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HABITAT DISTRIBUTION OF THE SHORE FLIES OF NORTHEASTERN OHIO (DIPTERA: EPHYDRIDAE)[1, 2]

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ABSTRACT

A study of the habitat distribution of 68 species of shore flies (Ephydridae) was carried out in northeastern Ohio between April of 1968 and November of 1969. Ten ephydrid habitats were recognized: mud-shore, sand-shore, grass-shore, limnic-wrack, marsh-reed, sedge-meadow, floating-vegetation, floating-algal-mat, rain-pool, and salt-pool habitats. The mud shore contained the greatest diversity of Ephydridae, whereas the salt-pool habitat produced the largest populations. The floating algal mat possessed the fewest number of species, as well as the least number of individuals.

Three species were recorded from Ohio for the first time: *Atissia litoralis* (Cole), *Ephydra cinerea* Jones, and *E. niveiceps* Cresson. A listing of all species collected, together with information on habitat from which taken, abundance, and relation of data to other published material, is also included.

INTRODUCTION AND METHODS

Although the taxonomy and adult morphology of the ephydrid flies have been studied intensively, relatively little attention has been given to understanding their ecological requirements. The different species occur in an amazing diversity of aquatic and semi-aquatic habitats and have been highly successful in invading unusual environments not tolerated by most other species of Diptera. They have elicited considerable interest because of their abundance in highly alkaline and saline waters, such as those found in many areas of our arid west. They are also well represented in hot and cold mineral springs. Larvae of one species thrive in California oil pools.

Those ephydrids that have become adapted to apparently unfavorable habitats naturally have generated the greatest curiosity, but there are numerous other species that are prominent components of freshwater environments. Ohio has relatively few of the more bizarre aquatic situations, but does possess a goodly array of wetland habitats that support large and diverse ephydrid faunas. Our study was aimed at locating and describing the ephydrid habitats existing in northeastern Ohio and analyzing the ecological preferences of the shore-fly species occurring in this part of the state.

The most comprehensive study of shore-fly ecology is that of Dahl (1959), who has investigated the natural history and habitat distribution of the Scandinavian species. The only published work on the habitat preferences of North American Ephydridae was carried out in Iowa by Deonier (1964). There are no papers dealing specifically with the ecology of Ohio shore flies.

Northeastern Ohio is considered, in this paper, to include the following counties: Ashland, Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Mahoning, Medina, Portage, Stark, Summit, Trumbull, and Wayne. However, most of the collecting effort was concentrated in localities in or near Portage County; very few trips were taken to the counties bordering Lake Erie. Habitats sampled quantitatively were selected only after careful study of the papers by Dahl (1959) and Deonier (1964) and after intensive preliminary collecting in the area. The numerous sites selected for subsequent quantitative sampling are scattered widely enough, we believe, to give representative data that can be applied to all of northeastern Ohio.

Collecting localities were sampled approximately 30 minutes each at least once

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every 8 to 10 days during the warm season between April of 1968 and early November of 1969. Adults were obtained by sweeping the habitats with a standard aerial insect net. Specimens were then transferred to the laboratory where they were killed, pinned, and labelled for subsequent determination. Larvae and puparia were taken by examining samples of different substrates (mud, algal mats, masses of decaying vegetation, etc.) collected from the habitats. Some of these immature individuals were subsequently reared to the adult stage in the laboratory. Whenever feasible, guts of a sample of the field-collected larvae were examined shortly after their collection for information on material being ingested.

DESCRIPTIONS OF EPHYDRID HABITATS

Ten major shore-fly habitats are recognized in northeastern Ohio, on the basis of this study, although the differences between them frequently are slight and hard to describe. Habitats generally do not exist as easily recognized and distinctive units, but rather merge gradually one with another in space. Though these habitats are admittedly somewhat arbitrary, their recognition appears to us to be of value in understanding the ecological role of the ephydrid species occurring in this section of Ohio.

Mud-Shore Habitat

(fig. 1)

This is a highly unstable habitat located along muddy shores of lakes, rivers, and streams that are characterized by repeated inundation. It contains a high content of organic matter, large amounts of finely divided detritus, and an abundant microflora of yeasts, bacteria, diatoms, and unicellular Cyanophyta and Chlorophyta. Later in the summer, at least by mid-August, the mud shore is invaded by such pioneer plants as hydrophilic grasses, so that it gradually changes to a grass-shore habitat. The ephydrid fauna undergoes concomitant changes, and becomes dominated by species more typical of the grass shore.

The mud shore supported the largest and most diverse ephydrid fauna of the 10 habitats recognized in this study. It was ideally suited for those shore-fly larvae that filter out microorganisms from a semi-liquid medium. Species commonly found in this habitat were: *Discocerina obscurella* (Fallén), *Parydra aguila* (Fallén), *P. quadrituberculata* Loew, *Scatella picea* (Walker), and *Coenia curvicauda* (Meigen).

Sand-Shore Habitat

(fig. 2)

The sand shore is formed as water recedes along the more exposed shores of lakes, rivers, and streams. It is somewhat more stable than the mud shore, and is characterized by a substrate consisting of fine to coarse sand, a relatively low content of organic matter, an abundant microflora of algae and bacteria, and a sparse macroflora. The particle sizes of the substrate components are distinctly larger than those composing the mud shore. As summer advances, the sand shore is invaded by flowering plants and gradually changes to a grass-shore habitat. Accompanying the alteration of the habitat is a corresponding change in the composition of the ephydrid fauna.

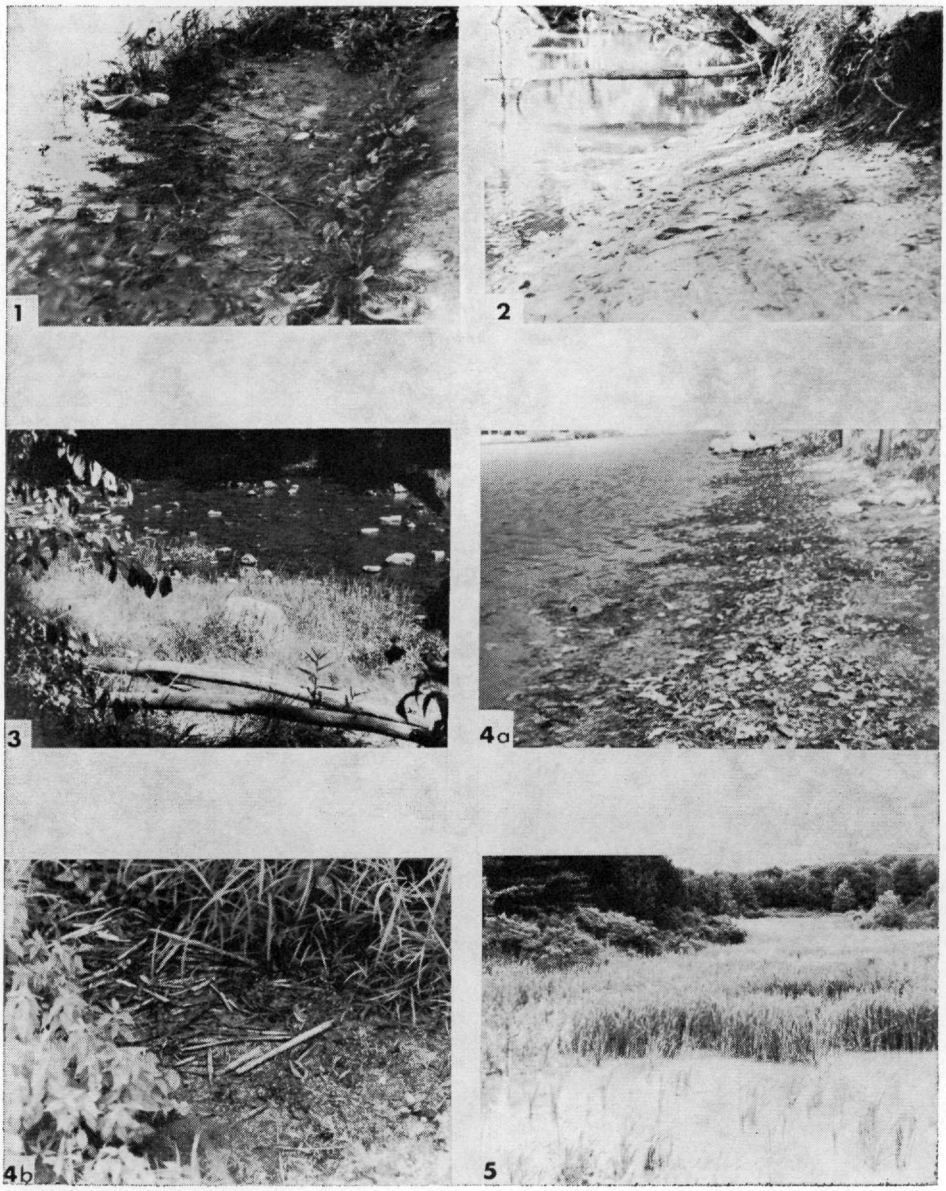
Species of Ephydridae repeatedly found on the sand shore were: *Parydra aguila*, *Ochthera mantis* (De Geer), and *Scatella obsoleta* Loew.

Grass-Shore Habitat

(fig. 3)

The habitat consists of the grass-covered shores of streams, lakes, and ponds. It is usually permanent in places during the entire year and in other places appears as mud and sand shores are invaded by grasses and other higher plants in mid- to

late summer. Plants typical of the grass-shore include *Leersia oryzoides* (L.) Swartz (Cut Grass), *Glyceria striata* (Lam.) Hitchc. (Manna Grass), *Carex lurida* Wahl. (Sedge), *Eleocharis smallii* Britt. (Spike Rush), *Polygonum hydropiper* L. (Water Pepper), and *Bidens cernua* L. (Beggar's Ticks). Other species found at one time or another in the grass-shore habitat were: *Echinochloa crusgalli* (L.) Beauv. (Barnyard Grass), *Ranunculus septentrionalis* Poir. (Swamp Buttercup),



FIGS. 1–5. Ephydrid habitats of northeastern Ohio. 1, mud-shore; 2, sand-shore; 3, grass-shore; 4a, limnic-wrack composed mostly of filamentous algae and pondweeds (*Potamogeton* spp.); 4b, limnic-wrack composed mostly of decaying cattail (*Typha latifolia*); 5, marsh-reed.

Impatiens capensis Meerb. (Jewel Weed), and *Polygonum sagittatum* L. (Tear Thumb).

Shore flies typical of the grass shore were *Discocerina obscurella*, *Hydrellia griseola* (Fallén), *Notiphila olivacea* Cresson, and *N. scalaris* Loew.

Limnic-Wrack Habitat

(fig. 4)

This habitat consists of varying quantities of wet, decaying plant materials lying on the shores of lakes and ponds. It is formed by an accumulation of aquatic and semi-aquatic organic material from plants that have been uprooted by repeated freezing and thawing during the spring months. Strong wave action then washes the mass of roots, stems, and leaves onto shore, where it undergoes decomposition. In some areas, this accumulation, the "limnic-wrack," is present throughout the year, but elsewhere it lasts for only a few weeks before being washed away by renewed wave action. The main floral constituents of the wrack are decaying remains of *Typha latifolia* L. (Broad-leaved Cattail), *Scirpus validus* Vahl (Bulrush), *Potamogeton* spp. (Pondweeds), and *Lemna minor* L. (Common Duckweed), along with tangled masses of blue-green and green filamentous algae. In addition, a rich microflora of bacteria, yeasts, and unicellular algae quickly forms a slimy film over the decomposing plant material.

Species of Ephydridae typical of the limnic-wrack habitat were *Discocerina obscurella* and *Dichaeta caudata* (Fallén).

Marsh-Reed Habitat

(fig. 5)

The marsh-reed habitat is considered to be synonymous with the reed-swamp stage of the hydrosere succession (Weaver and Clements, 1938) and the marsh-reed habitat of Deonier (1964). It is an intermediate zone between strictly aquatic and strictly terrestrial vegetation types. The substrate varies from water-saturated soil to soil covered by a few inches or a few feet of water. The dominant plant frequently is the Broad-leaved Cattail. Other plant species commonly found in this habitat are: *Typha angustifolia* L. (Narrow-leaved Cattail), *Scirpus validus*, *Leersia oryzoides*, *Eleocharis calva* Torrey, *Sparganium eurycarpum* Engelm. (Bur Reed), *Asclepias incarnata* L. (Swamp Milkweed), and *Lycopus americanus* Muhl. (Water Horehound). Large amounts of decaying vegetation float on the water surface, and there is a large and diverse microflora of bacteria, yeasts, and algae.

Shore flies collected commonly in this habitat included: *Notiphila vittata* Loew, *Dichaeta caudata*, *Hydrellia griseola*, and *Parydra breviceps* Loew.

Sedge-Meadow Habitat

(fig. 6)

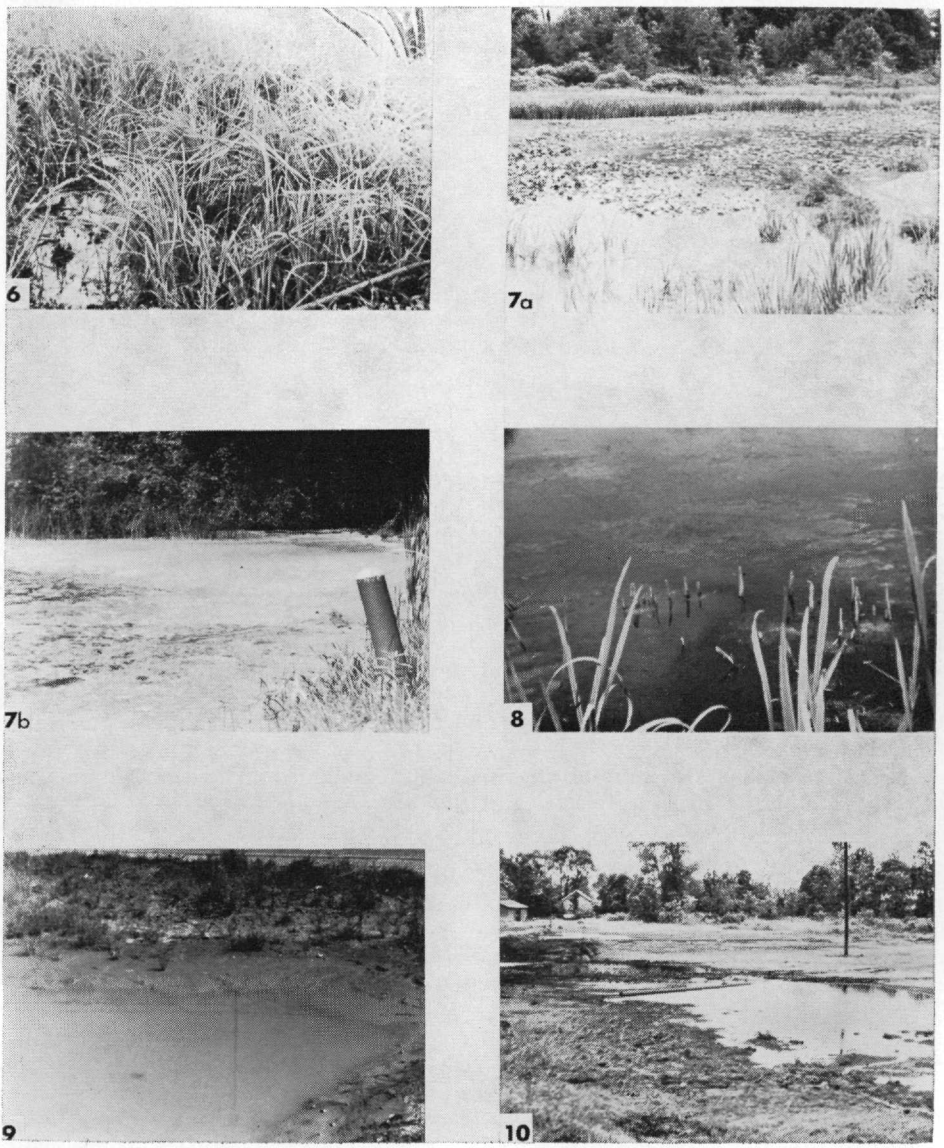
This, the most stable of the 10 habitats sampled, is considered to be synonymous with the sedge-meadow stage of the hydrosere succession of Weaver and Clements (1938). Although somewhat similar to the grass-shore habitat in terms of substrate and amounts of decaying vegetation present, the sedge meadow is not restricted to shoreline situations and contains a different array of plant species. The macroflora is dominated by various coarse sedges, especially *Carex lurida*, *C. bromoides* Schkl., *C. vulpinoides* Michx., and *C. cristatella* Britt. Other plant species commonly encountered are: *Juncus effusus* L. (Common Rush), *Glyceria striata* (Manna Grass), *Scirpus cyperinus* (L.) Kunth. (Wool Grass), *Impatiens capensis*, *Eupatorium perfoliatum* L. (Boneset), and *Solidago patula* Muhl. (Goldenrod).

Species of Ephydridae typical of the sedge meadow were *Discocerina obscurella*, *Notiphila scalaris*, and *Lytogaster excavata* (Sturtevant and Wheeler).

Floating-Vegetation Habitat

(fig. 7a, 7b)

This habitat is considered to be identical with the floating-vegetation stage of the hydrosere succession of Weaver and Clements (1938) and, in aspect at least, with the floating-vegetation habitat of Deonier (1964). The macroflora consists primarily of *Nuphar advena* (Ait.) Ait. f. (Spatterdock), *Alisma subcordatum* Raf. (Water Plantain), *Lemna minor*, *Spirodela polyrhiza* (L.) Schleiden (Giant Duck-



FIGS. 6–10. Ephydrid habitats of northeastern Ohio. 6, sedge-meadow; 7a, floating-vegetation composed mostly of spatterdock (*Nuphur advena*); 7b, floating-vegetation composed mostly of various species of duckweeds (*Lemna*, *Spirodela*, *Wolfia*); 8, floating-algal-mat; 9, rain-pool; 10, salt-pool.

weed), and *Wolffia* sp. (Small Duckweed). Wholly submerged plants are abundant beneath the floating species, with *Potamogeton crispus* (L.) (Pondweed), *P. foliosus* Raf., *Elodea canadensis* L. (Water Weed), *Ceratophyllum* sp. (Hornwort), and *Myriophyllum exalbescens* Fernald (Water-milfoil) being particularly abundant.

The genus *Hydrellia* dominated the ephydrid fauna in the floating-vegetation habitat, particularly *H. formosa* Loew and *H. procteri* Cresson.

Floating-Algal-Mat Habitat

(fig. 8)

Although these floating mats are composed primarily of intermingled masses of filamentous, colonial, and unicellular algae, duckweeds and fragments of decaying leaves and stems are present also. Algal genera commonly found in the mats are *Ulothrix*, *Oedogonium*, *Rhizoclonium*, *Spirogyra*, *Nostoc*, *Aphanocapsa*, and several groups of diatoms.

Both species abundance and diversity were low in this habitat; only *Hydrellia formosa* and *H. harti* were found consistently.

Rain-Pool Habitat

(fig. 9)

This is the most unstable and ephemeral habitat of those investigated in this study. It consists of small temporary pools and shallow puddles that form in slight depressions along roadsides, in construction sites, and in other low or disturbed areas after heavy rains. The pools usually disappear within a few days, although many re-form every few weeks due to summer storms. There is little macrovegetation (mostly scattered grasses and weedy annuals), but a rich and diverse microflora of unicellular algae and saprophytic microorganisms quickly develops once the pools come into existence.

Discocerina obscurella, *Parydra breviceps*, *Hydrellia griesola*, and *Ephydra riparia* Fallén were the most commonly encountered shore flies in this habitat.

Salt-Pool Habitat

(fig. 10)

This habitat consists of several small pools of saline water formed by drainage from a large brine storage pond on the property of the Morton Salt Plant in Rittman (Wayne County). The pools differ greatly in surface area and depth, varying from a few feet in extent and no more than an inch or so in depth to sizeable ponds covering about a quarter of an acre and having a depth of from two to three feet. The concentration of dissolved salts varies greatly also, being very low in early summer due to the influx of fresh water from spring rains, and becoming distinctly higher than the concentration in sea water during late summer and early fall as the water evaporates.

The shorelines are generally muddy and support relatively little macrovegetation because of the heavy salt concentration. Such halophilic forms as *Salicornia rubra* A. Nels (Glasswort) and *Atriplex argentata* Nuttall (Silverscale) are the dominant species. There is an abundant microflora of saline-tolerant bacteria, yeasts, and unicellular algae. Algal genera commonly found in the salt pools are *Navicula*, *Dunaliella*, *Cymbella*, *Porphyridium*, *Oscillatoria*, *Rhizoclonium*, *Closteriopsis*, *Euglena*, and *Spirulina*.

The shore-fly fauna was very restricted, although the few species that did occur were generally present in large numbers. *Ephydra cinerea* Jones and *E. riparia* were exceedingly abundant, and their puparia frequently formed conspicuous windrows along the shores. *Atissa litoralis* (Cole) and *Lamproscatella dichaeta* (Loew) were present in lesser numbers, although floating puparia of the former species occasionally became abundant.

HABITAT DISTRIBUTION OF THE EPHYDRIDAE

According to Wirth (1965), some 347 species of Ephydridae are known from America north of Mexico. We found 68 species and 39 genera of all four recognized subfamilies during our study of the shore flies of northeastern Ohio. A further indication that this part of the state is relatively rich in its ephydrid fauna is the fact that Deonier (1964) reported only 100 species for all of Iowa.

Each species collected in this survey is listed below, together with information about the habitats in which it was found, its relative abundance in these habitats, and the relation of these new data to previously published material. The relative abundance of each species in each habitat is given in words, which are interpreted, as given below, to represent the percentage of adults of a single species in the total number of ephydrid specimens collected in a particular habitat. For example, if 10 adults of *Notiphila carinata* Loew were collected in a sedge-meadow habitat that produced a total of 220 ephydrid specimens, then that species would have a percentage ranking of 4.5 and would be considered as being "occasional" in that habitat.

rare (r)—1–2%
occasional (occ)—3–8%
common (c)—9–14%
abundant (a)—15–25%
very abundant (va)—26%+

The arrangement of species followed below is that of the recently published Diptera catalog (Wirth, 1965). Voucher specimens are deposited in the Kent State University collection.

Psilopinae

Athyroglossa granulosa (Cresson). Limnic wrack, c; mud shore, occ; grass shore, r; rain pool, r. Adults of this widely distributed species were collected from mid-April until late August on shorelines near the water's edge. Deonier (1964) reported this to be a rare species in Iowa in the limnic-wrack and sand-shore habitats.

Athyroglossa ordinata Becker. Grass shore, r. Only a single specimen of this species was taken in late August. Deonier (1964) found adults in the sand-shore and stream-rocks habitats in Iowa.

Atissa litoralis (Cole). Salt pool, c. Numerous adults were reared from floating puparia collected at the Rittman salt pools during September. This species formerly was considered to be a scarce inhabitant of western saline lakes (Sturtevant and Wheeler, 1954), and the collection of this species at Rittman constitutes a new state record and extends its known range considerably eastward (Scheiring and Foote, 1970).

Ptilomyia enigma Coquillett. Marsh reed, r. Only a single adult was taken on floating debris of a small cattail marsh near Rittman in Wayne County during early September.

Pseudohecamede sp. (*abdominalis* Williston ?). Grass shore, r. The single adult of this undetermined species was collected in early May near Kent, Ohio. Deonier (1964) reported that *P. abdominalis* is a rare species in Iowa in sedge-meadow and limnic-wrack habitats.

Allotrichoma sp. (*simplex* (Loew) ?). Grass shore, c; mud shore, occ. Adults of the genus *Allotrichoma* are very difficult to determine to species. Our specimens were taken from moist substrates between early May and late August and were particularly abundant during the month of May. The immature stages of the Nearctic species are unknown, but a species in Guam was reared from larvae found in mud containing pig manure (Bohart and Gressitt, 1951).

Discocerina obscurella (Fallén). Mud shore, va; limnic wrack, va; rain pool, va; floating vegetation, va; sedge meadow, va; grass shore, a; sand shore, c; cattail marsh, occ. This is probably the most common and widespread ephydrid known from Ohio. Adults were found abundantly in a great range of habitats from early April to late October and became particularly noticeable after late June on exposed shores. The larvae apparently preferred moist rather than wet substrates and usually were found in surface mud or sand at some distance from the water. They fed mostly on bacteria, yeasts, and unicellular green algae (Eastin, 1970).

Hydrochasma buccatum (Cresson). Sand shore, r. Only a few adults of this apparently rare species were collected in late August. Deonier (1964) reported it to be an uncommon inhabitant of mud- and sand-shore habitats in Iowa.

Diclasiopa lacteipennis (Loew). Mud shore, r; rain pool, r. All adults were taken close to the water's edge during August, although less than five specimens were taken on any one day in any one collecting site. In contrast, Deonier (1964) found this to be a common species in Iowa on sand and mud shores.

Ditrichophora sp. Marsh reed, occ. Adults of this undetermined species were collected in mid-April and again in mid-September. Nothing is known of the immature stages.

Polytrichophora orbitalis (Loew). Marsh reed, r. The only record obtained for this species was from an adult that was reared from a puparium found floating near shore in mid-April. This is a common species in Iowa mud- and sand-shore habitats (Deonier, 1964).

Psilopa dupla Cresson. Marsh reed, r. Adults were collected only in mid-September, although Deonier (1964) reported it from July through September in Iowa sedge-meadow and *Eragrostis* habitats.

Leptopsilopa atrimana (Loew). Limnic wrack, c. Adults were collected between mid-April and late May. Deonier (1964) found this species in the marsh-reed, sedge-meadow, and *Eragrostis*-mat habitats in Iowa. Interestingly, the junior author has found adults of this species abundantly in a flower bed of chrysanthemums in the city of Tucson, Arizona. The larvae developed in the laboratory on a diet of decaying lettuce, although they probably were utilizing primarily saprophytic microorganisms.

Trimerina madizans (Fallén). Sedge meadow, r. All adults were taken in May, although in Montana the junior author found specimens in sedge marshes in July and August. In Montana, eggs were found on the egg-cocoons of some marsh-inhabiting spiders, and the larvae preyed on the developing spider eggs. Up to five puparia were found in one cocoon. The larval feeding habits have been discussed briefly by Becker (1926).

Notiphilinae

Typopsilopa atra (Loew). Sedge meadow, c; rain pool, c. Specimens were taken in May, July, and October. Larvae in laboratory rearings fed on such saprophytic microorganisms as yeasts and bacteria. The life cycle was completed in 15 to 20 days.

Hydrellia crassipes Cresson. Floating vegetation, r. Only two specimens were taken in early June. Deonier (1971) reared adults taken from the rush *Juncus debilis* Gray in North Carolina.

Hydrellia formosa Loew. Floating vegetation, occ; floating algal mat, occ; mud shore, r; limnic wrack, r. Although never abundant, this species was the dominant

ephydrid in the floating-vegetation and floating-algal-mat habitats. Adults were seen walking about on the sodden mats and rarely flew, even when disturbed.

Hydrellia griseola (Fallén). Grass shore, va; sedge meadow, c; rain pool, c; floating vegetation, c; floating algal mat, c; mud shore, occ; sand shore, occ; limnic wrack, occ; marsh reed, occ; salt pool, r. Adults of this ubiquitous species were found in every habitat sampled between mid-May and late September. The larvae are known to be leaf miners in numerous species of hydrophilic grasses and can be serious economic pests in rice-growing areas (Grigarick, 1959; Deonier, 1971).

Hydrellia harti Cresson. Floating algal mat, occ; sedge meadow, r; floating vegetation, r. Adults were collected between mid-June and late August.

Hydrellia ischiaca Loew. Grass shore, r. The single adult taken during the study was obtained in late July. Deonier (1964) considered this species to be rare in Iowa, occurring in the floating-vegetation, sedge-meadow, and limnic-wrack habitats. He also reported (Deonier, 1971) that the larval host plants are grasses of the genera *Zizania* and *Glyceria*.

Hydrellia procteri Cresson. Floating vegetation, r; marsh reed, r. All adults were collected in July.

Hydrellia tibialis Cresson. Limnic wrack, r. Only one adult was taken in mid-August. Deonier (1964) listed this species as very abundant in the sedge-meadow habitat in Iowa. Adults have been reared from larvae infesting *Eleocharis obtusa* (Willd.) Schultes in Iowa (Deonier, 1971).

Hydrellia sp. Sedge meadow, r. One male of this apparently new species was taken on July 17, 1969, while sweeping in a wetter portion of a sedge meadow located just east of Kent.

Philygria debilis Loew. Grass shore, r. A few adults were taken during early April in a fairly tall stand of hydrophilic grasses. Deonier (1964) listed this species as uncommon in the sedge-meadow, marsh-reed, and limnic-wrack habitats in Iowa. Sturtevant and Wheeler (1954) reported that it is usually taken in habitats drier than those preferred by most ephydrid species.

Nostima scutellaris Cresson. Sedge meadow, r. Fewer than 10 specimens were collected in mid-June in a large marsh located 4.5 miles east of Kent.

Ilythea spilota (Curtis). Mud shore, c; limnic wrack, occ; grass shore, occ; rain pool, occ; marsh reed, occ. Adults were taken regularly from early April to early October on shorelines at varying distances from the water's edge. They were usually associated with substrates having a high content of organic material. Although numerous eggs were obtained from caged adults, no larval feeding occurred on the decaying organic matter provided. The eggs are distinctive in that they possess a slender filament projecting from the dorsal surface at mid-length.

Zeros flavipes (Williston). Marsh reed, occ. All adults were collected in mid-September. Deonier (1964) considered this species as occasional in sedge-meadow and mud-shore habitats in Iowa, where he collected specimens during July and August.

Notiphila carinata Loew. Cattail marsh, occ; sedge meadow, occ. Adults were taken fairly regularly between mid-July and mid-September, the period during which emergent vegetation is best developed in northeastern Ohio. The larvae probably are scavengers in oxygen-poor bottom muds surrounding the roots of hydrophilic plants.

Notiphila loewi Cresson. Floating vegetation, occ. All adults were taken during July. Berg (1950) found larvae of this species attached by their sharply pointed spiracular spines to the roots of two species of *Potamogeton*.

Notiphila olivacea Cresson. Sedge meadow, occ; grass shore, r. Specimens were taken between mid-June and late July. Deonier (1964) recorded this species as common in Iowa in the marsh-reed and limnic-wrack habitats.

Notiphila riparia Meigen. Marsh reed, c. Several adults were taken during late June and early July. Houlihan (1969) described the process by which the larvae tap intercellular air spaces within the roots of hydrophilic plants.

Notiphila scalaris Loew. Grass shore, va; sedge meadow, va. This species was taken in June and July and was most abundant in early July. It is a common form in the marsh-reed and limnic-wrack habitats in Iowa (Deonier 1964). Adults held in breeding jars oviposited repeatedly on the lower surfaces of blades of various grasses. Shortly after hatching, the larvae moved down into the mud surrounding the grass rootlets. However, we did not observe feeding, and all larvae died within a few days. A few nearly mature larvae were found in nature in organic-rich mud surrounding the roots of hydrophilic grasses.

Notiphila vittata Loew. Grass shore, c; sedge meadow, c; marsh reed, c; limnic wrack, c; floating vegetation, occ. This species showed the widest habitat distribution of the six species of *Notiphila* collected in our study. Adults were taken from mid-June to early September. Eggs were laid in groups of 23 to 25, in rows of four to seven, on the underside of grass blades in the laboratory breeding jars. Larvae moved down into the mud and rotting vegetation forming a substrate in the jars, but no feeding was observed. However, a few other larvae were reared to the second instar on decaying lettuce, indicating that the larvae of this species are probably scavengers on decaying organic matter.

Notiphila sp. marsh reed, r. Only one adult of this undetermined species was swept from a small stand of cattails growing in a marsh located near Rittman in early July.

Dichaeta caudata (Fallén). Limnic wrack, c; marsh reed, c; mud shore, occ; sedge meadow, r. Adults were taken repeatedly from decaying plant remains littering the surface of the limnic-wrack and mud-shore habitats and were swept quite frequently from the stems of vegetation bordering such habitats. Dahl (1959) reported that the males establish territories on plant stems which they defend against the encroachments of other males. He also described the courtship behavior. Eastin and Foote (1971) reported that the larvae feed on saprophytic microorganisms, with a life cycle requiring from 19 to 44 days.

Paralimna decipiens Loew. Marsh reed, r. Only one adult was taken in mid-September. Deonier (1964) did not report this species from Iowa, but Wirth (1965) indicated that it is widely distributed in North America. In southern Arizona, the junior author found abundant adults around the margins of drying pools in intermittent desert streams and over an algal mat covering a sewage effluent. Eggs were found on the surface of the algal mat, and larvae were reared in the laboratory on decaying lettuce.

Parydrinae

Parydra appendiculata Loew. Sedge meadow, r. Only a few specimens of this distinctive species were collected during late August, although in Iowa it was found commonly in sedge-meadow, marsh-reed, limnic-wrack, and mud-shore habitats (Deonier 1964). Sturtevant and Wheeler (1954) stated that this species is the most abundant member of the genus in the western states.

Parydra aquila (Fallén). Mud shore, va; sand shore, va; grass shore, c; rain pool, r. This was the most abundant of the six species of *Parydra* collected during the survey. Adults were particularly abundant over exposed shores in May and June, but were collected in lower numbers as early as mid-April and as late as mid-October. Thousands of eggs were found on small sticks that projected above the substrate, and numerous larvae were present in the surface mud. Gut samples showed that the larvae had fed mostly on unicellular diatoms.

Parydra breviceps Loew. Marsh reed, va; rain pool, c; mud shore, occ; grass shore, r; limnic wrack, r. Specimens were taken from early April until mid-September. The larval stages are unknown.

Parydra pinguis (Walker). Mud shore, r. Only a few specimens of this widely distributed but uncommon species were taken in early July.

Parydra quadrituberculata Loew. Mud shore, c; rain pool, occ; cattail marsh, occ; sand shore, r. Numerous adults were taken between early April and late August. Gut samples from larvae found in surface muds indicated that they were ingesting mostly diatoms.

Parydra unituberculata Loew. Mud shore, c; grass shore, occ; sand shore, occ. Adults were taken in April and again in August and September.

Hyadina albovenosa (Coquillet). A single specimen was taken during a collecting trip to a marsh-woodland complex 4.5 miles east of Kent on June 2, 1969, but the exact habitat where the specimen was taken was not recorded. Deonier (1964) stated that he found this species occasionally in the marsh-reed habitat in Iowa.

Hyadina binotata (Cresson). Mud shore, r. Adults were taken in April and May. Deonier (1964) found specimens occasionally in the marsh-reed, sedge-meadow, and *Eragrostis*-mat habitats and rarely in the sand-shore habitat in Iowa.

Hyadina subnitida Sturtevant and Wheeler. Rain pool, r. Only two specimens were collected 4.5 miles east of Kent: one in late July, the other in late August. Apparently this species is rare throughout its range. Deonier (1964) found only two adults during his survey of Iowa Ephydridae; both were taken in a sedge meadow.

Axysta extera (Cresson). Marsh reed, r. The two collected specimens of this obscure species were taken in Kent during early May and mid-September.

Lytogaster excavata (Sturtevant and Wheeler). Sedge meadow, a; limnic wrack, occ; mud shore, occ; sand shore, r. Adults were taken fairly regularly in May, June, and August, although they were most abundant in June. All were found on shorelines close to the water's edge.

Pelina truncatula Loew. Limnic wrack, c; mud shore, c. The largest number of adults of this widely distributed and common species were found around sewage effluent flowing into a marshy area. In southern Arizona, the junior author found numerous larvae and puparia in an algal mat that had formed over a shallow pool in an intermittent canyon stream.

Gastrops nebulosus Coquillett. Grass shore, r; sedge meadow, r. Two specimens of this relatively rare species were collected near Kent in early July and early September. Bokerman (1957) reported that he had reared adults of *G. niger* Williston, a South American species, from larvae found in egg masses of a frog. Although larvae of *G. nebulosus* that we placed in egg masses of the chorus frog (*Pseudacris triseriata* [Wied]) remained alive for several days, no feeding on the young embryos or surrounding matrix was observed. No larva molted into the second instar.

Ochthera mantis (De Geer). Sand shore, a; mud shore, c; rain pool, r; sedge meadow, r. Specimens were taken from mid-July through late September. Adults and larvae are highly predacious (Eastin, 1970).

Ochthera tuberculata Loew. Sand shore, c; mud shore, c. This species usually was somewhat more abundant than *O. mantis;* both species frequently were found in the same habitats on the same day.

Brachydeutera argentata (Walker). Rain pool, occ. Only a few specimens of this widely distributed species were collected in early August. All were found on the surface of small ephemeral pools of water that formed after summer rains. The junior author has reared larvae of a related species, *B. sturtevanti* Wirth, on decaying lettuce. Williams (1939) reported that larvae of an Hawaiian species fed on decomposing organic matter in woodland pools.

Ephydrinae

Ephydra cinerea Jones. Salt pool, va. Adults were exceedingly abundant around the salt pools at Rittman in company with *E. riparia*. Larvae were found within the bottom muds and occasionally were seen swimming in the open water. They seemed quite independent of atmospheric air and rarely extended their elongate breathing tubes to the surface film. Aldrich (1912) suggested that the two long tube-like structures projecting from the anal region of the larva may serve as tracheal gills, enabling the larva to absorb oxygen from the surrounding water. Nemenz (1960) found that the larval cuticle is highly impermeable to dissolved salts and that the larvae possess a highly efficient osmoregulatory mechanism. We found that the guts of larvae collected in the bottom muds contained mostly bacteria and yeast cells. The discovery of this species in northeastern Ohio extends the known range within the United States considerably eastward and constitutes a new record for the state (Scheiring and Foote, 1970).

Ephydra riparia Fallén. Salt pool, va; rain pool, occ. Although most abundant around the salt pools at Rittman, this species was found also in freshwater habitats. Larvae in the laboratory seemed to develop equally well in distilled, fresh, mildly saline, and highly saline water, indicating that they are capable of a high level of osmoregulation. Larvae apparently are less adapted to a submerged way of life than are larvae of *E. cinerea*, and commonly were found in nature with their elongate breathing tubes in contact with the surface film. Examination of guts of larvae collected at the salt pools showed that they had ingested mostly unicellular algae. Puparia of *E. riparia* and *E. cinerea* formed massive windrows on the shorelines at the salt pools; many others were attached to submerged sticks.

Ephydra niveiceps Cresson. A single specimen of this western species was found during a collecting trip to the property of the Morton Salt Plant in Rittman in early September, but we do not know whether the adult was taken from the area of the salt pools or from one of the nearby freshwater marshes. The collection of this species in northeastern Ohio constitutes a new state record (Scheiring and Foote, 1970). It is a fairly common species in the midwest (Wirth, 1971).

Setacera atrovirens (Loew). Mud shore, r. A few adults were collected in April, May, and October.

Coenia curvicauda (Meigen). Mud shore, a; limnic wrack, c. Specimens were taken from early April through early October, although they were much less abundant in July and August. Larvae were found in moist to wet substrates having a high content of organic matter. Laboratory-reared larvae ingested mostly saprophytic microorganisms.

Paracoenia bisetosa (Coquillett). Limnic wrack, occ. A few adults were swept from the margins of a small sluggish stream that was heavily laden with sewage. In northwestern Montana, scores of adults of this species were collected by the junior author over the unshaded, muddy shores of a shallow, highly alkaline lake. Larvae and puparia were found in the shoreline mud of the lake, and larvae developed to puparia on decaying lettuce in the laboratory. In nature, the larvae probably ingest primarily saprophytic microorganisms or possibly unicellular algae.

Paracoenia fumosalis Cresson. Mud shore, occ. Adults were collected in low numbers in May, June, and August. Larvae were found in highly organic sewage-impregnated mud, where they fed mostly on bacteria and yeasts.

Philotelma alaskense Cresson. Mud shore, r. One specimen was taken in mid-April, another in early May. Both were collected 4.5 miles east of Kent. Apparently this is a widely distributed, though uncommon, species. Deonier (1964) stated that he collected only three specimens in Iowa, all from the limnic-wrack habitat.

Lamproscatella dichaeta (Loew). Salt pool, occ; rain pool, r. Specimens were collected in late August and again in mid-September. They were somewhat more abundant around the salt pools at Rittman than they were in habitats near Kent. Sturtevant and Wheeler (1954) reported that this species is taken most frequently at inland saline habitats and only occasionally in freshwater situations.

Scatella favillacea Loew. Mud shore, occ; rain pool, occ. Adults were taken in April, May, and June.

Scatella obsoleta Loew. Sand shore, va; grass shore, r. Specimens were taken between early May and late July, but were most abundant in early June. Numerous eggs and larvae were found just below the surface of moist to wet sand along the shores of a small stream. Puparia were found buried slightly in the sand at varying distances from the water's edge. Guts of larvae collected in the field contained mostly unicellular algae, particularly diatoms and flagellates.

Scatella paludum (Meigen). Sand shore, r; rain pool, r; salt pool, r. This western species has been recorded as far east as Ontario (Wirth 1965). Dahl (1959) discussed the ecology, seasonal distribution, and mating behavior of this species in Scandinavia. The junior author has collected larvae and puparia from an algal mat that was growing over sewage effluent in southern Arizona.

Scatella picea (Walker). Mud shore, c; marsh reed, occ; sand shore, r; grass shore, r; rain pool, r. Adults were taken between early April and late September over more open shores, frequently in company with the closely related *S. stagnalis*. Immature stages were found just below the surface of organic-rich mud, where the larvae fed on microorganisms, particularly unicellular algae.

Scatella stagnalis (Fallén). Mud shore, va; floating vegetation, c; sand shore, c; grass shore, occ; limnic wrack, occ; marsh reed, occ; sedge meadow, r; rain pool, r. Adults of this abundant and widely distributed species were found in a wide array of habitats from late April to mid-October. It commonly occurred with *Discocerina obscurella*, another species having a wide habitat distribution. Eggs, larvae, and puparia were found in the surface layers of muddy shores. Probably larvae in nature feed mostly on unicellular algae, although we reared many larvae in the laboratory on decaying lettuce containing large populations of saprophytic microorganisms.

Limnellia stenhammari (Zetterstedt). Mud shore, r. Only a few adults of this relatively uncommon, though widely distributed, species were taken in mid-April.

Scatophila despecta (Haliday). Mud shore, r. All adults were collected in mid-October from exposed shores of small woodland streams. In Scandinavia, Dahl (1959) stated that this species had a weak halophilic tendency and occurred most commonly in moist habitats having dense vegetation.

SUMMARY

1. Four subfamilies, 39 genera, and 68 species of Ephydridae were collected in northeastern Ohio between April, 1968, and November, 1969.
2. Three species constitute new records from Ohio; *Atissa litoralis*, *Ephydra cinerea*, and *E. niveiceps*.
3. Ten ephydrid habitats are recognized in the area under study; mud-shore, sand-shore, grass-shore, limnic-wrack, marsh-reed, sedge-meadow, floating-vegetation, floating-algal-mat, rain-pool, and salt-pool habitats.
4. The mud-shore habitat contains the greatest diversity of ephydrid species, whereas the salt-pool habitat has the greatest number of individuals. The floating-algal-mat habitat contains the fewest species, as well as the smallest number of individuals. The number of ephydrid species occurring in each habitat are: mud shore (27), marsh reed (20), grass shore (19), sedge meadow (17), limnic wrack (15), rain pool (15), sand shore (13), floating vegetation (9), salt pool (8), and floating algal mat (3).

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