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Diversity, Habitat Preferences, and Seasonality of Kansas Carrion Beetles (Coleoptera: Silphidae)

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ABSTRACT: Pitfall trapping, blacklighting, and examinâtion of institutional collections produced records for 13 species of Silphidae in Kansas: ***Necrodes surinamensis*** (Fabricius), ***Necrophila americana*** (Linnaeus), *Nicrophorus* ***americanus*** Olivier, ***Ni. carolinus*** (Linnaeus), ***Ni. marginatus*** Fabricius, ***Ni. mexicanus*** Matthews, ***Ni. orbicollis*** (Say), ***Ni. pustulatus*** Herschel, ***Ni. tomentosus*** Weber, ***Oiceoptoma inaequale*** (Fabricius), ***O. noveboracense*** (Forster), ***Thanatophilus lapponicus*** (Herbst), and ***T. truncatus*** (Say). No current populations of the federally endangered silphid, ***Ni. americanus*** or ***Ni. mexicanus*** were documented in Kansas, and records for both species are more than 50 years old. Data based on 2007 specimens resulting from 1709 pitfall trapnights in 23 Kansas counties are standardized and used in an assessment of habitat preferences and seasonality among the encountered taxa. Four species ***(Ni. carolinus, Ni. marginatus, T. lapponicus,*** and *T. truncatus*) are nearly restricted to open prairies with sandy soil, 2 species ***(Ne. americana*** and ***O. noveboracense)*** are dominant in woodlands, and 3 species ***(Ni. orbicollis, Ni. pustulatus,*** and ***O. inaequale)*** occur in both wooded and open habitats. ***Necrodes surinamensis*** and ***Ni. pustulatus*** have bimodal peaks of activity in Kansas. Adults of ***O. inaequale*** and ***O. noveboracense*** were not captured in Kansas after mid-summer. ***Necrophila americana, Ni. marginatus, Ni. orbicollis,*** and ***Ni. tomentosus*** occur in Kansas from spring to late summer.

The purpose of this study is to reveal current pattems of diversity, distribution, habitat preferences, and seasonality for Kansas carrion beetles (Coleoptera: Silphidae). Although Peck and Kaulbars (1987) summarized these attributes for all species in the conterminous United States, this study provides more detailed information about the habitats and seasonality of Kansas taxa.

Carrion beetles have been widely studied for severa1 reasons. First, most have a well-defined ecological role as primary scavengers of carrion and thus appeal to ecologists. Second, members of the subfamily Nicrophorinae (Nicrophorus spp.) stimulate interest from behavioral and evolutionary biologists due to their parenta1 care (summarized in Anderson and Peck, 1985), a behavior quite uncommon among beetles. Third, the presence within this family of a federally endangered insect, the American burying beetle, Nicrophorus *americanus* Olivier, has drawn attention from biologists, conservationists, and the news media. Populations of this species have been intensively studied on Block Island, Rhode Island (Kozol et al., 1988), and in Oklahoma (Creighton et al., 1993), while populations in Arkansas (USFWS, 1991) and Nebraska (Ratcliffe and Jameson, 1992) were more recently re-discovered and are currently being investigated. Another reason contributing to interest in Silphidae concems the attractiveness of many species that have contrasting aposematic coloration (noted in Anderson and Peck, 1985).

With abundant resources, coexistence of species with similar niche requirements can occur. As resources begin to limit populations, however, altemative niche

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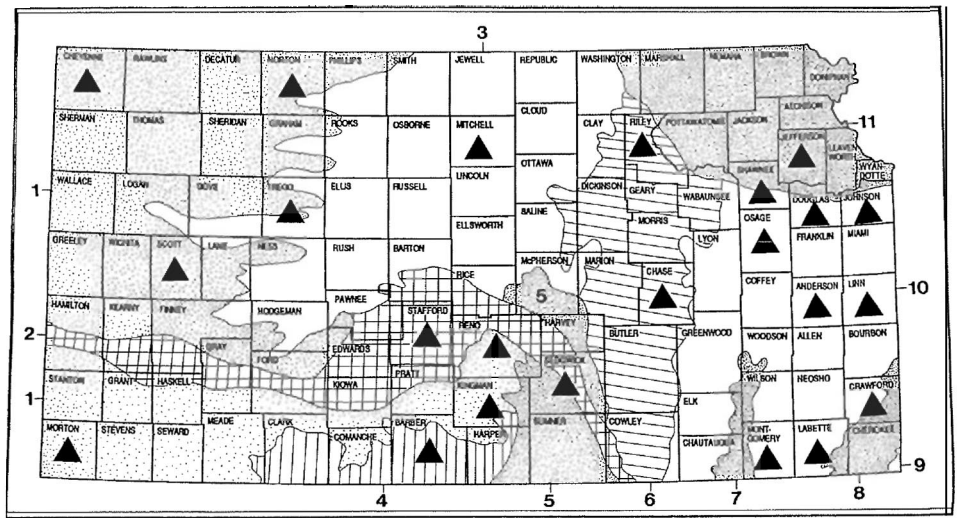

Fig. 1. Localities of pitfall traps (represented by tnangles) used from 1992–1994 superimposed on physiographic regions of Kansas (identified by numbers). Physiographic regions are as follows: 1 = High Plains, 2 = Arkansas River Lowlands, 3 = Smoky Hills, 4 = Red Hills, 5 = Wellington-McPherson Lowlands, 6 = Flint Hills Uplands, 7 = Chautauqua Hills, 8 = Cherokee Lowlands, 9 = Ozark Plateau, 10 = Osage Cuestas, 11 = previously glaciated region. Physiographic limits and terms adapted from map prepared by the Kansas Geological Survey.

dimensions must be exploited to ensure survival. In Silphidae, direct competition can be lessened by segregation of the geographical distributions (Anderson, 1982; Anderson and Peck, 1985; Peck and Kaulbars, 1987), habitat preferences (Anderson, 1982; Shubeck, 1983, 1993), seasonal (Anderson, 1982; Shubeck et al., 1981) and diel (Shubeck, 1971) periods of adult activity, and size of carrion resource (Anderson, 1982). I focussed on the first three of these in my studies of the Kansas Silphidae.

Kansas Physiography

Kansas is located in the Great Plains and consists of many distinct vegetational zones. The potential vegetation[2] of Kansas was described in detail by Kuchler (1974). The zones depicted on his map are mostly edaphic, thus corresponding well with the geologically defined physiographic regions shown in Fig. 1 (adapted from a map prepared by Kansas Geological Survey). Using Kiichler's (1974) map and terminology, the potential vegetation zones corresponding to the numbered zones in Fig. 1 are as follows. The western third of Kansas is defined as high plains with the dominant potential vegetation consisting of short grass prairies. The Arkansas River divides these prairies into the northern and southern grama-buffalo grass prairies. The central third of Kansas, from the Smoky Hills north of the Arkansas River to Red Hills to the south, potentially consists of mixed prairies, primarily comprised of bluestem-grama prairie. The eastem third of Kansas is bordered on the west by Flint Hills and consists of the previously

[2] Potential vegetation is deüned by Kuchler (1974) as the vegetation which, under natural conditions, would become reestablished in a particular region, given enough time.

glaciated region in the northeast and the Osage Cuestos over the remainder. The Chautauqua Hills intrude into this region from the south as do the Cherokee Lowlands and Ozark Plateau from the southeast. Most of this eastern third is potentially tallgrass prairie, specifically bluestem prairie. The extreme eastern margin of Kansas consists of encroaching oak-hickory forests and mosaics of these forests and bluestem prairies. The vegetation of the Chautauqua Hills region (the Cross Timbers) consists of open oak forests with dense grassy understory. The greatest concentrations of sand prairies in Kansas are primarily found along the Arkansas and Cimarron Rivers and, to a lesser extent, the Kansas River. My habitat definitions differ in part from Kuchler's because of the more localized habitats in which I trapped. Below are the regions (and their descriptions) which I used in the habitat preference analyses.

Woods refer to any band of trees that are dense enough to provide nearly continuous canopy shade at all times of the day during spring and summer. Woods may refer to some of the denser forests in northeastern Kansas as well as comparatively sparse riparian bands of trees. *Open prairies (non-sandy soil)* refer to generally mesic regions consisting of grasses and forbs growing from highly organic and fertile soil. Since trees are uncommon, very little canopy shade is provided in this habitat. *Borders between woods and open (non-sandy) prairies* are areas of fertile soils which produce trees as well as grasses and forbs. Incomplete shade is afforded in these areas most of the day. *Open prairies (sandy soil)* refer to generally xeric and sparsely vegetated habitats consisting primarily of grasses, forbs, and sages. Since trees are rare, very little canopy shade is provided in this open habitat. Soil in this habitat is very sandy and of low organic content. *Disturbed areas* are farmed or urban regions. In my results, I will correlate these localized habitats to the broader regions defined by Kuchler (1974).

Materials and Methods

Data in this study are the result of carrion-baited pitfall trapping, blacklighting, and examination of incidentally encountered dead vertebrates (primarily road kills and fish dumps) during the three year period 1992–1994. In addition, I examined the institutional collections of the Snow Entomological Museum, University of Kansas (SEMC), Kansas State University (KSU), Fort Hays State University (FHSU), and University of Nebraska State Museum (UNSM), which provided historical distribution data.

As the potential existed for capturing the endangered silphid, *Nicrophorus americanus*, all pitfall trapping was non-lethal and so no killing agent was used. Except for the following variations, the pitfall trap design did not differ markedly from that of USFWS (1991). The trap containers were either plastic, 500 ml cups (used in 1992 and 1993) or 350 ml glass jars (used in 1994). The carrion bait used consisted of ca. 50 g combination of chicken hearts and gizzards. Bait was ripened in a sealed container exposed to the sun for ca. 1–2 days before being placed in the traps.

At each site, efforts were made to sample each habitat, i.e., prairies, woods, and disturbed areas. In most cases, traplines consisting of 5–10 traps were placed in each habitat at each site. Traps were always spaced ca. 30–50 m apart. Pitfall trapping results are based on 64 traplines in 23 counties of Kansas for three years of activity from 1992–1994 (triangles, Fig. 1). Since the attractiveness of a 50 g

Table 1. Number of pitfall trap captures for each species of carrion beetle during 1992–1994 for each of the five designated habitats.

Species	Woods	Open prairie (non-sandy soil)	Border of woods–non-sand prairie	Open prairie (sandy soil)	Disturbed	Total
Necrophila americana	74	21	42	0	3	140
Necrodes surinamensis	0	2	24	13	1	40
Nicrophorus carolinus	0	0	0	189	0	189
Nicrophorus marginatus	5	66	15	336	10	433
Nicrophorus orbicollis	207	57	249	92	4	609
Nicrophorus pustulatus	1	1	3	0	0	5
Nicrophorus tomentosus	2	43	36	54	31	166
Oiceoptoma inaequale	114	95	73	11	55	348
Oiceoptoma noveboracense	6	0	1	0	0	7
Thanatophilus lapponicus	0	0	2	41	0	43
Thanatophilus truncatus	2	1	0	24	0	27
Trapnights	275	612	432	138	252	1709

piece of carrion aged for two days normally peaks at the fourth day of exposure (second day in trap) and is minimal by the sixth day of exposure (fourth day in trap), traps were most often checked for three days after baiting. Normally, all contents were removed, identified, counted, and retained after the first and second days, and the contents were counted, identified, and released on the third day. This insured that all the data used in habitat preference and abundance analyses would not be biased by recaptures of previously recorded individuals.

Because there was unequal collecting effort in each of the designated habitats, data was standardized. I did this by taking the absolute numbers of each species collected in pitfall traps (Table 1), dividing that by the number of trapnights per habitat (Table 1), and then converting that number to a percentage of the total standardized values for all five habitats. The use of percentages in tests of statistical significance has "major drawbacks" (Sokal and Rohlf, 1981), and consequently no such tests were performed on these data. Figure 2 was generated from these standardized percentages. All references to percentages that follow are based on standardized, not absolute numbers. A total of 2007 specimen records are included in these data. All specimens collected in this study were deposited in the SEMC.

Results and Discussion

A total of 13 species of Silphidae is reported for the state of Kansas in this study. These include *Necrodes surinamensis* (Fabricius), *Necrophila americana* (Linnaeus), *Nicrophorus americanus* Olivier, *Ni. carolinus* (Linnaeus), *Ni. marginatus* Fabricius, *Ni. mexicanus* Matthews, *Ni. orbicollis* (Say), *Ni. pustulatus* Herschel, *Ni. tomentosus* Weber, *Oiceoptoma inaequale* (Fabricius), *O. noveboracense* (Forster), *Thanatophilus lapponicus* (Herbst), and *T. truncatus* (Say). Of these species, all but *Ni. americanus* and *Ni. mexicanus* were taken in pitfall traps during 1992–1994. Discussion of distribution (based on all specimen records) and abundance, habitat preference, and seasonality (based on pitfall collections) for each species is presented here.

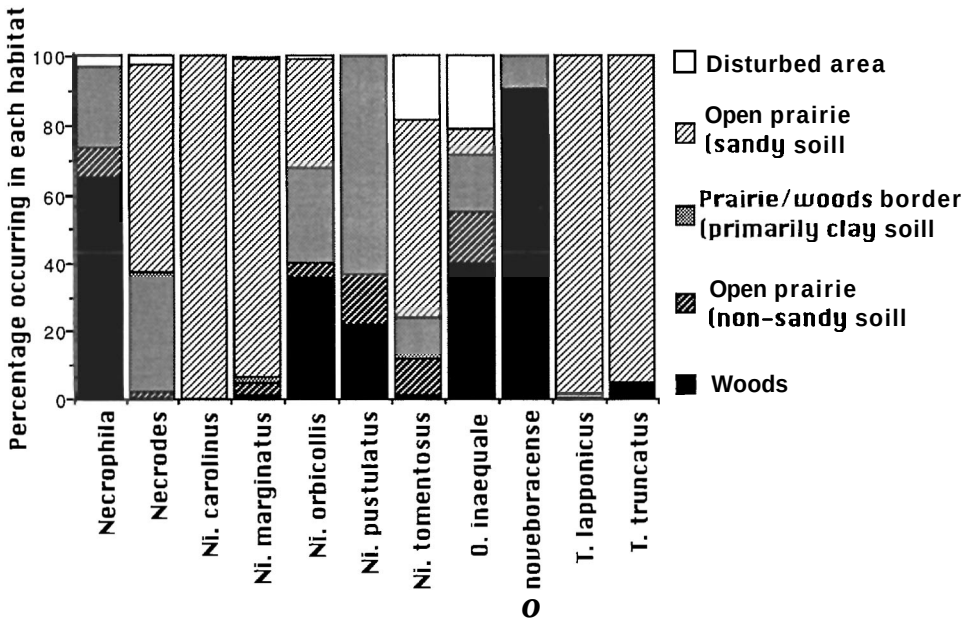

Fig. 2. Habitat preferences among Kansas Silphidae taken in pitfall traps during 1992–1994. Bars represent the percentages of each taxon occurring in each of the five defined habitats. Percentages are based on standardized data to eliminate biases of unequal trapping effort in different habitats.

Necrodes surinamensis (Fabricius)

This species is well-represented in Kansas, having been collected from 15 counties as far west as Gove County (Fig. 3). Although only 40 specimens were taken in pitfall traps (Table 1), I collected many more at blacklights. This species apparently prefers open areas (Fig. 2), as I collected no specimens in wooded habitats. Anderson (1982) recorded this species from coniferous forests and meadows, while Shubeck (1983) reported it to have a strong preference for wooded areas. In this study, most (60%) specimens were taken from sandy praines. This species has bimodal peaks of adult activity in May and July; no specimens were taken in June or August. Ratcliffe (1972) showed this species to be "homodynamic," with continuous generations of adults during favorable climatic conditions in Nebraska.

Necrophila americana (Linnaeus)

Dense populations of this species occur in the more mesic eastern third of Kansas, although no Kansas localities were indicated by Peck and Kaulbars (1987). I captured 140 specimens in pitfall traps (Table 1) in nine counties (Fig. 3) corresponding well with Kuchler's (1974) delimitation of oak-hickory forests and mosaics of these and tallgrass prairies. Over half (65%) of the specimens were taken in wooded areas and 25% in marginal areas of woods and non-sandy prairies (Fig. 2). Shubeck (1983) reported a strong preference for open fields among *N. americana*, while Anderson (1982) found it to be rare in open meadows. This species was collected from May through August.

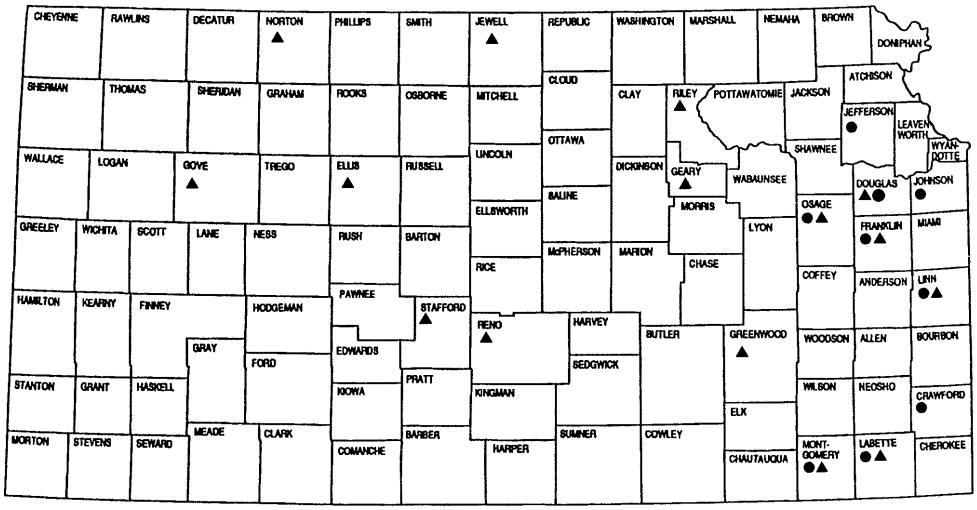

Fig. 3. Kansas county records for *Necrophila americana* **(L.) (circles) and** *Necrodes surinamensis* **(Fabr.) (triangles).**

Nicrophorus americanus Olivier

Although this species had a historical distribution throughout eastern Kansas (Fig. 4), intensive surveys (Lingafelterand Busby, 1992, 1993), revealed no current populations. All historical Kansas records for this species are more than 50 years old.

Nicrophorus carolinus (Linnaeus)

This species is recorded from five Kansas counties, although none was taken east of the Flint Hills (Fig. 5). One-hundred and eighty-nine specimens collected

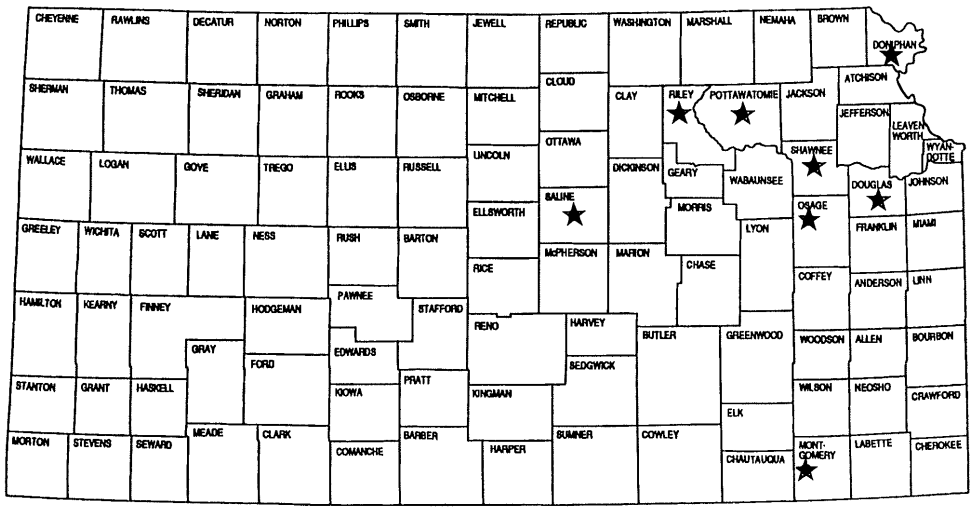

Fig. 4. Historical county records of the American burying **beetle,** *Nicrophorusamericanus* **(Olivier), in Kansas.** All **records are** greater **than** fifty **years old. (Based** in part **on U.S. Fish and Wildlife** Service, **1991.)**

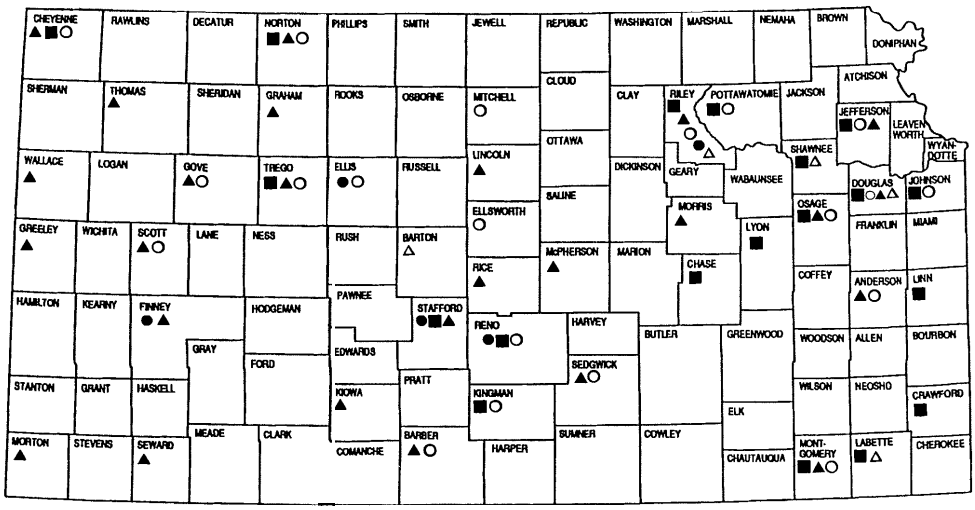

Fig. 5. Kansas county records for *Nicrophorus* species. Symbols are as follows: *N. carolinus* (L.) (solid circles), *N. marginatus* Fabr. (solid triangles), *N. orbicollis* (Say) (solid squares), *N. pustulatus* Herschel (open triangles), *N. tomentosus* Weber (open circles).

in pitfall traps (Table 1) were taken in areas defined as open, sandy prairies (Fig. 2). Seasonal data is wanting for this species as they were encountered only once (mid-July) during this study. Peck and Kaulbars (1987) indicate the adult activity of this species is from March through October.

Nicrophorus marginatus Fabricius

Recorded from 25 counties spanning the breadth of Kansas (Fig. 5), this is the most widespread species of the genus in the state. It was second in pitfall trap representation with 433 specimens collected (Table 1). Other specimens were taken on dead fish and coyote. Nearly all specimens were taken in sandy prairie (92%), although 5% represent samples from non-sandy prairies (Fig. 2). This species' preference for open habitats has also been demonstrated by Anderson (1982) and Shubeck (1983). Adults of this species also have a broad period of activity, being taken from May to as late as October in southern Kansas.

Nicrophorus mexicanus Matthews

The single specimen of *Ni. mexicanus* I examined is more than 70 years old (specific date uncertain due to incomplete label data) and was collected in Douglas County—considerably east of the nearest known historical populations in central Colorado (Peck and Kaulbars, 1985). Ratcliffe (pers. comm.) noted one specimen in the UNSM from central Nebraska.

Nicrophorus orbicollis (Say)

This is the most abundant silphid in Kansas, having been recorded from 19 counties extending to every border (Fig. 5). The western Kansas records represent the approximate geographic limit of this eastern species (based on Peck and Kaulbars, 1987). A total of 609 specimens were taken in pitfall traps (Table 1),

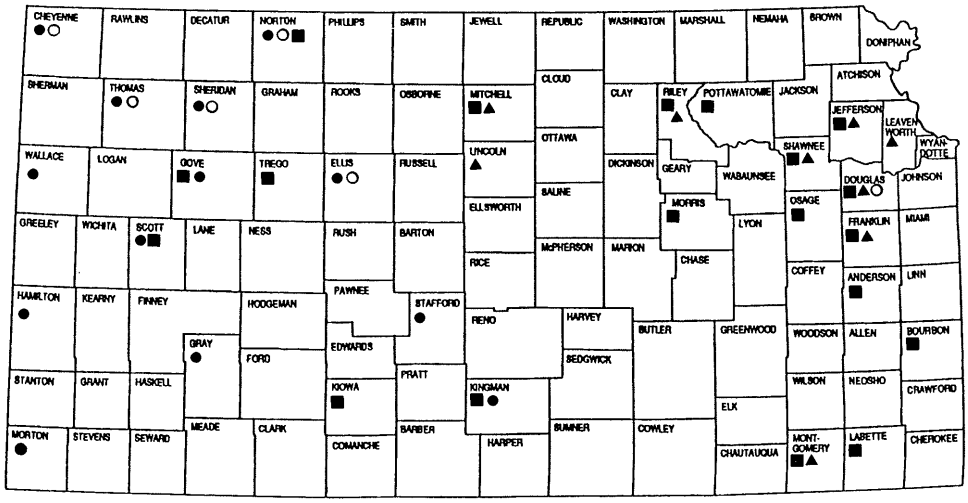

Fig. 6. Kansas county records for *Thanatophilus truncatus* **(Say) (solid circles),** *Thanatophilus lapponicus* **(Herbst) (open circles),** *Oiceoptoma inaequale* **(Fabr.) (solid squares), and** *Oiceoptoma noveboracense* **(Forster) (solid** triangles).

while additional specimens were captured at blacklight in eastern and western Kansas. Specimens were collected in roughly equal percentages in woods, sandy prairies, and marginal areas between woods and non-sandy prairies (Fig. 2) from May through August, indicating that this is a species that occupies a broad niche, which may explain its success in Kansas. Anderson (1982) recorded this species from marshes, woods, and meadows, although he and Shubeck (1983) indicated it had a strong preference for forests.

Nicrophorus pustulatus Herschel

This species is uncommon in Kansas and only five specimens were collected in pitfall traps during this study (Table 1). Three additional specimens were taken at blacklights. All specimens taken from 1992–1994 were from eastern Kansas; one specimen from Barton County in central Kansas was examined from FHSU. In total, five counties of Kansas have records of this species (Fig. 5). Pitfall records are from woods, open non-sandy prairies, and transitional (mosaic) regions of these habitats (Fig. 2). Both Anderson (1982) and Shubeck (1983) indicate a strong preference of Ni. pustulatus for woods. This species, like N. *surinamensis*, shows a bimodal period of activity; I collected adults in May and late July. The extremely small sample could misrepresent the actual period of adult activity. Robertson (1992) reported continuous, stable population levels of this species from June to mid-July in Ontario, Canada.

Nicrophorus tomentosus Weber

Nicrophorus tomentosus is widespread and was recorded from 20 Kansas counties (Fig. 5). I collected 166 specimens in pitfall traps during this study (Table 1). Sixty percent of the specimens were taken in open, sandy prairies, while the remainder were collected in disturbed areas, transitional habitats, and non-sandy prairies (Fig. 2). Shubeck (1983) indicated a slight preference of this species for

open fields, while Anderson (1982) showed it common in all habitats (marshes, meadows, and woods.) This diurnal silphid was collected from May through October in pitfall traps in Kansas.

Oiceoptoma inaequale (Fabricius)

This taxon, like Ni. orbicollis, has broad geographical distribution and habitat preferences in Kansas. In terms of absolute numbers, this species was third in abundance, with 348 specimens collected in pitfall traps (Table 1). They were recorded from 19 Kansas counties (Fig. 6) and all five of the sampled habitats (Fig. 2). Woods, however, harbored the greatest portion of specimens, accounting for 40% of the total. Shubeck (1983) indicated that 0. inaequale had a slight preference for fields; Anderson (1982) showed deciduous forests harbored the greatest portion of specimens. Members of this species were recorded only until early July, apparently avoiding the hotter, drier period of the summer.

Oiceoptoma noveboracense (Forster)

This is less common than its sister species, 0. inaequale. Only seven specimens were collected in pitfall traps during this study (Table 1). Most heavily concentrated in northeast Kansas, the westernmost records of this species approximate the mixed and tallgrass prairie transition of Kuchler (1974) (Fig. 6). This is primarily a woodland species as 90% were collected in that habitat (Fig. 2). However, Anderson (1982) indicated a broader range of habitats including marshes, woods, and meadows. Oiceoptoma noveboracense, like 0. inaequale, was collected early in the summer, with no specimens collected after late June.

Thanatophilus lapponicus (Herbst)

Specimens were taken in pitfall traps only in the high plains of western Kansas (Fig. 6). In addition to the five county records of northwest Kansas, one record from Douglas County in eastern Kansas (probably greater than 70 years old—incomplete label data) was seen in the SEMC. It is unlikely that any populations remain in eastern Kansas currently. The other Kansas records, however, probably represent the southeastern-most extremes of the distribution of this species in the United States based on the map in Peck and Kaulbars (1987). In total, 43 specimens were taken in pitfall traps (Table 1). Nearly all specimens (99%) were collected in open, sandy prairie habitats (Fig. 2). Anderson (1982) also recorded T. lapponicus only from open meadows. Since this species was encountered on only one collecting trip during early July, information regarding seasonality is incomplete. Peck and Kaulbars (1987) mention a broad period of activity for this species.

Thanatophilus truncatus (Say)

This species, like its congener, is primarily a western Kansas species. Specimens were recorded from 13 counties, all comprising the high plains (Fig. 6). Twenty-seven specimens were taken in pitfall traps during this study (Table 1). Others were taken on dead fish. Like T. lapponicus, nearly all specimens were captured in open, sandy prairies (Fig. 2). This species was taken in late May, early to mid-July, and October. Peck and Kaulbars (1987) indicated that in parts of the range, adults are active by March.

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