

# A Survey of the Branchiopod Crustaceans of Ohio<sup>1</sup>

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**ABSTRACT.** A survey of the non-cladoceran (for example, "large") branchiopod crustaceans of Ohio was undertaken to identify the current distribution of these temporary pool inhabitants. A total of 49 temporary pools spanning 15 counties in Ohio were found to contain large branchiopods. Three species of large branchiopods were identified: two cold-water anostracans (*E. neglectus* and *E. bundyi*) and one warm-water conchostracan (*C. gynecia*). Of these 3, *E. neglectus* was the most common, being found in 46 sites. The other 2 were comparatively rare, with *E. bundyi* found in 4 sites, and only 1 site having *C. gynecia*. The relative abundance of the anostracans is approximately similar to earlier surveys, indicating that where these temporary pools still exist, conditions remain conducive for survival of these shrimp. Four additional branchiopod species that have been previously described from Ohio (*Eubbranchipus holmani*, *Lynceus brachyurus*, *Eulimnadia inflecta*, and *Cyxicus morsei*) were not found in this survey.

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## INTRODUCTION

Branchiopods are a primitive class of crustaceans that live in fresh and saltwater ponds and small pools on every inhabited continent on the planet. In the Americas, branchiopods are found from the tundra regions of Canada all the way to the tropics of South America. There are 4 recognized orders of branchiopods: anostraca (the fairy shrimp, including brine shrimp), cladocera ("water fleas," including *Daphnia*), conchostraca (the clam shrimp), and notostraca (the tadpole shrimp). Branchiopods often inhabit temporary pools that dry or freeze once or more per year. They are able to persist in these habitats by producing desiccation-resistant eggs, which can withstand extreme environmental conditions (Belk and Cole 1975). When the ponds refill, the dried eggs take up water and split to release fully-developed nauplius larvae (Hall and MacDonald 1975, Khalaf and Hall 1975). These larvae develop into adults in as little as 3 days (for many clam shrimp) or as long as several weeks (for example, cold-water fairy shrimp). The fairy and clam shrimp are primarily filter feeders, whereas the tadpole shrimp are predators and detritivores.

The order cladocera is by far the best known and most often studied of the branchiopod crustaceans. However, the other 3 orders (especially the anostraca and conchostraca) are well represented in most North American states, but have been studied less. There are at least 3 species of anostraca (*Eubbranchipus bundyi*, *E. holmani*, and *E. neglectus*), representing one family (Dexter 1966, Belk and Brtek 1995), and at least 4 species of conchostraca (*Lynceus brachyurus*, *Eulimnadia inflecta*, *Caenestheriella gynecia*, and *Cyxicus morsei*), representing 3 families (Mattox 1966) so far described from Ohio. Most of the work on these "large" branchiopods of Ohio was done in the 1940s to 1960s by Dr. Ralph Dexter of Kent State University (Dexter 1943, 1946; Dexter and Kuehnle 1951; Dexter and Sheary 1943). Dexter worked primarily on anostracans, and described several species in the northern midwest. Since

then, only limited work on large branchiopods has been conducted in Ohio (Velardo 1949, Brett 1950, Mattox 1950, Emberton 1980), and none of this has been distributional in nature. Given the declining ephemeral habitats associated with these shrimp (2 Californian anostracans—*Branchinecta conservatio* and *B. longiantenna*—have recently been added to the state endangered species list, and *L. brachyurus* has been placed on the "watch list" in Indiana), the current survey of the large branchiopod crustaceans of Ohio was undertaken to help determine the number and distribution of these shrimp in Ohio. Both of these are vital to our understanding of human impact on our local freshwater fauna.

In 1995-96, we conducted a survey of large branchiopod habitats in Ohio. Our goal was to identify and record as many branchiopod sites as possible, and to describe the large branchiopod communities in these temporary ponds. We used a combination of laboratory rearings and field collections to identify both early spring and late summer branchiopod communities. Our efforts resulted in the identification of 49 large branchiopod sites ranging from southern to northeastern Ohio. We positively identified 3 branchiopod species: 2 early spring anostracans (*E. bundyi* and *E. neglectus*) and a summer conchostracan (*C. gynecia*).

## MATERIALS AND METHODS

Two forms of collection were used: laboratory rearings and field collections. The crustaceans studied produce resting-stage eggs, which allows the collection of soil samples and the indefinite storage of viable eggs in plastic containers. For the laboratory rearings, several bags of soil were obtained from potential branchiopod sites. These were brought back to the lab and hydrated under "Spring" and "Summer" conditions. From 1 to 5 soil samples were hydrated per site per condition. The early Spring hydrations were conducted in 27 liter, glass aquaria in a cold room (4° C) under constant light and aeration. Approximately 500 ml of field-collected soil was added to each aquarium, and then aged tap water was added to each tank. Anostracan eggs hatched

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from 4-10 weeks after hydration, were initially fed a suspension of baker's yeast for 2 weeks, and then left to feed from the natural algal blooms which developed in each aquarium. After the shrimp attained adult size (4-6 weeks after hatching), they were preserved in 70% ethanol, and identified to species. The Summer hydrations were also conducted in 27 liter, glass aquaria under constant light and aeration, but were kept in a heated room (28° C) to simulate summer conditions. Only one sample yielded large branchiopod crustaceans (conchostracans). These shrimp hatched within 1 week of hydration, were initially fed a baker's yeast solution for 3 days, and then left to feed on algal blooms, as described above. The clam shrimp attained adult size 3 weeks after hatching, and again were preserved in 70% ethanol for identification.

Field surveys were conducted in late summer 1995 and early spring 1996. The summer surveys were primarily in southern Ohio (near Columbus, Athens, and Cincinnati), but no live branchiopods were collected. The early spring surveys resulted in 45 sites from which live anostracans were collected and preserved. Site choice was by a combination of re-surveying several sites previously sampled by Ralph Dexter (Dexter and Sheary 1943, Dexter and Kuehnle 1951), and by sites independently identified by our laboratory group (see Table 1). Early spring surveys started in February, and continued until May of 1996. Shrimp were collected using hand-held dip nets. Only adult fairy shrimp were collected and preserved (in 70% ethanol) for later identification.

## RESULTS

Overall, 99 sites were sampled in Ohio. Of these 99 sites, large branchiopods were found in 49 localities (Table 1, Fig. 1). The locations ranged from southwestern Ohio (Hamilton County) to northeastern Ohio (Geauga County; Table 1, Fig. 1). Approximately one-half of the sites sampled contained large branchiopod crustaceans. However, this is an over-estimate of the true distribution of these shrimp because many of the collection sites were reported for successful captures only. Of the 56 sites originally identified for survey (Table 1), large branchiopods were found in only 11. Thus more accurately, approximately 20% of the predetermined collection sites contained shrimp.

The most abundant large branchiopod found in this survey was the anostracan *Eubbranchipus neglectus* (Table 1, Fig. 1). Of the 49 sites found to contain shrimp, 46 had *E. neglectus*, or 94% of all sites with shrimp. Only 4 of the 49 sites had the anostracan *Eubbranchipus bundyi* (8%), and only 1 had the conchostracan *Caenestheriella gynecia* (2%). The 5 sites that had the 2 rarer species were in wooded areas that were relatively free from human disturbance. On the other hand, *E. neglectus* was found in all types of habitats, ranging from undisturbed (for example, Gahanna Woods Wetland) to highly disturbed (for example, Elton Road near Route 241). It appears that *E. neglectus* is very tolerant of disturbed habitats, whereas the other 2 species appear to be less tolerant of human disturbance. The only location

TABLE 1

Description of all sampled sites. "Sp." refers to species of branchiopods that were collected from each site (En = *E. neglectus*, Eb = *E. bundyi*, and Cg = *C. gynecia*). Latitude and longitude data were measured with a hand-held GPS unit, and were not collected for each site.

Site	Latitude	Longitude	County	Spp.
1	N 41° 8.94'	W 81° 32.97'	Summit	*
2	N 41° 13.56'	W 81° 32.80'	Summit	*
3			Lorain	*
4	N 41° 9.80'	W 81° 48.95'	Medina	En
5			Summit	En
6	N 40° 47.55'	W 83° 33.15'	Hardin	En
7	N 41° 12.03'	W 81° 34.01'	Summit	En
8	N 41° 11.76'	W 81° 33.96'	Summit	*
9	N 40° 51.76'	W 81° 33.91'	Summit	En*
10	N 40° 42.50'	W 83° 37.59'	Hardin	En, Eb
11	N 39° 35.02'	W 83° 0.01'	Pickaway	En
12	N 40° 33.20'	W 83° 43.56'	Hardin	En
13	N 41° 5.21'	W 81° 23.35'	Portage	*†
14			Geauga	*
15			Geauga	*†
16	N 41° 12.72'	W 81° 22.12'	Portage	*†
17	N 40° 0.33'	W 83° 50.12'	Franklin	En, Eb
18	N 40° 43.87'	W 81° 38.95'	Stark	En
19	N 39° 20.96'	W 84° 30.60'	Butler	En*
20	N 41° 9.90'	W 81° 34.08'	Summit	*
21	N 41° 9.98'	W 81° 34.01'	Summit	En*
22	N 39° 35.19'	W 82° 57.15'	Pickaway	*
23			Lake	En
24			Hamilton	En
25	N 39° 48.43'	W 84° 8.54'	Montgomery	En
26	N 39° 26.35'	W 84° 45.99'	Butler	*
27	N 39° 26.35'	W 84° 45.99'	Butler	*
28	N 41° 11.01'	W 81° 34.95'	Summit	*
29	N 41° 17.25'	W 81° 33.85'	Cuyahoga	En*
30			Geauga	*
31	N 41° 7.80'	W 81° 21.25'	Portage	*†
32	N 41° 14.71'	W 81° 33.27'	Summit	En
33	N 41° 14.79'	W 81° 33.28'	Summit	En
34	N 40° 33.53'	W 83° 34.45'	Hardin	En
35	N 41° 3.18'	W 81° 36.06'	Summit	En
36	N 41° 3.21'	W 81° 36.21'	Summit	En
37			Portage	*
38			Portage	*
39	N 39° 50.00'	W 83° 10.37'	Franklin	En*
40	N 41° 28.35'	W 81° 5.14'	Geauga	En*†
41	N 39° 54.36'	W 83° 10.10'	Franklin	En
42	N 40° 52.37'	W 80° 45.79'	Columbiana	En
43	N 41° 8.94'	W 81° 32.97'	Summit	*
44			Portage	*
45			Summit	*†
46			Summit	*
47	N 41° 11.02'	W 81° 51.75'	Summit	En
48	N 41° 10.74'	W 81° 51.76'	Summit	En
49	N 41° 10.68'	W 81° 51.57'	Summit	En
50	N 39° 17.15'	W 84° 44.97'	Butler	En*
51	N 39° 17.70'	W 84° 44.87'	Butler	*
52	N 41° 17.16'	W 81° 23.74'	Portage	En
53	N 41° 10.01'	W 81° 35.52'	Summit	*
54	N 41° 13.39'	W 81° 33.46'	Summit	En
55	N 39° 17.90'	W 84° 42.14'	Hamilton	En*
56	N 39° 17.90'	W 84° 42.14'	Hamilton	*
57	N 41° 4.60'	W 81° 30.80'	Summit	*
58	N 40° 58.50'	W 81° 36.08'	Summit	En
59	N 40° 58.50'	W 81° 36.08'	Summit	En

TABLE 1 (CONT.)

Site	Latitude	Longitude	County	Spp.
60			Summit	En
61	N 39° 50.08'	W 82° 54.45'	Franklin	En
62	N 41° 8.89'	W 81° 43.24'	Medina	En
63	N 41° 8.92'	W 81° 43.11'	Medina	En
64	N 41° 9.45'	W 81° 50.15'	Medina	En
65	N 41° 16.30'	W 81° 33.93'	Summit	
66	N 41° 16.31'	W 81° 33.93'	Summit	
67	N 41° 14.23'	W 81° 22.80'	Portage	*†
68	N 41° 13.44'	W 81° 33.44'	Summit	*
69			Summit	En
70	N 41° 7.86'	W 81° 32.69'	Summit	*
71	N 41° 7.84'	W 81° 32.62'	Summit	*
72	N 41° 7.79'	W 81° 32.70'	Summit	*
73	N 41° 13.63'	W 81° 34.98'	Summit	*
74	N 39° 16.65'	W 84° 45.24'	Butler	*
75	N 40° 42.78'	W 81° 38.16'	Stark	En
76	N 41° 15.15'	W 81° 57.23'	Medina	En
77	N 41° 9.76'	W 81° 34.52'	Summit	*†
78	N 40° 43.87'	W 81° 38.95'	Stark	En
79	N 40° 6.02'	W 83° 5.09'	Franklin	En
80	N 41° 8.93'	W 81° 32.97'	Summit	*
81	N 41° 17.10'	W 81° 23.46'	Portage	En*†
82	N 41° 7.16'	W 81° 15.78'	Portage	*†
83	N 41° 13.57'	W 81° 32.81'	Summit	*
84	N 41° 10.20'	W 81° 18.28'	Portage	*†
85	N 41° 10.40'	W 81° 17.99'	Portage	*†
86	N 41° 10.50'	W 81° 17.98'	Portage	*†
87	N 41° 10.55'	W 81° 18.02'	Portage	*†
88	N 41° 10.45'	W 81° 18.14'	Portage	*†
89	N 41° 10.49'	W 81° 18.15'	Portage	Eb*†
90	N 41° 10.34'	W 81° 18.12'	Portage	Eb*†
91	N 41° 16.50'	W 81° 54.88'	Medina	En
92	N 41° 12.74'	W 81° 34.63'	Summit	
93	N 41° 2.78'	W 81° 36.08'	Summit	En
94	N 41° 11.32'	W 81° 47.34'	Medina	En
95	N 39° 16.05'	W 82° 18.42'	Vinton	*
96	N 39° 15.87'	W 82° 18.37'	Vinton	Cg*
97	N 39° 15.82'	W 82° 18.19'	Vinton	*
98	N 39° 15.21'	W 82° 18.30'	Vinton	*
99	N 39° 15.21'	W 82° 18.36'	Vinton	*

\* = Predetermined site.

† = Previously sampled by R. Dexter (Kent State University).

in which *C. gynecia* was found was on the ridge of a hill in Zaleski Forest (Vinton County), which was a 45-minute hike from the nearest road.

Two of the 49 sites are in areas that are currently being developed, and the habitat will be eliminated. Even with such habitat losses (say 5% or more per year), it appears that *E. neglectus* has not been negatively affected by this level of development. This fairy shrimp was collected in pools closely associated with human development. Nine of the 49 sites (18%) were directly adjacent to railroad tracks, and several other sites were in highly disturbed areas such as near the Pittsburgh Plate Glass, Summit County (PPG) lime lakes or in a ditch next to a highly developed area of Akron (near Portage Path and Merriman roads).

## DISCUSSION

The current survey clearly shows that the "weedy" *E. neglectus* is doing quite well in temporary pools in Ohio. A total of 46 temporary pools were found to contain *E. neglectus*, and 15% of the pools predetermined for sampling were found to contain this species (Table 1), which was similar to that reported by Dexter and Sheary in 1943 (13%). Therefore, within pools conducive to branchiopod development (that is, temporary pools), human impact on natural habitats over the last 53 years does not appear to have negatively affected this species, which was underscored by finding the shrimp in such highly impacted areas as the PPG lime lakes, in a highly developed section of Akron, and near the Fernald plutonium plant (Hamilton County). Anecdotal evidence also indicates that these shrimp are resistant to low water quality, being collected in pools with an oily surface layer (Jeff Davis 1995, pers. comm.) and in pools with large amounts of garbage (John Olive 1995, pers. comm.). The current survey indicates *E. neglectus* is in no danger of extirpation in Ohio, and that this species may be "preadapted" to living near humans due to its apparent resistance to a wide range of water qualities, as well as its weedy life history. However, these fairy shrimp need standing water that will last for at least 6 weeks after a snow melt. Since the current survey did not compare the overall abundance of such pools over the last 50 years, no claim

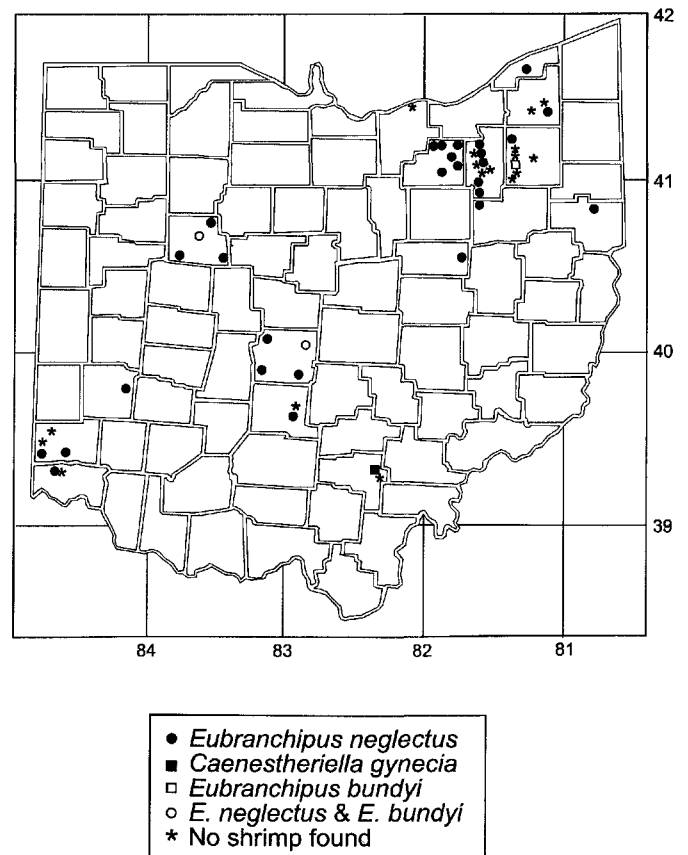


FIGURE 1. Distribution of large branchiopods in Ohio. Note: Some points represent more than one site.

can be made regarding the overall increase or reduction in abundance of appropriate temporary pools for these shrimp. The only definitive statement that can be made is that in the bodies of freshwater apparently suitable for anostracans, the abundance of *E. neglectus* has not significantly declined in the last 50 years.

This survey did not reveal sufficient samples of 2 other large branchiopods (*E. bundyi* and *Caenestheriella gynecia*) for any definitive statements regarding their distributional status. The overall abundance of *E. bundyi* was clearly low, being found in only 8% of the pools containing fairy shrimp (Fig. 1). Also, these pools appeared to be more sheltered from human disturbance than those of *E. neglectus*. It is possible that *E. bundyi* is threatened in Ohio. However, distributional work conducted in 1943 (Dexter and Sheary 1943) indicates an historically rare occurrence of these fairy shrimp in Ohio (2% of pools surveyed), and the current survey finds a fourfold increase in occurrence relative to this previous survey. Nevertheless, it is premature to make statements about the status of this rarer fairy shrimp, since no comparison has been made for the relative abundance of fairy shrimp habitats between the 1940s and the 1990s. Even though the relative proportion of *E. bundyi* may have increased in the last 50 years, if the overall number of appropriate pools has declined, the species may still be threatened in Ohio.

The rarest branchiopod found in the current survey was the conchostracan *C. gynecia* (Fig. 1). Although this all-female species has its type location in Ohio (Mattox 1950), very few reports of its occurrence in Ohio have been published (Velardo 1949, Brett 1950, Mattox 1966, Emberton 1980). Although we sampled 6 locations from previously reported *C. gynecia* sites near Columbus, Athens, and Cincinnati, only 1 of these sites contained clam shrimp (Fig. 1). We are continuing to survey these and other southern Ohio sites to make more definitive statements regarding the distributional status of this interesting conchostracan. Until additional information develops, the current status of this species remains unclear, but may conservatively be stated to be potentially threatened.

Equally important to the numbers of species found in this survey are the numbers of species missing from our collections. One species of anostracan (*Eubranchipus holmani*) was not found in the current survey, although it was reported in low abundance in 1951 (Dexter and Kuehnle 1951). Additional surveys need to be conducted to determine whether this species is extirpated from Ohio. Three additional conchostracans have been reported from Ohio (*Lynceus brachyurus*, *Eulimnadia inflecta*, and *Cyxicus morsei*; Mattox 1966). None of these three species were collected in this survey, indicating their rarity in Ohio.

Overall, the current survey has increased our knowledge of the distributional status of several large branchiopod species, and has suggested several areas in need of further study. Apparently, *E. neglectus* has remained largely unaffected by human development in Ohio over the past 50 years, indicating its resilience to human disturbance and to reduced water quality in temporary pools. Conversely, the resilience to human disturbance of a second anostracan (*E. bundyi*) remains unclear, as does the status of an all-female conchostracan (*C. gynecia*). Finally, 4 branchiopod species that have been previously described from Ohio (*Eubranchipus holmani*, *Lynceus brachyurus*, *Eulimnadia inflecta*, and *Cyxicus morsei*) were not found in this current survey, indicating that these species may be threatened or extirpated in Ohio. Continuing surveys will allow a better determination of the status of all 7 of these large branchiopod species.

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