for identifying *Crabro tenuis*, and to W. W. Wirth, F. C. Thompson, C. W. Sabrosky and R. J. Gagné, all of the Systematic Entomology Laboratory, IIBB, USDA-ARS, for naming the prey and parasitic flies. We thank D. J. Peckham, SUNY Health Science Center at Syracuse, for Fig. 2. This study was partly supported by a SUNY/RESA Grant-in-Aid of Research.

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THE ODONATA OF ISLE ROYALE, MICHIGAN

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ABSTRACT

This paper presents a list of the Odonata recorded from Isle Royale National Park, located in northwestern Lake Superior. Collections from Isle Royale include 38 species of Anisoptera and 12 species of Zygoptera. The list is typical of the boreal regions of North America, and includes nine new records for Isle Royale and one new record for the state of Michigan.

Isle Royale National Park is a wilderness island in northwestern Lake Superior. The flora and large fauna of Isle Royale have been well studied, beginning with a 1905 ecological survey of the island sponsored by the Michigan State Biological Survey (Adams 1909). Checklists of the vascular plants and vertebrates of Isle Royale have recently appeared (Johnsson and Shelton 1982, Slavick and Janke 1987), but there have been no published lists of the invertebrate fauna. Here I present a list of the Odonata known to occur at Isle Royale.

Isle Royale (48°10'N, 88°30'W, elevational range 183–425 m, Keweenaw County, Michigan, USA) is located in Lake Superior, 24 km south of the nearest Canadian mainland and 70 km north of the Michigan Upper Peninsula. The island (72 km long by 14 km wide, 540 km^2) is almost entirely forested with boreal vegetation. Forests in the cool, moist regions near the Lake Superior shore are composed of primarily white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), and white birch (*Betula papyrifera*), while those at higher elevations in the interior of the island contain yellow birch (*Betula alleghaniensis*) and sugar maple (*Acer saccharum*) (Krefting et al. 1970, Edwards 1978).

Isle Royale is formed by tilted bedrock strata covered with a relatively thin soil (Wolff and Huber 1973, Huber 1975). Much of the island is underlain by interbedded volcanic and sedimentary rocks, tilted toward the southeast due to subsidence within the basin that now forms Lake Superior. Stream erosion and glacial scouring have removed much of the softer sedimentary rock, resulting in a distinctive parallel ridge-and-valley topography. The thin azonal soil mantle has been formed during about 10,000 years since the most recent glacial retreat, and the flora and fauna have colonized the island from the mainland by crossing Lake Superior.

Surrounded by the world's largest freshwater lake, Isle Royale enjoys more moderate temperature fluctuations and higher precipitation than surrounding mainland areas (Peterson 1977). Minimum winter temperatures rarely drop below -34°C, and maximum summer temperatures rarely climb above 30°C,

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although such extremes are common in northern Minnesota. Precipitation on Isle Royale averages 70–80 cm per year, about 25% higher than northcentral Minnesota.

Aquatic habitats on Isle Royale are abundant. The island's ridge-and-valley topography creates numerous parallel streams, interrupted at regular intervals by beaver ponds and elongate lakes with weedy shores. Many of the smaller lakes and ponds have *Sphagnum* spp. bog mats extending up to 30 m out from the shore. Vernal temporary ponds are found in wooded depressions at higher elevations. On bedrock shores of exposed headlands and islands along Lake Superior are found small, clear rock pools.

SOURCES AND COVERAGE

Isle Royale odonate records were gathered from several published sources, museum collections, and my own observations and collections. The first published observations of Odonata on Isle Royale were made from 5 July to 17 August, 1905, by H.A. Gleason, participating in an expedition sponsored by the Michigan State Biological Survey. Determinations were made by E.B. Williamson and reported in Adams (1909).

Private collecting trips to Isle Royale have been made by Dr. R.R. Dreisbach (August 1936, published in Kormondy 1958), G. Steyskal (July 1938, unpublished), P.J. Martinat (September 1970, unpublished), and R.C. Glotzhober (August 1984, Glotzhober 1985). I have examined collections of the University of Michigan (hereafter UMMZ) for records of odonates taken on Isle Royale. My own observations extend from 1983 to 1991, and are focused on the northeastern end of the island. During most years I arrived at Isle Royale between 10 May and 5 June, and remained until early August. During four summers (1988–1991) I made repeated samples of larval odonates using a dip net in 22 ponds, bogs, and streams in northeastern Isle Royale.

RESULTS AND DISCUSSION

The following list of the Odonata recorded for Isle Royale includes the earliest and latest adult records where possible, whether the material is adult or larval if known, and for uncommon species the locality of capture. Specimens representing new records that were collected by me have been verified by Dr. Sidney W. Dunkle, and are deposited in the UMMZ.

There are records for 12 Zygoptera and 38 Anisoptera from Isle Royale. The list includes eight new species for the island: *Aeshna clepsydra*, *Aeshna juncea*, *Leucorrhinia glacialis*, *Libellula pulchella*, *Pantala flavescens*, *Sympetrum costiferum*, *Sympetrum danae*, and *Sympetrum semicinctum*. One species (*Aeshna juncea*) represents a new record for Michigan. *Aeshna juncea* is an abundant dragonfly in the High Arctic; at Isle Royale the larvae are common in small splash pools along exposed shores of Lake Superior (Van Buskirk 1990). Isle Royale is one of the southernmost localities of *Aeshna juncea* in North America (Needham and Westfall 1954, Walker 1958).

In the following list, the collectors and sources of records are abbreviated as follows:

A = Expedition of the State Biological Survey of Michigan, 5 July to 17 August 1905. Specimens collected by H.A. Gleason, determined by E.B. Williamson, and deposited at UMMZ (Adams 1909).

D = Collections of R.R. Dreisbach of Midland, Michigan, 3–7 August 1936, deposited at UMMZ.

G = Collection of R. C. Glotzhober of Colombus, Ohio, 6–11 August 1984, deposited in the Natural History Museum of Isle Royale National Park.
J = Collections of J. Van Buskirk, 1983–1991, deposited at UMMZ.
M = Collection of Peter J. Martinat, 7–11 September 1970, deposited at UMMZ.
S = Collections of Michigan State University, exact dates and localities unknown (Kormondy 1958).
St = Collection of G. Steyskal, 10–18 July 1938, deposited at UMMZ.

Suborder Zygoptera

CALOPTERYGIDAE
Calopteryx aequabilis Say. (A,S)

LESTIDAE
Lestes congener Hagen. (S)
Lestes disjunctus Selys. (D,G,J,S; adults and larvae) Common and widespread. 20 July–7 August.
Lestes dryas Kirby. (D; adult) 3–7 August 1936.
Lestes forcipatus Rambur. (D; adult) 3–7 August 1936.
Lestes unguiculatus Hagen. (D,S; adult) 3–7 August 1936.

COENAGRIONIDAE
Coenagrion interrogatum (Selys). (S,St; adult) 12 July 1938.
Enallagma boreale Selys. (G,S,St; adult) 10 July–6 August.
Enallagma carunculatum Morse. (S)
Enallagma exsulans (Hagen). (A; adult) 20 August 1905.
Enallagma hageni (Walsh). (D,G,J,S; adults and larvae) Common and widespread. 23 July–7 August.
Nehallenia irene (Hagen). (D,G,J,S; adult) Common and widespread. 23 July–9 August.

Suborder Anisoptera

GOMPHIDAE
Dromogomphus spinosus Selys. (D,G; adult) 3–7 August.
Gomphus exilis Selys. (S)
Gomphus spicatus Hagen. (J,St; adults and larvae) Common and widespread. 29 May–23 July.
Hagenius brevistylus Selys. (G,S; adult) 6 August 1984 at Lake Richie.
Ophiogomphus colubrinus Selys (A,S; adult) 7 August 1905 at Siskiwit Lake.

AESHNIDAE
Aeshna canadensis Walker. (D,G,J,S; adults and larvae) Common and widespread. 6 July–9 August.
Aeshna clepsydra Say. (M; adult) 7 September 1970 at Chickenbone Lake.
Aeshna eremita Scudder. (D,G,J,M,S; adults and larvae) 30 July–11 September.
Aeshna interrupta Walker. (D,G,J,M,S; adults and larvae) Common and widespread. 16 June–11 September.
Aeshna juncea (Linnaeus). (J; adults and larvae) 25 June–19 August, small pools on the outer islands. New state record.
Aeshna sitchensis Hagen. (A,M; adult) 21 August–11 September.

Aeshna subarctica Walker. (A; adult) 8–16 August 1905.
Aeshna umbrosa Walker. (D,G,J,M,S; adults and larvae) Common and widespread. 25 June–9 September.
Anax junius (Drury). (A,J; adult) 23 May–19 August.
Boyeria grafiana Williamson. (S; adult)

CORDULEGASTRIDAE
Cordulegaster maculata Selys. (S)

CORDULIIDAE
Cordulia shurtleffi Scudder. (A,J,S; adults and larvae) Common and widespread. 25 May–30 July.
Dorocordulia libera (Selys). (S)
Somatochlora franklini (Selys). (D; adult) 3–7 August 1936.
Somatochlora kennedyi Walker. (S)
Somatochlora minor Calvert. (A,D,S,St; adult) 17 July–7 August.
Somatochlora williamsoni Walker. (D,S; adult) 3–7 August 1936.
Tetragoneuria spinigera Selys. (A,J,S,St; adults and larvae) 23 June–21 July.

LIBELLULIDAE
Leucorrhinia frigida Hagen. (J,S; adult) 11–14 July.
Leucorrhinia glacialis Hagen. (J; adults and larvae) Common in bogs. 27 June–26 July.
Leucorrhinia hudsonica (Selys). (A,J; adults and larvae) 25 May–8 August.
Leucorrhinia proxima Calvert. (A,D,J,S; adults and larvae) Common and widespread. 18 July–7 August.
Libellula julia Uhler. (J,S; adults and larvae) Common and widespread. 31 May–23 July.
Libellula lydia Drury. (J,S; adults and larvae) Common and widespread. 26 June–9 August.
Libellula pulchella Drury. (J; adult) 5 August 1988 at Hidden Lake.
Libellula quadrimaculata Linn. (A,D,J,S; adults and larvae) Common and widespread. 27 May–7 August.
Pantala flavescens (Fabricius). (J; adult) 13 July–18 August.
Sympetrum costiferum (Hagen). (M; adult) 8 September 1970 at Mount Franklin.
Sympetrum danae (Sulzer). (J; adults and larvae) 15 July–5 August.
Sympetrum internum Montgomery. (G,M,S; adult) 11 August–8 September.
Sympetrum obtrusum (Hagen). (A,D,J,S; adults and larvae) Common and widespread. 14 July–13 August.
Sympetrum occidentale Bartenev. (G; adult) 7 August 1984 at Lake LeSage.
Sympetrum semicinctum (Say). (J; tenerals) 14 July 1989 at Moose Lake.

ACKNOWLEDGEMENTS

I thank Richard Edwards, Joan Edwards, David Smith, and the National Park Service for their hospitality at Isle Royale. Thomas E. Moore and Theodore Cohn kindly permitted access to the collection at the University of Michigan. Sidney Dunkle checked some of the identifications. My research at Isle Royale was supported by Sigma Xi, The Explorer's Club, and the National Science Foundation (BSR-8801008 to J. Van Buskirk and H.M. Wilbur, and BSR-8516600 to D.C. Smith).

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HOPLISTOSCELIS SORDIDUS (HETEROPTERA: NABIDAE) IN CANADA

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ABSTRACT

Hoplistoscelis sordidus is recorded for the first time from Canada. The distribution of the species, its establishment in Canada, and its bionomics are discussed. Characters are given that distinguish *Hoplistoscelis* from all other eastern Canadian genera of Nabinae. The potential role of the genus as a biological control agent is also briefly outlined.

The genus *Hoplistoscelis* Reuter is a North and Central American group; in America north of Mexico, six species are known, mainly from the southern half of the United States. Only *H. sordidus* (Reuter) is known to be well established and wide-ranging in northeastern North America. Its previously reported distribution includes the following records (Henry and Lattin 1988): Connecticut, District of Columbia, Florida, Iowa, Illinois, Indiana, Louisiana, Massachusetts, Maryland, Maine, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New York, Ohio, Pennsylvania, South Dakota, Texas, and Wisconsin.

The species is here reported for the first time from Canada, from 25 adults contained in the Canadian National Collection (CNC), Ottawa, and the Royal Ontario Museum (ROM), Toronto. Collection data for all 25 specimens are summarized below. The known range of *H. sordidus* in Canada is shown in Figure 1.

ONTARIO. Ojibway [Provincial Park]: 30.VIII.1961, 1 ♀ (CNC). Point Pelee [National Park]: 13.VI.1920, 2 ♀ (ROM); 30.V.1929, 6 ♀ (CNC); 10.VI.1929, 1 ♀ (CNC); 23.VI.1931, 1 ♂ (CNC); 11.IX.1961, 1 ♀ (CNC). Rondeau [Provincial] Park: 10.IX.1954, 2 ♂ and 4 ♀ (CNC); 18.VII.1955 on silver poplar, 1 ♀ (CNC); 15.VI.1977, understory and trees of deciduous forest, 2 ♀ and 1 ♂ (ROM). Tillsonburg: 20.VI.1962, 1♂ and 2 ♀ (CNC).

The specimens listed above are all short-winged, a condition apparently more common than the long-winged form (Blatchley 1926, Harris 1928, Froeschner 1944). The short-winged condition (no dispersion by flight) and the fact that the species has been collected repeatedly between 1920 and 1977 suggest that it is well established in the southern Ontario peninsula. Animals found nowhere else in Canada inhabit this part of the country (Anon. 1990). The distribution of *H. sordidus* in southern Canada apparently represents the northern distributional limit of a species whose range follows the Carolinian forest biogeographic zone. In Canada, this zone is restricted to the southern-

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