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DISTRIBUTION AND BIOLOGY OF THE SPHECINE WASPS OF MICHIGAN (HYMENOPTERA: SPHECIDAE: SPHECINAE)

Mark F. O'Brien¹

ABSTRACT

Biological information and distribution maps are provided for the 26 species of thread-waisted wasps that occur in Michigan. *Podium luctuosum* is a new state record. Sixty percent of the eastern North America sphecine fauna is represented in Michigan.

The thread-waisted wasps, or Sphecinae (*sensu* Bohart and Menke 1976) are conspicuous inhabitants of sandy areas, vacant lots, and human residences (mud daubers). They have long been a favorite group for ethologists and naturalists because of their large size and easily observed nesting habits. Early authors such as Peckham and Peckham (1898), Fabre (1915), Rau and Rau (1918), and Reinhard (1929) gave much attention to various sphecines such as *Sphex*, *Chlorion*, and *Ammophila* in their accounts of wasp behavior. Although much has been printed about the sphecines in technical and popular works, many species have been only sparingly studied, and others not at all. Much of the North American sphecid fauna is still poorly studied ethologically (Krombein 1979).

The sphecines are behaviorally diverse, and a general outline of their nesting habits is presented in Table 1. No attempt has been made to list all the references that pertain to each species in the text, as Krombein (1979) provides citations up to 1976. Only pertinent references are given in the species accounts that follow.

Most sphecine genera are fossorial, but *Podium*, *Chalybion*, *Sceliphron*, and *Isodontia* nest aerially, either in preformed cavities or in mud nests. Prey selection is diverse, ranging from spiders to various groups of Orthoptera and lepidopterous larvae. Wasp genera usually specialize on a given order or family, with the various species differing in prey selection at the family or genus level, stage of prey, size of prey, or site of prey capture (arboreal versus fossorial caterpillars). Evans and Eberhard (1970) gave an excellent review of all types of sphecid behavior, and Bohart and Menke (1976) provided behavioral synopses for each genus on a world-wide basis.

Owing to the effects of glaciation, Michigan abounds in sandy areas. As a consequence, there exists a wide range of habitable areas for sand wasps. Dreisbach (1944) provided the first key and annotated list of the thread-waisted wasps of the state. Due to later taxonomic revisions and extensive collecting, his paper has been long outdated. Michigan has representatives of all the 11 genera of North American Sphecinae, and 26 of the 127 North American species. Some of these species reach their easternmost or northernmost distribution in the state. Other species that are transcontinental are similarly widespread in Michigan. These distributions are discussed under the species accounts.

SYSTEMATICS

The sphecines are a taxonomically well-studied group in North America. For identification of North American taxa other than the Ammophilini, Bohart and Menke's

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	WASPS			PREY			NESTS				
	ARANEIDA	ORTHOPTERA	LEPIDOPTERA	FOSSORIAL	MUD OR CAVITY	1 - CELLED	MULTI-CELLED	1 PREY/CELL	2+ PREY/CELL		
SCELIPHHRINI	<i>Chlorion</i>	●		●		●		●			
	<i>Podium</i>		●		●		●		●		
	<i>Chlaybion</i>	●			●		●		●		
	<i>Sceliphron</i>	●			●		●		●		
SPHECINI	<i>Sphex</i>		●	●					●		
	<i>Isodontia</i>		●		●				●		
	<i>Palmodes</i>		●		●	●		●			
	<i>Prionyx</i>		●		●	●		●			
AMMOPHILINI	<i>Podalonia</i>		●	●		●		●			
	<i>Eremnophila</i>		●	●	●	●		●			
	<i>Ammophila</i>		●	●	●	● ^a		●	●		

^a Some *Ammophila* species maintain several nests simultaneously, and the number of prey per cell varies among species.

Table 1. A synopsis of the nesting habits of the Sphecinae.

reclassification of the subfamily (1963) is recommended. On a world-wide level, Bohart and Menke's 1976 generic revision of the family Sphecidae is the definitive work. For the Ammophilini, Murray (1940) is the best taxonomic reference for *Podalonia*, and Menke (1964) for *Eremnophila*. Keys to *Ammophila* published prior to 1964 are either incomplete or unreliable. Only Menke's (1965) revision of North American *Ammophila* is recommended for identification, but it is only available on microfilm or microfilm-based reprint from University Microfilms, Ann Arbor, MI. Additional information on biology and taxonomy was given by Krombein (1979).

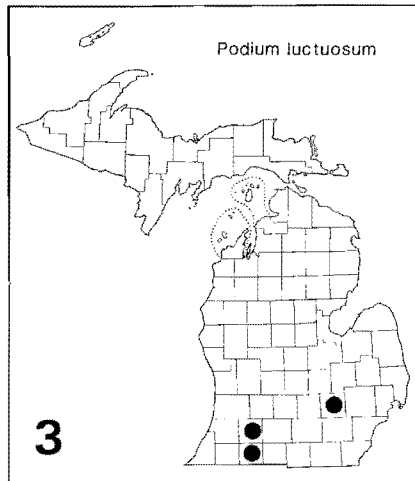
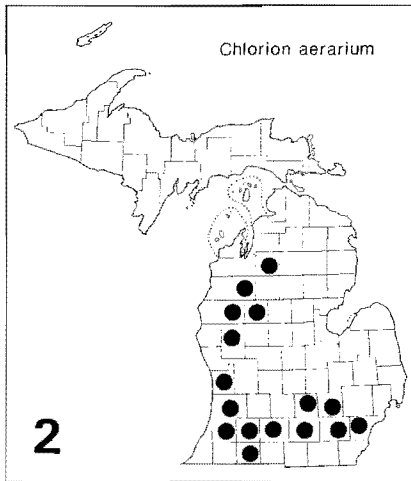
SPECIES ACCOUNTS

The following annotated list of the Michigan sphecines is based upon the examination of over 2500 specimens from various collections (see Acknowledgments), and from personal observations in the field. Voucher specimens for those species upon which behavioral data are based are deposited at The University of Michigan Museum of Zoology. Flower records are based upon personal observations or label data and do not



Fig. 1. The counties of the State of Michigan.

include previously published records. Localities given as Livingston County are from the Edwin S. George Reserve (ESGR). Abbreviations for sections of the state of Michigan are LP for Lower Peninsula, UP for Upper Peninsula, SLP and NLP for the southern and northern regions of the LP. The number of specimens examined is given as an indicator of relative abundance for the various species, and to indicate the sample size.



Family Sphecidae
Subfamily Sphecinae
Tribe Sceliphriini
Genus *CHLORION* Latreille

aerarium Patton 1879. (Fig. 2). This beautiful, large (25 mm) metallic blue wasp ranges from southern Canada to Mexico (Krombein 1979) and is known only from scattered localities in the LP, most of which are in the southernmost three tiers of counties.

BIOLOGY: Peckham and Kurczewski (1978) found females mass-provisioning several serial cells, each containing from 2 to 9 nymphs or adults of *Gryllus pennsylvanicus* Burmeister (Gryllidae). Burrows were invariably dug from the sides of the main burrows of the cicada-killer (*Sphecius speciosus* [Drury]). Since *C. aerarium* also nests where *S. speciosus* is uncommon or absent, as in Michigan, some females may either start their own burrow from the surface, or perhaps utilize burrows of other wasps or bees.

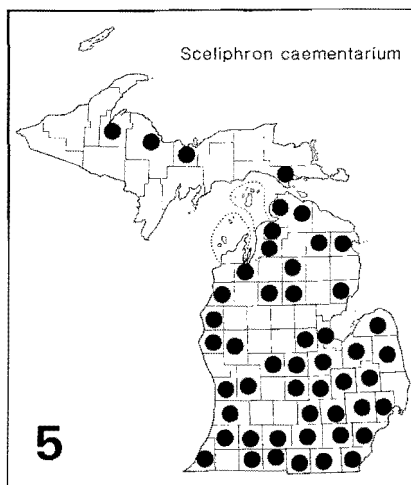
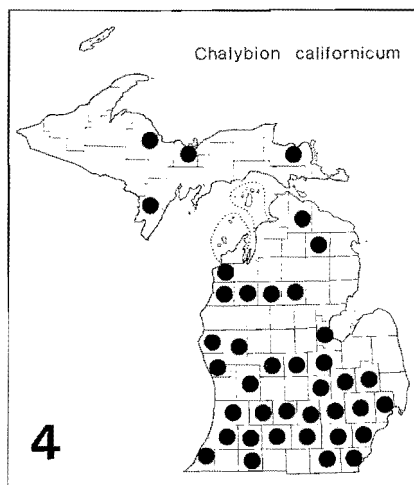
In the SLP (St. Joseph and Livingston counties), *C. aerarium* provisions its nests with *G. pennsylvanicus* nymphs in late July and early August. Prey are transported on the ground, venter-up, with the wasp's mandibles grasping the antennae of the cricket.

COLLECTION DATES: 42 specimens, 1 July to 17 September. Most dates are from late July to mid-August.

Genus *PODIUM* Fabricius

luctuosum Smith 1856. (Fig. 3). This uncommon species has been collected only in Livingston (ESGR), Kalamazoo and St. Joseph counties. An inhabitant of mesic woodlands, it should be found in other areas of the SLP. *P. luctuosum* has been infrequently collected from New York south to Texas, Missouri, and Kansas (Krombein 1979). The Michigan records are new for the state and considerably extend the known range.

BIOLOGY: These wasps prey on cockroaches, which, after being paralyzed, are placed in simple mud-covered cells under bark flaps or in pre-existing cavities in wood. *Parcoblatta virginica* (Brunner) and *Parcoblatta uhleriana* (Saussure) adults have been recorded as prey (Pate 1949, Krombein 1967). Three species of *Parcoblatta* occur in Michigan (Cantrall 1968) and are likely prey of *P. luctuosum*. Females caught at the



ESGR were hunting amongst fallen branches in an oak woods, whereas the specimens from Kalamazoo and St. Joseph counties were caught in Malaise traps.

COLLECTION DATES: Seven specimens, 15 June to 18 July.

Genus *CHALYBION* Dahlbom

californicum (Saussure) 1867. (Fig. 4). The blue mud-dauber is distributed transcontinentally, from southern Canada to northern Mexico (Krombein 1979), and is likely to be found in most areas of Michigan. There are few records from the UP, presumably from lack of collecting.

BIOLOGY: This species nests in sheltered locations such as sheds, under eaves of buildings, or beneath bridges, and usually appropriates old or recently abandoned nests of *Sceliphron caementarium* (Drury). Wasps carry water to manipulate mud previously placed there by *Sceliphron*, rather than carry mud as does *S. caementarium*. As a result of the reworking of the mud, nests of *C. californicum* have a rough, lumpy texture, versus the smooth, "finished" appearance of fresh *S. caementarium* nests. Rarely, *C. californicum* reopens a recently provisioned nest of *S. caementarium*, removes the prey, and usurps the nest for her own provisions (Rau 1928).

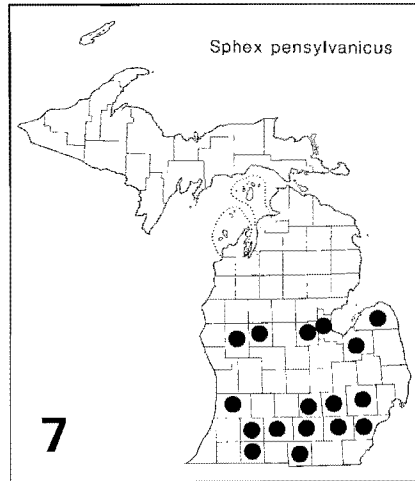
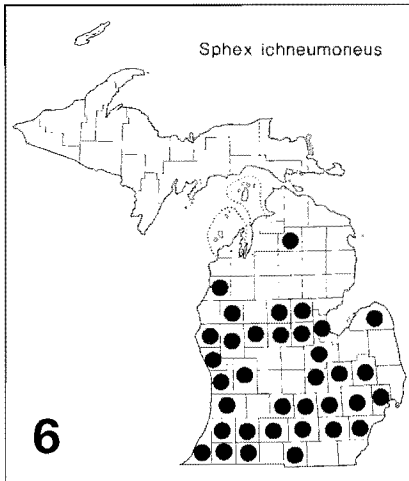
Chalybion californicum mass provisions each cell with spiders, usually from the families Theridiidae and Araneidae, occasionally Oxyopidae, Thomisidae, and Salticidae (Horner and Klein 1979, Krombein 1979). This wasp has gained notoriety due to its preying on black widow spiders (*Latrodectus* spp.) (Rau 1935a, Horner and Klein 1979). Wasps have been observed catching araneids by landing on the orb webs, enticing the spiders out from their retreat and capturing them without becoming entangled in the spider's web (Coville 1976). Perennial sleeping aggregations have been noted (Ward 1972).

FLOWER RECORDS: *Berberis vulgaris*, *Daucus carota*, *Zizia aurea*.

COLLECTION DATES: 190 specimens, 25 May to 9 September. Most dates are between late June and early August.

Genus *SCELIPHRON* Klug

caementarium (Drury) 1773. (Fig. 5). This black and yellow mud dauber is probably the most widespread and familiar of the sphecines, due to its synanthropic habits.



Transported via cargo, it has established itself in Europe, Australia, and many Pacific Islands (Bohart and Menke 1976). In the New World, *S. caementarium* occurs from southern Canada to Central America and the West Indies (Krombein 1979). It is found over much of Michigan, and is probably more widespread in the UP than collection records indicate.

BIOLOGY: Multicelled mud nests are constructed in sheltered spots such as sheds, barns, picnic pavilions, and attics. Spider prey belong mostly to the families Araneidae and Thomisidae (Rau 1935b, Muma and Jeffers 1945, Shafer 1949, Horner and Klein 1979). A favorable site may be used for many years, sometimes resulting in an enormous conglomeration of nests being occupied by both *C. californicum* and *S. caementarium*.

FLOWER RECORDS: *Berberis vulgaris*, *Clematis virginiana*, *Daucus carota*, *Pyraecantha* sp., *Spiraea* sp.

COLLECTION DATES: 200 specimens, 24 May to 1 October. Most records are from late June to early August. Wasps emerging in greenhouses in Michigan have been seen as early as mid-March (A. O'Brien, pers. comm.).

Tribe SPHECINI

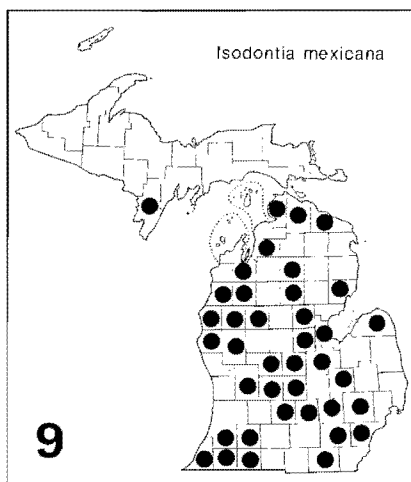
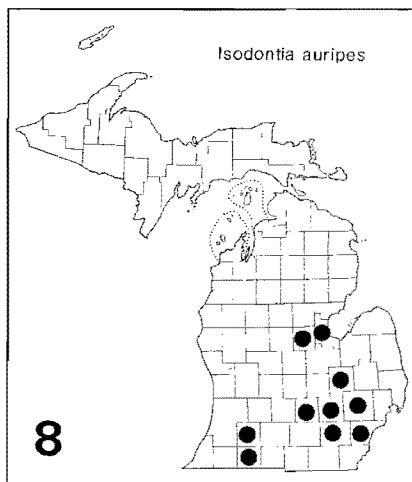
Genus *SPHEX* Linnaeus

ichneumoneus (Linnaeus) 1758. (Fig. 6). The great golden digger is widespread over much of North America and its range extends deeply into South America (Krombein 1979). In Michigan, it is most common in the SLP with fewer records northward, and is unknown from the UP.

BIOLOGY: Females nest in hard-packed sandy or gravelly soil, with several cells per nest provisioned with two to four Tettigoniidae. *Neoconocephalus ensiger* (Harris) adults and nymphs are utilized as prey in Michigan (pers. obs.). Krombein (1979) listed all of the recorded prey and references for this well-studied species. More recently, Brockmann (1979, 1980) and Brockmann, Grafen and Dawkins (1979) discussed effects of environmental factors on nesting behavior, nest-site selection, and various nesting strategies (e.g., some females may usurp others' nests).

FLOWER RECORDS: *Asclepias tuberosa*, *Asclepias* sp., *Daucus carota*, *Eryngium yuccifolium*, *Melilotus alba*, *M. officinalis*.

COLLECTION DATES: 126 specimens, 8 June to 27 September, with most dates in late July to mid-August.



pensylvanicus Linnaeus 1763. (Fig. 7). Distributed transcontinentally in North America, except for northwestern states (Krombein 1979). *Spheg pensylvanicus* appears to be less common throughout its range than *S. ichneumoneus*. Most Michigan records are from the SLP, and it appears that it is absent from the extreme NLP and UP.

BIOLOGY: This wasp nests in soft ground, usually in sheltered locations. Prey are katydids (Tettigoniidae), with *Scudderia* spp. commonly reported. The oblique burrow contains several cells with 2–6 prey in each (Reinhard 1929, Frisch 1938, Krombein 1979, F.E. Kurczewski pers. comm.).

FLOWER RECORDS: *Asclepias* spp., *Daucus carota*, *Eryngium yuccafolium*, *Melilotus alba*.

COLLECTION DATES: 68 specimens, 19 June to 5 September. Most dates are from late July to mid-August.

Genus *ISODONTIA* Patton

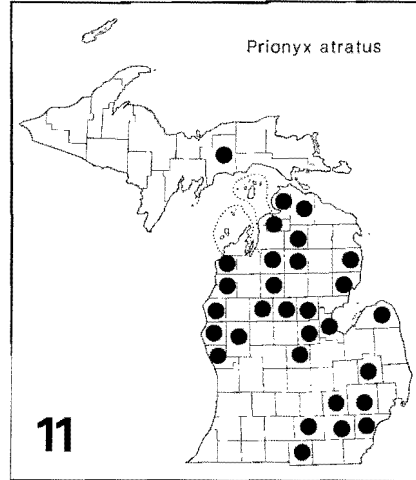
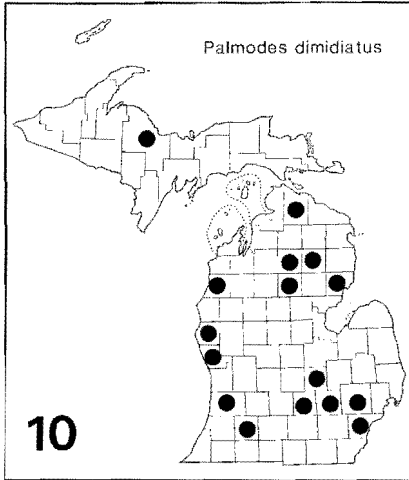
auripes (Fernald) 1906. (Fig. 8). This eastern U.S. species ranges as far west as Kansas, south to Texas (Krombein 1979). It is uncommon in Michigan, being restricted to the SLP.

BIOLOGY: Members of this genus are called the grass-carrying wasps due to their habit of using grass blades to partition cells and form closing plugs in their cavity nests. They are easily studied if trap-nests (Krombein 1967) are used, such as lengths of bamboo, or borings in wood placed in an open location. *Isodontia auripes* nests contain a single large brood chamber in which several larvae develop together (Krombein 1967, 1979). Krombein (1979) listed prey as various species of *Oecanthus*, *Orocharis*, *Orchelimum*, *Neoxabea* (Gryllidae); *Conocephalus* and *Scudderia* (Tettigoniidae). It appears that gryllids, especially those in the genus *Oecanthus* are preferred.

FLOWER RECORDS: *Melilotus alba*.

COLLECTION DATES: 42 specimens, 3 July to 22 August, with most dates in late July.

mexicana (Saussure) 1867. (Fig. 9). *Isodontia mexicana* is a widespread North American species ranging into Central America (Krombein 1979) that is relatively common in the LP of Michigan. Only a few records are known from the UP.



BIOLOGY: This species is similar to *I. auripes* in its nesting behavior, but differs in that it often provides loose partitions between brood cells containing a single larva with prey. Often a single large brood chamber may contain bits of grass spread loosely throughout it (Medler 1965, Lin 1966, Krombein 1967, pers. obs.). Several species of *Oecanthus* are the preferred prey, but it is also known to take *Gryllus* and other genera (Krombein 1979). Not only does *I. mexicana* nest in cavities in wood, but it has been reported to nest in pitcher plant leaves in the southeast (Hubbard 1896, Rau 1935c). Two generations per year occur in the SLP.

FLOWER RECORDS: *Daucus carota*, *Eryngium yuccafolium*, *Melilotus alba*, *Pastinaca sativa*, *Rhus glabra*, and *Rudbeckia hirta*.

COLLECTION DATES: 196 specimens, 17 June to 12 October, with most dates in July and August.

Genus *PALMODES* Kohl

dimidiatus (DeGeer) 1773. (Fig. 10). The only member of this genus in eastern North America, *P. dimidiatus* is recorded from scattered localities in Michigan. Although only one record exists from the UP (Marquette Co.), it may occur in other areas where its prey is found.

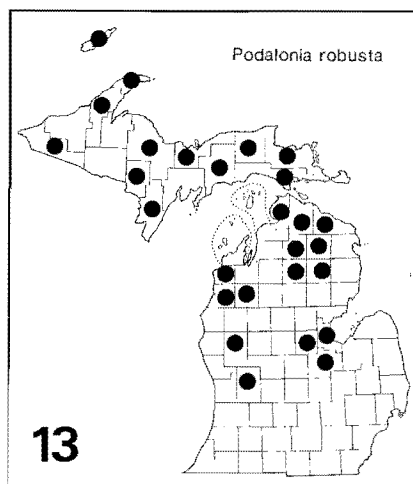
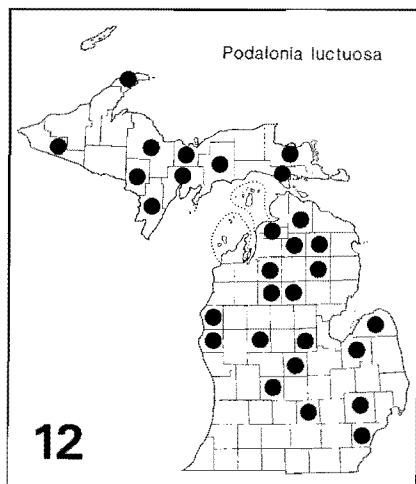
BIOLOGY: Females nest in sandy soil, storing a single prey (usually a nymphal tettigoniid) in a shallow, one-celled nest (Krombein 1979). A female nymph of *Atlantiscus testaceus* Scudder is the only prey record for the state (ESGR). Females at the ESGR hunted for *Atlantiscus* nymphs in open oak-hickory woods with low, shrubby undergrowth. Krombein (1979) listed other prey records in addition to *A. testaceus*.

COLLECTION DATES: 50 specimens, 19 June to 28 August. Most records are from late July.

Genus *PRIONYX* Van der Linden

atratus (Lepelletier) 1845. (Fig. 11). This species occurs transcontinentally from southern Canada to northern Mexico (Krombein 1979). It is quite widespread across the LP, but rare in the UP.

BIOLOGY: Wasps nest in gravelly or sandy (heavy) soils, constructing one-celled nests after procuring prey. A single adult grasshopper is used to provision the cell, with over 20 species of acridids recorded as prey (Krombein 1979).



COLLECTION DATES: 117 specimens, 10 July to 3 October, with the majority of specimens taken in August. This coincides with the appearance of most adult acridids.

Tribe AMMOPHILINI

Genus *PODALONIA* Fernald

Members of this genus are considered to be more primitive than those of *Ammophila*. *Podalonia* typically prey on soil-dwelling noctuid larvae (cutworms) and excavate a shallow, one-celled nest after capturing prey. (Most sphecids excavate the burrow before capturing prey). The caterpillar is usually cached on a clump of vegetation while the wasp digs her burrow. Only one prey is used per nest.

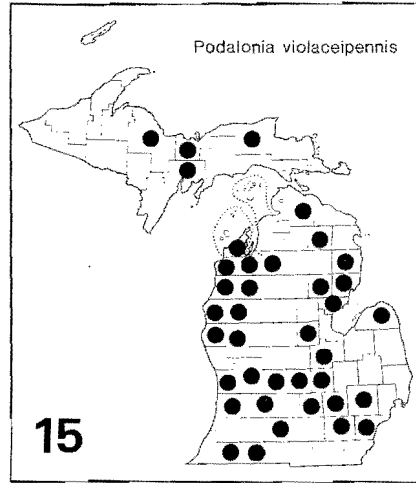
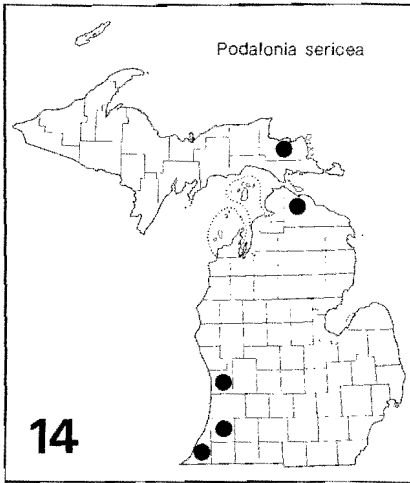
The apparently one-segmented petiole is perhaps the easiest character for separating *Podalonia* from *Ammophila* and *Eremnophila*. The biology and systematics of the genus have been reviewed by Bohart and Menke (1976).

luctuosa (Smith) 1856. (Fig. 12). *Podalonia luctuosa* is a transmontane and boreal North American species that is probably widespread in Michigan. The females are the only all-black *Podalonia* east of the Rocky Mountains.

BIOLOGY: Females emerge from hibernation in late April to early May and begin nesting during warm, sunny days. This species is bivoltine, and a variety of cutworm species have been recorded as prey (O'Brien and Kurczewski 1982). Females of the second generation mate in late summer and dig deep, overwintering burrows which they enter in the fall, with several wasps often sharing a burrow (O'Brien and Kurczewski 1982). Steiner (1983) has studied the hunting and stinging behavior of *P. luctuosa* under laboratory conditions.

FLOWER RECORDS: *Achillea millefolium*, *Barbarea vulgaris*, *Cerastium vulgatum*, *Chrysanthemum leucanthemum*, *Daucus carota*, *Erigeron canadensis*, *Fragaria virginiana*, *Hypericum perforatum*, *Lepidium virginicum*, *Melilotus alba*, *Potentilla recta*, *Solidago* spp., *Taraxacum officinale*, *Trifolium agrarium*, *T. pratense*, *T. repens*.

COLLECTION DATES: 180 specimens, 16 April to 3 October. Due to the hibernation of adult females, and the two generations (in most cases), there are three adult peak appearances: May, early July, and late August to early September. The males generally peak in late June to early July, and in mid-August.



robusta (Cresson) 1865. (Fig. 13). This species is distributed throughout the montane and northern areas of North America much like *P. luctuosa*. In Michigan, it is found primarily in the UP and NLP.

BIOLOGY: Females prey on a variety of cutworms in disturbed sandy areas. One female in Crawford Co. was carrying a noctuid caterpillar venter-up along the margin of a compacted sandy road (1 August) when she was collected. There appears to be only one generation per year, based upon collection records and field observations.

FLOWER RECORDS: *Asclepias* sp., *Linaria vulgaris*, *Melilotus officinalis*, *Pastinaca sativa*, *Solidago* spp.

COLLECTION DATES: 140 specimens, 11 June to 25 September. The majority of dates are from mid-June to mid-August.

sericea Murray 1940. (Fig. 14). A wide-ranging, western North American species (Krombein 1979), *P. sericea* reaches its easternmost limit in Michigan. It has a shoreline dunes distribution within the state. No inland records have been found.

BIOLOGY: At Warren Dunes State Park (Berrien Co.), females were flying along old dune crests overgrown with herbaceous vegetation. Prey are presumed to be noctuids, as Hicks (1933) listed *Homoptera salicis* Behr and *Zale lunata* (Drury) as prey in California.

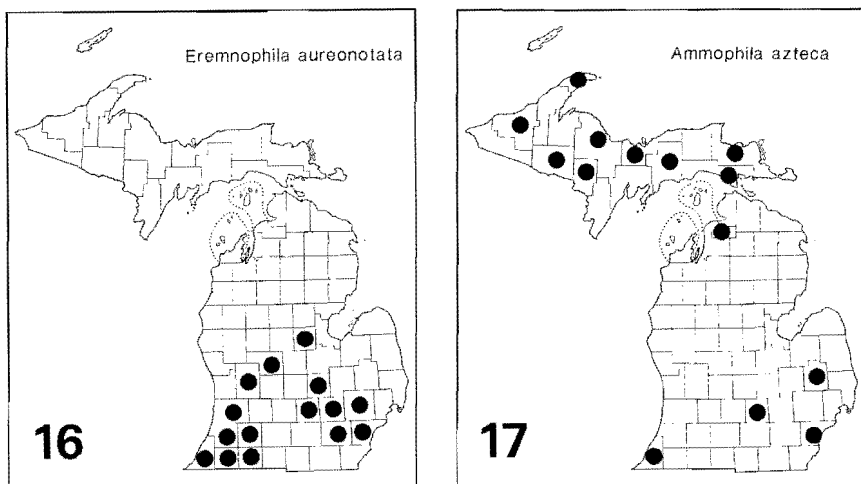
FLOWER RECORDS: *Euphorbia corollata*.

COLLECTION DATES: 25 specimens, 3 July to 23 August.

violaceipennis (Lepelletier) 1845. (Fig. 15). A predominantly eastern North American species, *P. violaceipennis* is widespread in Michigan, being common in the LP.

BIOLOGY: *Podalonia violaceipennis* nests in coarser sand and heavier soil than the other three species listed above. Nests are often dug in proximity to small clumps of vegetation. One nest from Washtenaw County (Half Moon Lake, 7 June) contained a *Lacinipolia* sp. (Noctuidae), and a nest from Marquette County (Huron Mtn. Club, 9 August) contained a larva of *Faronta diffusa* (Walker) (Noctuidae). The burrow diameters were 7.0 and 8.0 mm, respectively. Burrow lengths were 1.5 and 3.0 cm, while the cells measured 1.6 and 2.1 cm deep, respectively.

FLOWER RECORDS: *Daucus carota*, *Erigeron philadelphia*, *Galium triflorum*, *Solidago juncea*, *S. nemoralis*, *Solidago* spp.



COLLECTION DATES: 204 specimens, 1 June to 5 October. Most dates are in July and August.

Genus *EREMNOPHILA* Menke

aureonotata (Cameron) 1888. (Fig. 16). A member of a predominantly Neotropical genus, *E. aureonotata* extends from southern Canada to Central America (Krombein 1979). In Michigan, it has been found in the central and southern LP, but is not commonly collected.

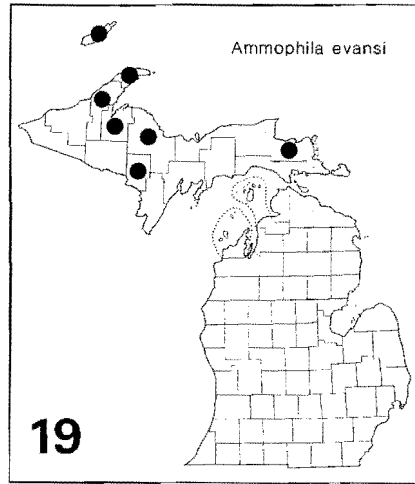
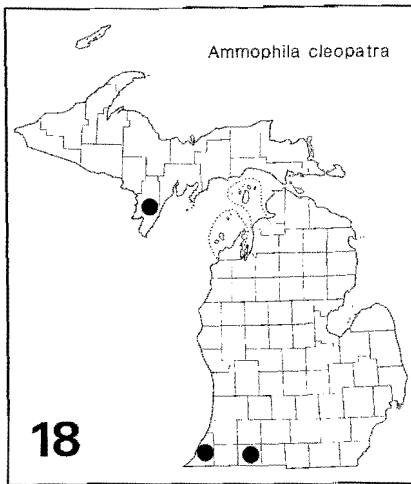
BIOLOGY: Nests are dug in sandy or loamy soils, and are provisioned with a single, large caterpillar. Nests are simple and unicellular like those of other Ammophilini. Females are often seen searching among the leaves of oaks for prey. Krombein (1979) listed *Heterocampa guttivitta* (Walker) and an unknown hesperiid larva as prey.

COLLECTION DATES: 59 specimens, 24 June to 16 September. Most dates range from late July to mid-August.

Genus *AMMOPHILA* Kirby

azteca Cameron 1888. (Fig. 17). *Ammophila azteca* is distributed widely throughout North America, occurring as far north as the Yukon and south to Mexico (Krombein 1979). In Michigan, it is primarily found in the UP and NLP and only rarely collected in the SLP, probably because it is a montane and northern species.

BIOLOGY: Females often maintain several nests simultaneously using progressive provisioning. The simple, shallow, one-celled nest has a vertical burrow and may contain up to nine prey. A variety of naked arboreal caterpillars in the families Gelechiidae, Geometridae, Spingidae, and Tenthredinidae have been recorded as prey (Powell 1964, Evans 1965). My own observations at the Huron Mountain Club (Marquette Co., 29 July–4 Aug. 1984, 3–9 Aug. 1985, 21–28 June 1986) revealed *A. azteca* utilizing pierid larvae, *Faronta diffusa* (Walker), *Pseudeletia unipunctata* (Haworth) and *Morrisonia confusa* (Hübner) (Noctuidae), undetermined Noctuidae, *Plathypena scabra* (F.) (Geometridae), undetermined Geometridae; and *Orgyia antiqua* (L.) (Lymantriidae, a new prey family). The prey were captured on bracken fern, clover (*Trifolium*), or other low herbage and flown to the nest after being immobilized. Nests are temporarily closed between provisioning trips.



FLOWER RECORDS: *Daucus carota*, *Rubus* spp., *Solidago* spp., *Tanacetum vulgare*.
 COLLECTION DATES: 160 specimens, 17 June to 28 September, with most dates from mid-July to mid-August.

cleopatra Menke 1964. (Fig. 18). Another transcontinental species, *Ammophila cleopatra* is primarily found in the western and montane regions of North America (Krombein 1979), but in Michigan it is apparently restricted to dune areas bordering Lake Michigan.

BIOLOGY: *A. cleopatra* has been found near areas where young oaks have taken hold on stabilized dunes and near the peripheries of blowouts at Warren Dunes State Park (Berrien Co.). Evans (1959) found wasps nesting in restricted areas of sand near oaks in Kansas, and recorded Notodontidae and Noctuidae as prey. One species of prey, *Macrurlocampa marthesia* (Cramer) was an oak feeder. One or two larvae are used to provision the simple nest which is temporarily closed between provisioning trips.

FLOWER RECORDS: *Euphorbia corollata*.

COLLECTION DATES: 12 specimens, 1 July to 5 September.

evansi Menke 1964. (Fig. 19). This species is apparently restricted to eastern North America (Krombein 1979, Finnamore 1982). In Michigan, it is found only in the UP and Isle Royale, where exposed rocky outcrops occur (O'Brien and O'Brien 1988).

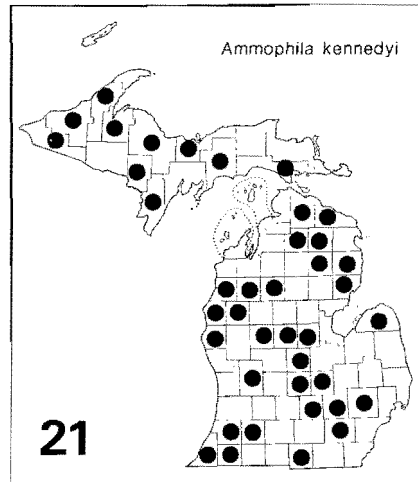
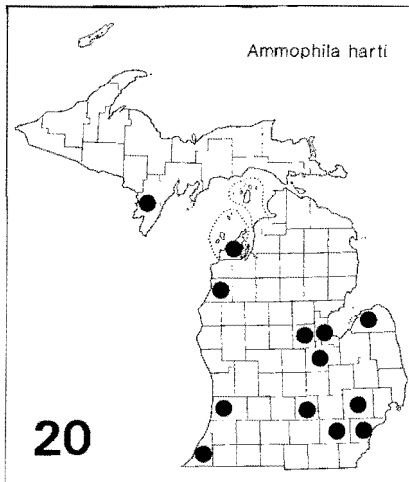
BIOLOGY: Females nest in pockets of loamy soil nestled among vegetation on outcrops of exposed rock. The burrow is temporarily closed while the wasp is off hunting. A single large, noctuid larva (*Zale* sp.) is placed in the shallow burrow (O'Brien and O'Brien 1988).

FLOWER RECORDS: *Rhus glabra*, *Rubus idaeus*, *Solidago hispida*.

COLLECTION DATES: 25 specimens, 9 June to 17 August.

harti (Fernald) 1931. (Fig. 20). Another widespread species, *Ammophila harti* is distributed from Vermont to Alberta and south to Texas (Krombein 1979). In Michigan, its scattered distribution pattern matches the occurrence of sand dunes and blowouts (see fig. IX-20 in Dorr and Eschman 1970).

BIOLOGY: An oblique burrow is prepared in open sand and is progressively provisioned over several days. Females may maintain several nests simultaneously, providing mostly small caterpillars of the families Noctuidae, Geometridae, Pyralidae,



and Gelechiidae, which are carried in flight to the nest (Evans 1959, Hager and Kurczewski 1986). At Warren Dunes State Park I have usually associated *A. harti* with the same sites chosen by *Microbembex monodonta* Say, i.e., on dunes with scattered growths of the beach grass, *Ammophila arenaria*.

Hager and Kurczewski (1985a, 1985b) have also published on the male reproductive behavior of *A. harti* and its interactions with cleptoparasitic flies.

COLLECTION DATES: 70 specimens, 25 June to 28 September, with most dates in July and August. Hager and Kurczewski (1986) found this species to have two to three generations per year in central New York.

kennedyi (Murray) 1938. (Fig. 21). A species found throughout North America (Krombein 1979), *A. kennedyi* likewise occurs throughout Michigan.

BIOLOGY: Nothing has been published on the behavior of *A. kennedyi*. A member of the *urnaria* species-group, it probably shares similar ethological traits. Papers published on *A. urnaria* behavior prior to 1938 may have unknowingly included *A. kennedyi* due to their morphological similarity.

FLOWER RECORDS: *Melilotus alba*, *Solidago rigida*.

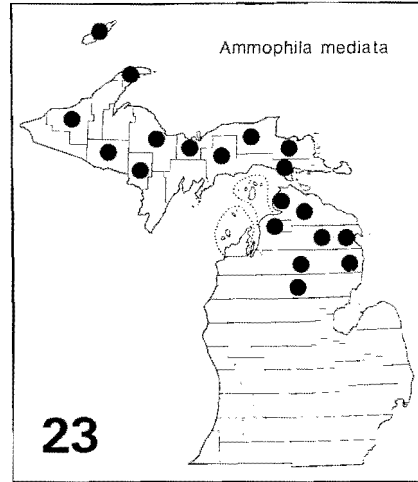
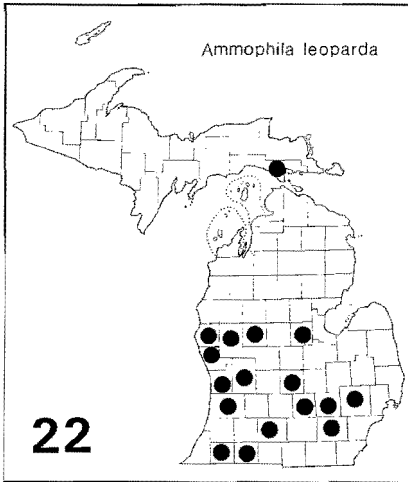
COLLECTION DATES: 100 specimens, 5 June to 8 October, with most dates in late July to early August.

leoparda (Fernald) 1934. (Fig. 22). This species occurs uncommonly in the eastern U.S. (Krombein 1979). In Michigan, it has been collected from scattered localities in the SLP.

BIOLOGY: Nothing has been reported about the habits of *A. leoparda*. One female was collected as she was flying close to the ground in a gravelly-sandy area with large amounts of clay. The soil was very hard and compacted (Washtenaw Co., Half Moon Lake).

COLLECTION DATES: 32 specimens, 14 June to 14 September, with most dates in late July and early August.

mediata Cresson 1865. (Fig. 23). A western, montane, and Canadian species, *A. mediata* is found as far north as the Yukon (Krombein 1979). In Michigan it occurs only in sandy plains dominated by *Pinus banksiana* on Isle Royale, the UP, and some areas of the NLP.



BIOLOGY: O'Brien and O'Brien (1988) studied *A. mediata* at the Huron Mountain Club, and found females nesting in Jack pine-dominated habitats. Nests were constructed in sandy soil, and were provisioned with a single large caterpillar, usually an arboreal noctuid or geometrid. Females temporarily closed the nest before hunting for prey. Females ran up and down branches of trees searching for prey. This was the most common species of *Ammophila* in Malaise traps from the Huron Mountains (O'Brien and O'Brien 1988).

FLOWER RECORDS: *Apocynum andraesifolium*, *Chrysanthemum leucanthemum*, *Galium triflorum*, *Solidago* spp.

COLLECTION DATES: 200 specimens, 13 June to 5 September. Most dates are in late June and early July.

nigricans Dahlbom 1843. (Fig. 24). This widespread eastern species has not been collected frequently in the state. Most records are from the SLP, with two specimens from Marquette County being the only records from the UP.

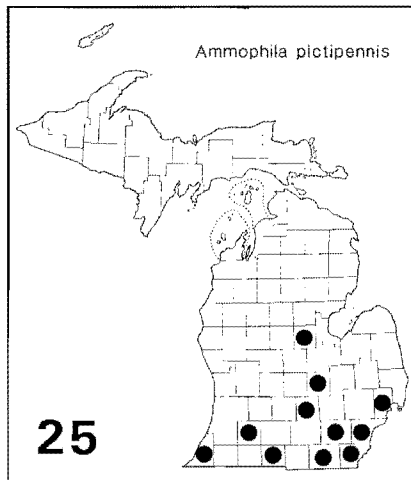
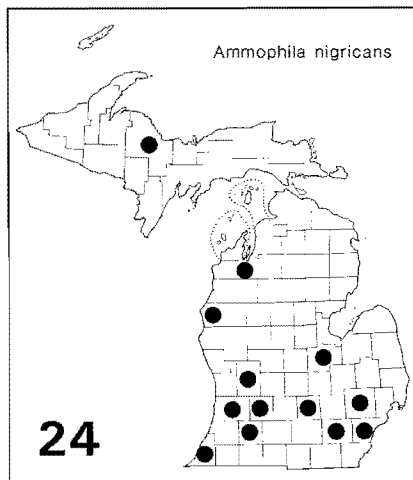
BIOLOGY: Nests are in sandy-clayey soil, the burrow being either oblique or vertical with a horizontal terminal cell. A single caterpillar, usually a noctuid, is used for provision the cell, with the genera *Catocola*, *Euparthenos*, and *Zale* reported as prey (Evans 1959, Krombein 1979).

COLLECTION DATES: 49 specimens, 17 June to 28 August, with most dates from mid-July to early August.

pictipennis (Walsh) 1869. (Fig. 25). This species occurs in the eastern U.S. with a few records from Mexico (Krombein 1979). In Michigan, it is found primarily in the southernmost three tiers of counties. It is never common, but further collecting should reveal a wider distribution in the SLP.

BIOLOGY: *Ammophila pictipennis* is similar to many *Podalonia* with regards to prey selection. Noctuid larvae, mostly cutworms, such as *Leucania unipuncta* (Haworth), *Agrotis c-nigrum* (L.), *Prodenia ornitogalli* Guenée, *Heliothis zea* (Boddie), and *Pholisora catullus* F., are placed singly in a shallow, unicellular nest. *Hilarella hilarella* Zetterstedt (Diptera: Sarcophagidae) is recorded as a parasite (Walsh and Riley 1869, Rau and Rau 1918, Krombein 1979).

COLLECTION DATES: 16 specimens, 14 June to 3 October.



procera Dahlbom 1843. (Fig. 26). Another transcontinental North American species, *A. procera*'s range extends into Guatemala (Krombein 1979). It is widespread over much of the LP of Michigan, with only one record from the UP. It is the largest and most conspicuous *Ammophila* in eastern North America.

BIOLOGY: Nesting takes place in small patches of firm sand that are often interspersed with shrubs and trees. Burrows may be oblique or vertical with a single, large caterpillar, usually a notodontid, in the cell. Wasps at the ESGR (Livingston Co.) provisioned their nests with *Heterocampa manteo* (Doubleday) (Notodontidae). Krombein (1979) listed as prey *Nadata gibbosa* (Abbott), *H. manteo*, *H. astarte* Doubleday, *Datana* sp., *Schizura ipomoeae* (Doubleday), *Symmerista* spp. (all Notodontidae), *Smerinthus cerisyi* Kirby (Sphingidae), and Noctuidae spp. Because their prey are arboreal, the females are often found searching among the branches (especially oaks) several meters above the ground. Males can also be found among the branches where they may either be searching for mates or imbibing honeydew. Papers by Evans (1959) and Krombein (1953, 1958) contain the most extensive observations of *A. procera*.

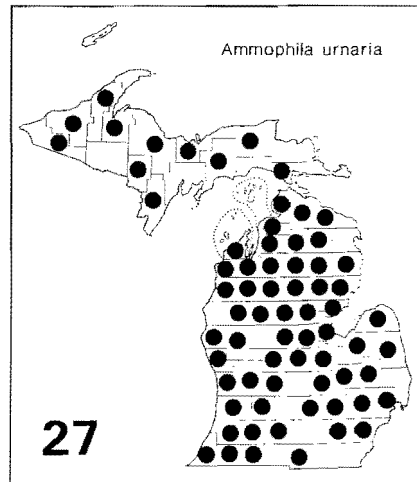
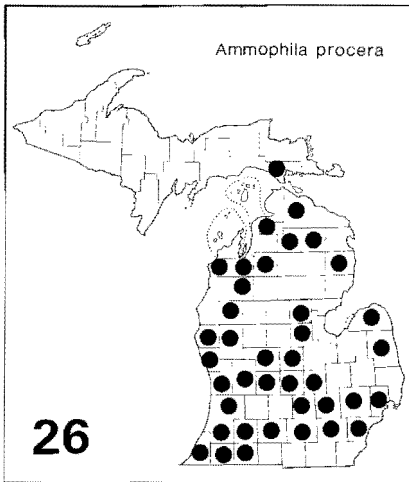
FLOWER RECORDS: *Asclepias tuberosa*, *Asclepias* sp., *Daucus carota*

COLLECTION DATES: 165 specimens, 17 June to 3 October, with most dates ranging from early July to mid-August.

urnaria Dahlbom 1843. (Fig. 27). Probably the commonest species of *Ammophila* in eastern North America, *A. urnaria* occurs from the eastern side of the Rocky Mountains to the Atlantic coast, from southern Canada to Florida (Menke 1965, Krombein 1979). Extremely widespread in Michigan, *A. urnaria* is the most often collected species of the genus.

BIOLOGY: Nests are excavated in firm, often pebbly soil in a variety of situations, such as waste areas, paths, gravel pits, and unpaved roads. Prey are located in low herbaceous vegetation, shrubs, and small trees that surround the nesting site. Small geometrid and noctuid larvae are captured, which the wasps often carry in flight to the nest. One to six prey are mass-provisioned in the cell at the end of the oblique or vertical burrow (Evans 1959, Powell 1964, pers. obs.)

FLOWER RECORDS: *Achillea millefolium*, *Chrysanthemum leucanthemum*, *Clematis*



virginiana, *Daucus carota*, *Erigeron philadelphia*, *Erigeron* spp., *Melilotus alba*, *Rubus* sp., *Solidago juncea*.

COLLECTION DATES: 600 specimens, 30 May to 1 October, with most dates in late July to mid-August. Collection records suggest that *A. urnaria*, like *A. harti*, may be bivoltine.

DISCUSSION

The distribution of species of sphecines in Michigan show that there are elements of four faunas: (1) Northern Transition zone, (2) Canadian, (3) Western Montane, and (4) Neotropical. Generally, wasps that occur throughout eastern North America (Northern Transition Zone) are found in Michigan, and are usually widespread within the state, or if restricted, are commonly found in the appropriate habitats, such as *A. harti* on dune areas. Since Michigan has few natural barriers to hamper the movement of insect populations (i.e., mountain chains), it should not be surprising to find many species widely distributed within the lower peninsula.

Members of what I call the "western-montane" fauna are those species that exist in the western states and montane areas, but are found at northern latitudes east of the Rocky Mountains. Prime examples of this type of distribution are *Ammophila mediata*, *A. cleopatra*, *Palmodes dimidiatus*, *Podalonia sericea*, and non-sphecine wasps, such as *Tachysphex aethiops* (Cresson) (O'Brien 1987). Some of these, such as *A. mediata*, can also be considered boreal in distribution, and good examples of species best exhibiting a Canadian or boreal faunal association are *Ammophila azteca*, *Podalonia luctuosa*, and *P. robusta*. Steiner (1973) found these species as far north as the Northwest Territories and Yukon, and in Michigan they are quite widespread in the UP and northern LP, but rare in the central and southern parts of the state.

Some genera that occur only in the southernmost part of the state, such as *Podium* and *Eremnophila* are predominantly tropical in origin, and appear to have reached there the limit of their northward distribution. In the case of *Sphex*, a widespread genus, their northward distribution appears to be determined by the presence of appropriate tettigoniid prey. Species more commonly associated with the southeastern U.S., such as *Ammophila*

nigricans and *A. pictipennis*, are likewise found in the southern tiers of Michigan counties.

Faunal composition changes over time, especially as habitats are changed or destroyed. Therefore, there are some species in threatened habitats that deserve further study. Two such species in Michigan, *Ammophila cleopatra* and *Podalonia sericea*, occur in dune habitats along Lake Michigan, and are recorded from only a few localities. Although they are widespread west of the Rockies, Michigan is their easternmost limit. Intensive searching may reveal a wider distribution, but little is really known of the habits of these wasps in Michigan. Most other species of sphecines occupy habitats that are more or less regularly disturbed. Some species, such as *A. urnaria*, may actually increase their distribution or populations when new nesting areas are created (e.g., gravel pits or dirt roads). Synanthropic species, such as *Sceliphron caementarium*, have probably also increased in abundance and have certainly widened their distribution as a result of human activities.

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