The Great Lakes Entomologist

Volume 38
Numbers 1 & 2 - Spring/Summer 2005 *Numbers 1 & 2 - Spring/Summer 2005*
Article 4

April 2005

Carrion Beetles (Coleoptera: Silphidae) of Wisconsin

Kerry Katovich
University of Wisconsin

Nadine L. Kriska
University of Wisconsin

Andrew H. Williams
University of Wisconsin

Daniel K. Young
University of Wisconsin

Follow this and additional works at: https://scholar.valpo.edu/tgle

 Part of the Entomology Commons

Recommended Citation

Katovich, Kerry; Kriska, Nadine L.; Williams, Andrew H.; and Young, Daniel K. 2005. "Carrion Beetles (Coleoptera: Silphidae) of Wisconsin," *The Great Lakes Entomologist*, vol 38 (1)
Available at: https://scholar.valpo.edu/tgle/vol38/iss1/4

This Peer-Review Article is brought to you for free and open access by the Department of Biology at ValpoScholar. It has been accepted for inclusion in The Great Lakes Entomologist by an authorized administrator of ValpoScholar. For more information, please contact a ValpoScholar staff member at scholar@valpo.edu.

CARRION BEETLES (COLEOPTERA: SILPHIDAE) OF WISCONSIN

Kerry Katovich[1], Nadine L. Kriska[2], Andrew H. Williams[2], and Daniel K. Young[2]

ABSTRACT

The first comprehensive faunal survey of the carrion beetles (Coleoptera: Silphidae) of Wisconsin is presented. Six genera and 14 species are recorded from the state, including a new state record, *Heterosilpha ramosa* (Say). *Nicrophorus americanus* Olivier was not recovered during this study. An annotated checklist includes species-specific geographical and temporal distributions, remarks on foods and habitat, and counties of specimen collections for each species.

Faunal surveys of various Coleoptera (Cantharidae, Cleridae, Histeridae, Lycidae, Mordellidae, Nitidulidae, Pyrochroidae, Scarabaeoidea, Tenebrionidae) have recently been conducted in Wisconsin to better understand the state's biodiversity. The family Silphidae is well known taxonomically and several regional works have recorded distribution information (Anderson and Peck 1985, Ratcliffe 1996), but no faunal survey specific to Wisconsin exists save for Rauterberg's (1885) brief checklist. The objectives of this study were to complement the series of Wisconsin Coleoptera surveys already underway and to improve our knowledge of Wisconsin's Silphidae by providing distributional, temporal, and habitat information specific to Wisconsin.

Carrion beetles have recently attracted a great deal of attention, especially the federally endangered *Nicrophorus americanus* Olivier. In 1990 our carrion beetle survey was initiated in Wisconsin, searching especially for *N. americanus* in northeastern and central Wisconsin counties, and continued in 1992, focusing on southwestern counties. From 1993-2000, additional, low-intensity surveys were undertaken across most of the state.

Family Silphidae. Silphidae consists of two subfamilies: Nicrophorinae and Silphinae. Worldwide there are about 175 species in 15 genera; 30 species in eight genera occur in North America (Peck 2001). Silphids are large beetles, 10-35 mm long. They are predominantly black, often with a yellow, orange or pink pattern on the pronotum. Most nicrophorines have bright orange, presumably aposematic markings on their elytra. The term "carrion beetle" is widely applied to species of Silphidae; the terms "burying beetles" or "sexton beetles" more strictly apply to species of Nicrophorinae, which bury small vertebrate carcasses in the ground.

Silphids are important components of ecosystems, serving as scavengers and nutrient recyclers. A progression of scavengers can be seen throughout the decay process; different scavengers such as fungi, bacteria, and insects, are attracted to the carcass only after specific levels of decay have occurred. Silphids are attracted to carcasses in the early to middle stages of decay, depending on the subfamily. Nicrophorinae require fairly fresh carcasses to bury, a requisite for reproduction, though adults can be found on larger and older carcasses. Silphinae readily feed and breed on carcasses in a more advanced stage of decay and are often found alongside other invertebrate scavengers on the carcass. Members of this subfamily also may be found feeding on fungi and occasionally on dung. They are also known predators of fly larvae.

[1]Department of Biology, University of Wisconsin, Whitewater, WI 53190.
[2]Department of Entomology, University of Wisconsin, Madison, WI, 53706.

Early synoptic treatments of North American silphids were conducted by LeConte (1853) and Horn (1880). Portevin (1926) was the first to split the genus *Silpha* into most of the genera currently recognized in the subfamily Silphinae. Portevin (1926) monographed the world fauna, and Hatch (1928) compiled a catalog of the world fauna. Leng (1920), Blackwelder and Arnett (1974), and Peck and Miller (1993) provided catalogs of the North American species. Anderson and Peck (1985) and Peck and Kaulbar (1987) gave a more comprehensive treatment of North American silphids (Canada and the U.S. north of Mexico), including species keys for adults and larvae, species diagnoses, distributions, temporal information and notes on natural history. Several workers have provided state or regional silphid checklists or taxonomic treatments: Fall and Cockerell (1907) for New Mexico, Blatchley (1910) for Indiana, Hatch and Rueter Jr. (1934) for Washington, Hatch (1957) for the Pacific Northwest, Lago and Miller (1983) for Mississippi, Lingafelter (1995) for Kansas, and Ratcliffe (1996) for Nebraska. Rauterberg (1885) compiled a list of Wisconsin's silphids, providing brief notes on their abundance ("common", "rare", or "very rare") and food preferences ("on carrion"). Trumbo and Thomas (1998) discussed species diversity, population density, and body size of various *Nicrophorus* species on the Apostle Islands of Douglas County, Wisconsin.

Subfamily Nicrophorinae. This subfamily contains 65 extant species in three genera worldwide. The only nicrophorine genus in the United States is *Nicrophorus* with 61 species worldwide and 15 species in the U.S. (Sikes et al. 2002).

Nicrophorus species (Coleoptera: Silphidae) are best known for interring small vertebrate remains for the purpose of rearing their young. Usually a male and female pair will bury and process a carcass together, and both will remain in the chamber to care for the young. Several experimental studies and observations have suggested the presence of the male as well as the female greatly reduces the chances of the chamber being overtaken by a conspecific intruder and the brood killed (Scott 1990, Trumbo 1990, 1991, Scott and Gladstein 1993). The larvae receive parental care for the duration of their growth. Both parents have been observed to regurgitate droplets of partially digested food for the larvae, however this behavior declines by the third and fourth days. After four days, the care is mostly in the form of defense against potential predators and preparing the feeding cavity on the carcass, removing fungi, and possibly slowing decay of the carcass with antibacterial salivary secretions (Ratcliffe 1996). Larvae of some species can develop normally without the parental feeding or care (Trumbo 1992, Scott 1994) and neither the duration of parental feeding nor carrion tending have a significant effect on larval weight (Fetherston et al. 1990). Rather, it is the number of larvae in the brood chamber that affects larval growth (Bartlett and Ashworth 1988, Scott and Traniello 1990). The larvae usually consume all soft tissue from the carcass within about a week. They then move into the soil to pupate, emerging as adults about a month later. Upon pupation of their larvae, the parents depart typically with the male leaving before the female. Adults are capable of breeding more than once in a season, but probably not more than two or three times. Most broods produced later in the season overwinter as adults, but broods of some species (e.g., *Nicrophorus investigator* Zetterstedt and *Nicrophorus tomentosus* Weber) overwinter as prepupae. Females can also mobilize sperm stored in the spermatheca to fertilize eggs without a male to assist in rearing.

Burying beetles are adept at detecting the odor of a recently-dead animal. They were observed to find a one-hour dead mouse from as far away as two miles (Petruska 1975-1976). Typically burying beetles find carcasses that are one to two days old. Species of *Nicrophorus* are largely nocturnal, a strategy to perhaps reduce competition from diurnally active flies (Ratcliffe 1996). If flies manage to lay eggs on the carcass, it will rapidly become unfit for use by *Nicrophorus*. These beetles bury carcasses to secure them from the competition of other scavengers and to provide a safer environment in which to raise their young (Ratcliffe 1996).

Subfamily Silphinae. This subfamily is comprised of 119 species in 12 genera worldwide; 30 species in eight genera occur in the United States (Peck 2001). Instead of burying carcasses, adult silphines arrive at a carcass in the early to middle stages of decay (Payne 1965, Johnson 1974). Most species lay eggs in the soil adjacent to the carcass; eggs hatch in four to five days (Anderson 1982). Larvae crawl to the carcass to feed and pass through three instars, after which they pupate in earthen cells within the soil adjacent to the carcass.

MATERIALS AND METHODS

To determine which species had been collected in Wisconsin, historical collection and literature records, as well as data from private and public regional collections, e.g., University of Wisconsin-Madison Insect Research Collection (WIRC), University of Wisconsin-Oshkosh, and the Milwaukee Public Museum (MPMC), were compiled. Field sampling focused on counties where *N. americanus* had been collected, on less sampled areas, and areas that had historically proven to be interesting. Collection methods consisted of modified "live" pitfall traps baited with dead fish, examination of carcasses (most often encountered as road-killed vertebrates), and black light traps. The pitfall traps consisted of double-stacked, eight-inch plastic pots, with the bottom removed from each top pot. These were buried flush with the ground. A mesh-covered plastic cup containing a carrion bait (mostly fish) was placed in the center of the lower pot. Each trap was then covered by a wooden frame with a square of chicken wire stapled to it. The frame was secured by four, 30 cm spikes; each spike pushed into the ground through a three-inch square of carpeting to prevent the nail from slipping through the wire mesh (Fig.1). The depth of the traps prevented small animals, including raccoons, from destroying the bait cups, though many traps in northern counties were destroyed by black bears. The traps were designed to be "live" traps in the event that the endangered *N. americanus* might be trapped and vouchered by photograph rather than killed. This also allowed us to selectively collect specimens of interest, releasing many other trapped beetles. At each collecting site, two or three traps were set from one-half to one mile apart. Traps were checked weekly and the specimens of interest immediately placed in 80% EtOH. Field samples from other insect surveys (e.g., Wisconsin Department of Natural Resources, Fort McCoy inventory project, and inventory work at the Necedah National Wildlife Refuge) also contributed to this survey.

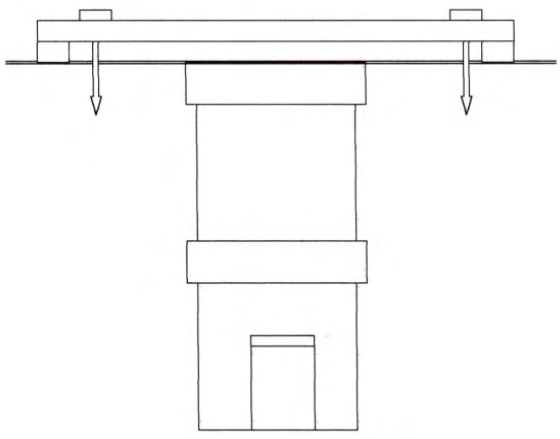

Figure 1. Modified carrion-baited pitfall trap.

Voucher material from this study resides in the WIRC. As opposed to a quantitative study, the authors focused their efforts on collecting distributional information in the form of site and county records. We use the term "collection event" to refer to specimens collected that represent new distribution records. Specimens representing new records were vouchered and databased. Additional material resides in the personal collections of the contributors to this study. The WIRC web site (Young 2005) includes information on Wisconsin distributions in the form of printable maps. All silphid collection data were entered into the ongoing, specimen-level database of Wisconsin's Coleoptera; this includes the locations of specimens from personal collections as well as those vouchered in the WIRC. The data reside with the authors and the WIRC within BIOTA software (Colwell 1996). Habitat types used in the species profiles come from Vegetation of Wisconsin (Curtis 1971).

RESULTS

This survey yielded 14 carrion beetle species in six genera including a new state record, *Heterosilpha ramosa* (Say). *Nicrophorus americanus* Olivier was not found. To simplify county associations, we followed Hilsenhoff's (1995) artificial division of Wisconsin into nine, 8-county regions which conveniently breaks up the state into north, south, east, west and central regions (Fig. 2). Pertinent label data and periods of adult activity are provided for each species. At the end of each species profile is a grey shaded bar indicating the activity period for the species in Wisconsin. The period with the highest number of collection events is indicated in black.

Figure 2. Regional divisions (nine, 8-county areas) of Wisconsin (after Hilsenhoff 1995).

Subfamily Nicrophorinae

***Nicrophorus americanus* Olivier.** (7 historical collection events studied). NC: Vilas; NE: Door; EC: Brown; SW: La Crosse; SC: Dane; SE: Jefferson, Milwaukee. Historical records from Wisconsin indicate activity from late February to late July. The most recent, directly verified, adult collection record is from 1944 in Dane County. Historical collection sites were northern mesic and pine forests, oak and pine savanna, and southern mesic forests. Some specimens were collected from decaying fish on a beach. Rauterberg (1885) reported this species as common at times.

***Nicrophorus defodiens* Mannerheim.** (22 collection events studied). NW: Bayfield, Burnett, Douglas, Polk, Washburn; NC: Ashland, Oneida, Taylor, Vilas; NE: Florence, Forest, Marinette; WC: Eau Claire, Jackson, Monroe; C: Juneau, Marquette, Waupaca, Waushara, Wood; SC: Columbia, Sauk. Active from late May to early September. Collection sites were from native habitats (northern mesic forests and northern pine forests, oak and pine savannas) in north and central Wisconsin. Collected from unbaited and carrion baited pitfall traps, and flight intercept traps. Rauterberg (1885) did not mention this species.

***Nicrophorus marginatus* Fabricius.** (17 collection events studied). NW: Polk; WC: Dunn, Monroe; C: Adams, Marquette, Portage; SW: Crawford, Grant; SC: Columbia, Dane, Green, Iowa, Rock, Sauk; SE: Jefferson, Milwaukee, Walworth. Active from early May to early September. Collection sites were native (oak and pine savannas, grasslands). Collected from: fox squirrel, white-tail deer, ornate box turtle, and fish carrion. Also collected from both carrion-baited and unbaited pitfall traps, on open sand, and on the surface of prairie vegetation. Our observations of adult activity suggest this species may be more diurnally active than previously thought (Anderson and Peck 1985). Rauterberg (1885) reported this species as common.

***Nicrophorus orbicollis* Say.** (46 collection events studied). NW: Bayfield, Burnett, Douglas, Polk, Washburn; NC: Ashland, Oneida, Taylor, Vilas; NE: Door, Florence, Forest, Marinette, Menominee, Shawano; WC: Eau Claire, Jackson, Monroe; C: Green Lake, Juneau, Marquette, Waupaca, Waushara, Wood; EC: Fond du Lac, Outagamie, Sheboygan, Winnebago; SW: Crawford, Grant, La Crosse, Richland, Vernon; SC: Columbia, Dane, Green, Iowa, Lafayette, Rock, Sauk; SE: Jefferson, Racine, Walworth, Washington, Waukesha. Active from late May to late September. Collection sites ranged from native (northern mesic and dry forests, southern mesic and dry forests, oak and pine savannas, oak and pine barrens) to disturbed areas. Collected from: white-tail deer, house cat, blue-winged teal, and fish carrion. Also collected from unbaited and carrion-baited pitfall traps, flight intercept traps, Lindgren funnel traps, and at black light traps. This was the most commonly collected species of *Nicrophorus* in the state during our survey. Rauterberg (1885) reported this species as common at times.

***Nicrophorus pustulatus* Herschel.** (39 collection events studied). NW: Bayfield, Polk, Rusk; NC: Ashland, Iron, Oneida, Price, Vilas; NE: Florence, Forest, Marinette; WC: Eau Claire, Jackson, Monroe, Pierce; C: Green Lake, Juneau, Marquette, Waupaca, Waushara, Wood; EC: Sheboygan, Winnebago; SW: Crawford, Grant, La Crosse, Richland, Vernon; SC: Columbia, Dane, Green, Iowa, Lafayette, Sauk; SE: Ozaukee, Racine, Walworth, Washington, Waukesha. Active from early June to late September. Collection sites ranged from native (northern mesic and dry forests, oak and pine savannas, southern mesic forests) to disturbed areas. Collected from raccoon carrion. Also collected from carrion-baited pitfall traps and at black light traps. Rauterberg (1885) reported this species as rare.

***Nicrophorus sayi* Laporte.** (32 collection events studied). NW: Bayfield, Burnett, Douglas, Polk; NC: Ashland, Oneida, Price, Vilas; NE: Florence, Forest, Marinette; WC: Dunn, Eau Claire, Jackson, Monroe; C: Green Lake, Juneau, Waupaca, Waushara, Wood; SW: Crawford, La Crosse, Richland, Vernon; SC: Columbia, Dane, Iowa, Sauk; SE: Jefferson, Racine, Walworth, Waukesha. Active from late March to late September. Collection sites were from native areas (northern mesic and dry forests, southern mesic forests, oak and pine savannas). Collected from raccoon carrion. Also collected from carrion-baited pitfall traps and at black light traps. Rauterberg (1885) reported this species as very rare.

***Nicrophorus tomentosus* Weber.** (45 collection events studied). NW: Barron, Bayfield, Burnett, Douglas, Polk; NC: Ashland, Iron, Oneida, Price, Vilas; NE: Door, Florence, Forest, Marinette, Shawano; WC: Eau Claire, Jackson, Monroe, Pierce; C: Green Lake, Juneau, Marquette, Waushara, Waupaca, Wood; EC: Fond du Lac, Winnebago; SW: Crawford, Grant, La Crosse, Richland, Vernon; SC: Columbia, Dane, Dodge, Iowa, Lafayette, Sauk; SE: Milwaukee, Ozaukee, Racine, Walworth, Washington, Waukesha. Active from mid-June to late September. Collection sites ranged from native (northern mesic and dry forests, southern mesic and dry forests, oak and pine savannas, oak and pine barrens, grasslands) to disturbed areas. Collected from: muskrat, opossum, porcupine, raccoon, red fox, white-tail deer, woodchuck, blue winged teal, ornate box turtle, and fish carrion. Also collected from unbaited and carrion-baited pitfall traps, flight intercept traps, and Lindgren funnel traps. Observations of adult activity suggest this species is primarily diurnal. Rauterberg (1885) reported this species as common at times.

***Nicrophorus vespilloides* Herbst.** (15 collection events studied). NW: Bayfield, Burnett; NC: Ashland, Oneida, Vilas; NE: Shawano; WC: Jackson,

Monroe; C: Juneau, Wood; EC: Fond du Lac, Outagamie, Winnebago; SC: Columbia, Sauk. Active from late May to early August. Collection sites were in native areas (northern mesic and dry forests, oak and pine savannas). Collected from carrion-baited pitfall traps. Also collected from Lindgren funnel traps. Rauterberg (1885) reported this species as rare.

J F M A M J J A S O N D

Subfamily Silphinae

***Heterosilpha ramosa* (Say).** NEW STATE RECORD. (10 collection events studied). NW: Burnett, Polk; NC: Iron; WC: Chippewa, Dunn, Monroe; C: Marquette, Waushara; EC: Calumet; SE: Walworth. Active from late March to early July. This species occurs throughout the Western United States and Canada, extending east into east-central Wisconsin. Collection sites included northern mesic forests and adjacent to disturbed areas. Collection sites in Wisconsin were mostly dry and with sandy soils. Specimens were collected from decaying fish along a sandy beach and from a human dung-baited pitfall trap. Observations of adult activity suggest this species is diurnal.

J F M A M J J A S O N D

***Necrodes surinamensis* Fabricius.** (43 collection events studied). NW: Bayfield, Burnett, Douglas, Polk, Rusk, Sawyer; NC: Lincoln, Oneida, Vilas; NE: Door, Florence, Forest, Marinette, Menominee, Oconto; WC: Monroe, Jackson; C: Adams, Green Lake, Juneau, Portage, Waupaca, Waushara, Wood; EC: Fond du Lac, Winnebago; SW: Crawford, Grant, LaCrosse, Richland, Vernon; SC: Dane, Dodge, Green, Iowa, Rock, Sauk; SE: Jefferson, Milwaukee, Ozaukee, Walworth, Washington, Waukesha. Active from early May to late August. Collection sites ranged from native (northern mesic and dry forests, oak savannas, southern mesic forests) to disturbed areas. Collected from: raccoon, red fox, white-tailed deer, woodchuck, turtle, and fish carrion. This species has been collected from carrion-baited pitfall traps and commonly at black light. Rauterberg (1885) reported this species as very common.

J F M A M J J A S O N D

***Necrophila americana* (Linnaeus).** (53 collection events studied). NW: Barron, Bayfield, Burnett, Douglas, Polk, Rusk, Sawyer, Washburn; NC: Ashland, Lincoln, Marathon, Oneida, Taylor, Vilas; NE: Florence, Forest, Marinette, Menominee, Shawano; WC: Chippewa, Dunn, Eau Claire, Jackson, Monroe, Pierce; C: Adams, Juneau, Marquette, Portage, Waupaca, Waushara, Wood; EC: Winnebago; SW: Crawford, Grant, La Crosse, Richland, Trempealeau, Vernon; SC: Columbia, Dane, Dodge, Green, Iowa, Lafayette, Rock, Sauk; SE: Jefferson, Milwaukee, Ozaukee, Walworth, Washington, Waukesha. Active from mid-May to late August. Collection sites ranged from native (northern mesic and dry forests, southern mesic and dry forests, oak and pine savannas, oak and pine barrens, grasslands) to disturbed areas. Collected from: opossum, porcupine, raccoon, rodents, white-tailed deer, American crow, black-billed cuckoo, and fish carrion. Also collected from banana-baited traps, unbaited, carrion-baited, and

human dung-baited pitfall traps, sticky traps, and flight intercept traps. Specimens were sometimes hand collected from fungi and vegetation. Observations of adults suggest this species may be primarily diurnal in activity. Rauterberg (1885) reported this species as notable on fish, with no information on abundance.

***Oiceoptoma inaequale* (Fabricius).** (17 collection events studied). WC: Monroe; C: Green Lake, Marquette; EC: Winnebago; SW: Grant, LaCrosse, Richland, Vernon; SC: Dane, Dodge, Iowa, Rock, Sauk; SE: Jefferson, Racine, Walworth, Waukesha. Active from late March to late June. Collection sites centered mainly in the southern region of Wisconsin, below or along the Tension Zone. Preferred sites were fairly open, native (dry forests) and disturbed locations. Collected from: house cat, raccoon, rat, white-tailed deer, woodchuck, ornate box turtle, and carp carrion. A specimen was collected on coyote dung. Rauterberg (1885) did not mention this species. Ratcliffe (1996) stated its distribution as southern Ontario and Quebec south to Florida and west to Texas and the Dakotas.

***Oiceoptoma noveboracense* (Forster).** (55 collection events studied). NW: Bayfield, Burnett, Douglas, Polk, Rusk, Washburn; NC: Ashland, Lincoln, Marathon, Oneida, Price, Taylor, Vilas; NE: Florence, Forest, Marinette, Menominee, Oconto, Shawano; WC: Chippewa, Dunn, Eau Claire, Jackson, Monroe, Pierce; C: Adams, Green Lake, Juneau, Marquette, Portage, Waupaca, Waushara, Wood; EC: Calumet, Fond du Lac, Manitowoc; SW: Crawford, Grant, LaCrosse, Richland, Vernon; SC: Columbia, Dane, Dodge, Green, Iowa, Lafayette, Rock, Sauk; SE: Jefferson, Milwaukee, Ozaukee, Walworth, Washington, Waukesha. Active from early April to late September. Collection sites ranged from native (northern mesic and dry forests, southern mesic and dry forests, oak and pine savannas, oak and pine barrens, grasslands) to disturbed areas. Collected from: coyote, house cat, opossum, porcupine, raccoon, red fox, red squirrel, white-tailed deer, woodchuck, rodents, common grackle, common snapping turtle, ornate box turtle, and fish carrion. Also collected from unbaited and carrion-baited pitfall traps, sticky traps, and flight intercept traps, as well as hand-collected from fungi and slime molds. A specimen was collected on coyote dung. Rauterberg (1885) reported this species as very common.

***Thanatophilus lapponicus* (Herbst).** (31 collection events studied). NW: Burnett, Douglas, Polk, Rusk; NC: Iron; NE: Door; WC: Dunn, Jackson, Monroe, Pierce; C: Green Lake, Juneau, Portage, Waushara, Wood; EC: Fond du Lac, Winnebago; SW: Vernon; SC: Columbia, Dane, Dodge, Green, Iowa, Lafayette; SE: Jefferson, Milwaukee, Ozaukee, Racine, Walworth, Washington, Waukesha. Active from early April to mid-August. Collection sites ranged from native (northern mesic and dry forests, southern mesic forests) to disturbed areas. Collection sites in Wisconsin were often adjacent to or associated with wetlands. Collected from: eastern cottontail, house cat, opossum, raccoon,

white-tailed deer, American crow, and fish carrion. Rauterberg (1885) reported this species as very common.

J F M A M J J A S O N D

DISCUSSION

Because carrion sources are randomly distributed in the environment, particular habitat requirements may be less important for silphids, out-weighed by the search for an appropriate carrion source (Holloway and Schnell 1996, Sikes and Raithel 2002). However, it does appear that some Wisconsin species show preferences for general habitat types (Anderson 1982), or have geographic range limitations within the state.

In the Silphinae, the northern range limit of *O. inaequale* in Wisconsin closely follows the Tension Zone which divides the state into distinct northern and southern floristic provinces. *H. ramosa* was sampled in only 10 of Wisconsin's 72 counties. Prior to this survey, its recorded range extended as far east as Minnesota (Ratcliffe 1996), so our data document a substantial eastward range extension. The remaining Silphinae are abundant and widespread throughout Wisconsin.

The enigmatic *N. americanus* was not found in our survey and is thought to have been extirpated from the state. Historical records indicate *N. americanus* used various habitats, ranging from northern mesic hardwoods, oak and pine savannas, and southern mesic hardwoods. *N. defodiens* apparently prefers northern mesic forests and oak and pine savannas, with the majority of collection sites concentrated north of the Tension Zone. *N. vespilloides* was infrequently collected in the central savannas and northern mesic forests of Wisconsin. Rauterberg (1885) reported that this species was rare and he did not mention *N. defodiens* at all. This is probably because these two species are difficult to separate and prior to Portvein (1926) they were considered synonyms by many authors.

Nicrophorus sayi was also infrequently collected, primarily north of the Tension Zone, a zone of transition running relatively horizontally from Minnesota through lower Michigan and to western Ohio separating the north and south sides of the band into fairly distinct floristic provinces (Curtis 1971). *N. sayi* was rarely found in southern Wisconsin. This species seems to prefer forested sites lightly impacted by human activities. *N. marginatus* was an infrequently collected species in Wisconsin, having been collected primarily from grasslands and savannas. *N. orbicollis* and *N. tomemtosus* were the most abundant species, often collected in large numbers during individual collecting events. *N. orbicollis*, *N. pustulatus,* and *N. tomentosus* were the most widespread *Nicrophorus* species throughout the state, each having been collected from more than 50% of the counties in Wisconsin. It is interesting to note that Rauterberg (1885) reported *N. pustulatus* to be "rare". Although never collected in large numbers, at least one to two specimens were usually consistently collected at the sampled sites. Collections of this species increased in frequency when blacklighting was utilized in the survey.

ACKNOWLEDGMENTS

We especially thank several former and present lab colleagues (Katie Anderson, Craig Brabant, Rebecca Christoffel, James Dunford, Jeff Gruber, Judith Maxwell, Katie Pope, Michele Price, Alistair Ramsdale, Michelle Schwengel) for assistance and contribution of material to this study. We also acknowledge curators and

staff at the University of Wisconsin-Madison Insect Research Collection (Steven Krauth), University of Wisconsin-Oshkosh (Gene Drecktrah), and Milwaukee Public Museum (Gary Noonan) for assisting us in examination of the collections under their care. We thank Thomas Meyers, Wisconsin Department of Natural Resources (WDNR) for assisting us with acquiring permits to sample in Wisconsin's State Natural Areas, Rich Henderson of WDNR for providing specimens collected during a prairie survey project, and other WDNR employees (especially Kathy Kirk) who brought in silphids for determination. We also thank Les Ferge and Merel Black for providing specimens and data of interest. This research was supported in part by a UW-Madison Natural History Museums Council Grant (1992) to Daniel K. Young, a Milwaukee Zoological Society Grant to Kerry Katovich and Daniel Young (1994), a Holstrum Environmental Scholarship to Nadine Kriska and Daniel Young (1995), a Holstrum Environmental Scholarship to Katie Anderson and Daniel Young (1997), and The Prairie Enthusiasts-Southwest Chapter who provided partial funding for the prairie insect research of Andrew Williams; for these resources we are grateful.

LITERATURE CITED

Anderson, R. S. 1982. Resource partitioning in the carrion beetle (Coleoptera: Silphidae) fauna of southern Ontario: ecological and evolutionary considerations. Can. J. Zool. 60: 1314-1325.

Anderson, R. S., and S. B. Peck. 1985. Carrion beetles of Canada and Alaska, Coleoptera: Silphidae and Agyrtidae. The insects and arachnids of Canada, part 13. Biosystematics Research Institute, Ottawa, Ontario, Canada. 121 pp.

Bartlett, J., and C. M. Ashworth 1988. Brood size and fitness in *Necrophorus vespilloides* (Coleoptera: Silphidae). Behav. Ecol. Sociobiol. 22: 429-434.

Blackwelder, R. E., and R. H. Arnett, Jr. 1974. Checklist of the beetles of Canada, United States, Mexico, Central America, and the West Indies. Volume 1, part 3, the scarab beetles, ant-loving beetles, clown beetles, and related groups (red version). The Biological Research Institute of America, Lanham, NY. [Parts separately paginated].

Blatchley, W. S. 1910. Illustrated descriptive catalog of the Coleoptera or beetles (exclusive of Rhynchophora) known to occur in Indiana. The Nature Publishing Co., Indianapolis. 1,386 p.

Colwell, R. 1996. BIOTA: The biodiversity data-base manager. Sinauer Associates, Sunderland, MA.

Curtis, J. T. 1971. The Vegetation of Wisconsin. The University of Wisconsin Press, Madison, Wisconsin, 657 pp.

Fall, H. C., and T. D. A. Cockerell. 1907. Coleoptera of New Mexico. Trans. Amer. Entomol. Soc. 33: 145-272.

Fetherston, I. A., M. P. Scott, and J. F. A. Traniello. 1990. Parental care in burying beetles: the organization of male and female brood-care behavior. Ethology 85: 177-190.

Hatch, M. H. 1928. Fam. Silphidae II. Coleopterorum Catalogus, partes 95: 63-244. W. Junk, Berlin.

Hatch, M. H. 1957. The Beetles of the Pacific Northwest. Part II: Staphyliniformia. Univ. Wash. Publ. Biol. 16: 1-386.

Hatch, M. H., and W. Rueter, Jr. 1934. Coleoptera of Washington: Silphidae. Univ. Wash. Publ. Biol. 1: 151-161.

Hilsenhoff, W. L. 1995. Aquatic Hydrophilidae and Hydraenidae of Wisconsin (Coleoptera). I. Introduction, key to genera of adults, and distribution, habitat, life cycle, and identification of species of *Helophorus* Fabricius, *Hydrochus* Leach, and *Berosus* Leach (Hydrophilidae), and Hydraenidae. Great Lakes Entomol. 28: 25-53.

Holloway, A. K., and G. D. Schnell. 1996. Relationship between numbers of the endangered American burying beetle *Nicrophorus americanus* Olivier (Coleoptera: Silphidae) and available food resources. Biol. Conserv. 81: 145-152.

Horn, G. H. 1880. Synopsis of the Silphidae of the United States with reference to the genera of other countries. Trans. Amer. Entomol. Soc. 8: 219-322.

Johnson, M. D. 1974. Seasonal and microseral variations in the insect populations of carrion. Amer. Midl. Nat. 93: 79-90.

Lago, P. K., and P. R. Miller. 1983. Records of Mississippi Silphidae (Coleoptera) with a key to the species known to occur in the state. J. Mississippi Acad. Sci. 28: 83-87.

LeConte, J. L. 1853. Synopsis of the Silphidae of America, north of Mexico. Proc. Acad. Nat. Sci. Phila. 6: 274-287.

Leng, C. W. 1920. Catalogue of the Coleoptera of America, North of Mexico. John D. Sherman, Jr. Publishing, Mount Vernon, NY. 470 p.

Lingafelter, S. W. 1995. Diversity, habitat preferences, and seasonality of Kansas carrion beetles (Coleoptera: Silphidae). J. Kans. Entomol. Soc. 68: 214-223.

Payne, J. A. 1965. A summer carrion study of the baby pig *Sus scrofa* L. Ecology 46: 592-602.

Peck, S. B. 2001. Family 21. Silphidae. pp. 268-271. *In* R. H. Arnett, Jr. and M. C. Thomas (eds.), American Beetles, volume 1. CRC Press, Boca Raton, FL.

Peck, S. B., and M. M. Kaulbars. 1987. A synopsis of the distribution and bionomics of the carrion beetles (Coleoptera: Silphidae) of the conterminous United States. Proc. Entomol. Soc. Ont. 118: 47-81.

Peck, S. B., and S. E. Miller. 1993. A catalog of the Coleoptera of America north of Mexico. Family: Silphidae. USDA Agriculture Handbook No. 529-28: 1-24.

Petruska, F. 1975-1976. The effect of predominating winds on the flight of some species of beetles from the group of Silphidae into pitfall traps (Coleoptera: Silphidae). [Vliv preladajicich smeru vetru na nalet nekterych druhu brouku z celedi Silphidae do zemnich pasti]. Acta Univ. Palacki. Olomuc. Fac. Rerum Natur. Biol. 16: 155-176.

Portevin, M. G. 1926. Les Grandes Necrophages du Globe. Encyclopedie Entomologique 6: 1-270.

Ratcliffe, Brett C. 1996. The Carrion Beetles (Coleoptera: Silphidae) of Nebraska. Bull. Univ. Nebr. State Mus. 13: 1-100.

Rauterberg, F. 1885. Coleoptera of Wisconsin. Proc. Nat. Hist. Soc. Wis. (1885): 48-62.

Scott, M. P. 1990. Brood guarding and the evolution of male parental care in burying beetles. Behav. Ecol. Sociobiol. 26: 31-39.

Scott, M. P. 1994. Competition with flies promotes communal breeding in the burying beetle, *Nicrophorus tomentosus*. Behav. Ecol. Sociobiol. 34: 367-373.

Scott, M. P., and D. S. Gladstein. 1993. Calculating males? An empirical and theoretical examination of the duration of paternal care in burying beetles. Evol. Ecol. 7: 362-378.

Scott, M. P., and J. F. A. Traniello. 1990. Behavioral and ecological correlates of male and female parental care and reproductive success in burying beetles (*Nicrophorus* spp.). Anim. Behav. 39: 274-283.

Sikes, D. S., R. B. Madge, and A. F. Newton. 2002. A catalog of the Nicrophorinae (Coleoptera: Silphidae) of the world. Zootaxa 65: 1-304.

Sikes, D. S., and C. J. Raithel. 2002. A review of hypotheses of decline of the endangered American burying beetle (Silphidae: *Nicrophorus americanus* Olivier). J. Ins. Conserv. 6: 103-113.

Trumbo, S. T. 1990. Interference competition among burying beetles (Silphidae, *Nicrophorus*). Ecol. Entomol. 15: 347-355.

Trumbo, S. T. 1991. Reproductive benefits and the duration of paternal care in a biparental burying beetle, *Necrophorus orbicollis*. Behav. 117: 82-105.

Trumbo, S. T. 1992. Monogamy to communal breeding: exploitation of a brood resource base by burying beetles (*Nicrophorus*). Ecol. Entomol. 17: 289-298.

Trumbo, S. T., and S. Thomas. 1998. Burying beetles (Coleoptera: Silphidae) of the Apostle Islands, Wisconsin: Species diversity, population density and body size. Gt. Lakes Entomol. 31: 85-95.

Young, D. K. 2005. University of Wisconsin Entomology Department Insect Research Collection. (http://www.entomology.wisc.edu/irc/colfamwi.html)