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GEOGRAPHIC DISTRIBUTION OF SIPHONAPTERA COLLECTED FROM SMALL MAMMALS ON LAKE MICHIGAN ISLANDS

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ABSTRACT

The distribution of ten flea species collected from five small mammal host species on 13 Lake Michigan islands is described. Four new eastern and southern records for *Hystrichopsylla dippiei* Rothschild are given. Speculative suggestions are made regarding dispersal routes of some of the small mammal host species, and the distribution of flea species from *Peromyscus maniculatus gracilis* LeConte is discussed in the context of island biogeography theory.

I collected fleas from small mammals on Lake Michigan Islands from 1965 to present. Two other previous studies from Lake Michigan islands (Hatt et. al 1948, and Arnsman unpublished) each reported on flea species from one host species from one island, and agree with my findings. I have verified the Arnsman specimens in the Michigan State University Entomology Department collection. The Hatt et. al specimens, residing in the University of Michigan Museum of Zoology collection were identified by the eminent siphonapterist, Karl Jordan. A small portion of the species listed here are included in Scharf and Stewart (1980), but most are identified there by county and host only.

This listing is intended to shed light on possible distribution, and immigration routes, to the islands by both the small mammals and their fleas beginning from the melting of the Pleistocene ice sheets. I have previously speculated that the possible mechanisms of small mammal distribution were by way of: (1) a land bridge during the Lake Chippewa low water stage; (2) rafting on flotsam; (3) concealment in Indian canoes or early settler's vessels (Scharf 1973, and Scharf and Jorae 1980). While offering little conclusive evidence, the present study offers a few hints of the dispersal pattern of both the hosts and fleas. This distributional evidence is then examined for hypothetical extinctions of fleas due to island size and distance from the mainland in the context of the island biogeography theory of MacArthur and Wilson (1967).

MATERIALS AND METHODS

I collected 590 fleas of 10 species from 5 species of small mammal hosts on 13 islands in northeastern Lake Michigan (Figure 1). Capture was primarily by snap-trapping, but a live-trapping grid on High Island in June of 1986 and 1988 accounted for many fleas from that island. Firearms were used to collect squirrels

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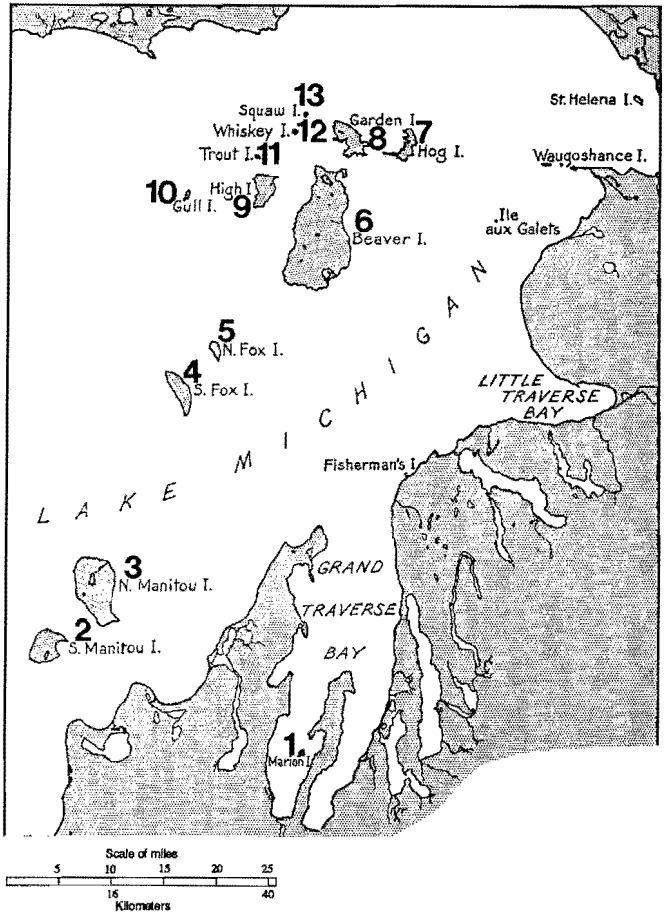

Figure 1. Islands in Lake Michigan where small mammal fleas were collected. Numbers correspond to Tables 1 and 2: 1—Marion Island; 2—South Manitou Island; 3—North Manitou Island; 4—South Fox Island; 5—North Fox Island; 6—Beaver Island; 7—Hog Island; 8—Garden Island; 9—High Island; 10—Gull Island; 11—Trout Island; 12—Whiskey Island; 13—Squaw Island.

during the hunting season. In most cases the mammals were brushed over a white surface to find the fleas, which were preserved in 70% ethyl alcohol, and mounted on microscope slides in Canada balsam for identification. The flea specimens remain in the private collection of the author. Skins and skulls of the hosts are in the Northwestern Michigan College collection of vertebrates.

The major problem regarding collecting methods remains whether completeness of seasonal, and habitat coverage is achieved, because some flea species show distinct seasonal and habitat abundance. I sampled all of the islands with a trapping pressure of at least 100 trap-nights. Some islands, such as the North and South Manitou

Table 1. — Flea species collected from *Peromyscus maniculatus gracilis* on Lake Michigan Islands. Islands arranged from south to north, east to west and with numbers corresponding to Figure 1.

FLEA SPECIES	ISLAND*												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Ctenophthalmus pseudagyrtes Baker		X	X	X	X	X	X		X	X	X		
Epetedia w. wenmanni (Rothschild)	X	X	X	X	X	X	X			X	X		
Hystrichopsylla dippiei Rothschild							X	X			X		X
Orchopeas leucopus (Baker)	X	X	X	X	X	X	X	X	X	X	X	X	X
Peromyscopsylla h. hesperomys (Baker)		X		X		X	X		X		X	X	

*1 – Marion Island; 2 – South Manitou Island; 3 – North Manitou Island; 4 – South Fox Island; 5 – North Fox Island; 6 – Beaver Island; 7 – Hog Island; 8 – Garden Island; 9 – High Island; 10 – Gull Island; 11 – Trout Island; 12 – Whiskey Island; 13 – Squaw Island.

Islands, South Fox Island, and High Island had over 2,000 trap-nights. These same intensively trapped islands had the greatest seasonal span of trapping too, with early spring to late fall trapping on the Manitou islands, and a wide span of summer to fall on South Fox Island and High Island. Most of the specimens from Garden Island were collected in August and September. The other islands were trapped between June and August only, and the number of fleas collected per island reflect some degree of the collecting effort. As a crude index of trapping pressure, I list the islands by increasing number of fleas collected at each: Squaw, 8; Whiskey, 11; Gull, 12; Hog, 19; Marion, 28; High, 37; Garden, 40; Trout, 42; North Fox, 43; South Fox, 58; Beaver, 59; South Manitou,79; and North Manitou, 154. Different habitat types, including hardwoods, dunes and swamps were trapped on most islands.

Mammal names are according to Hamilton and Whitaker (1979). Most Siphonaptera were identified using Holland (1949), but Benton (1983) was useful in a few instances. The nomenclature of Holland is followed here.

RESULTS AND DISCUSSION

The one mammal host species that is common to all of the islands visited is the Woodland Deer Mouse, *Peromyscus maniculatus gracilis* LeConte, although phenetic divergence has been shown between islands (Lederle et. al 1985). Table 1 shows the distribution of 5 flea species on this host by island and Figure 1 shows the location of the islands keyed to the numbers in Table 1. Noteworthy for its ubiquitous distribution on this mouse is the flea *Orchopeas leucopus* (Baker) which is found on every island.

The occurence of *Histrichopsylla dippiei* Rothschild from the deer mouse on four islands (Table 1) is an important new range extension. This paper represents the second Michigan record, and a new eastern and southern distribution for the species. While this flea has been noted on deer mice previously, the true host for this species is considered by many to be the Red Squirrel, *Tamiasciurus hudsonicus* (Erxleben), and the closest recorded occurrences of the flea are in Itasca and St. Louis Counties in northeastern Minnestoa both on *T. hudsonicus* and *P. maniculatus* (Timm 1975, and Benton 1980), and on *P. maniculatus* on Isle Royale (Nixon and Johnson 1971). Its presence on the four Beaver islands closest to the Upper Penninsula., and its distribution across Canada and the far northern U. S. provides a clue to the route the host took to these islands. The absence of this flea from the southern islands of the Lake Michigan archipelago indicates that small mammal invasion after glacial retreat may have been by more than one route.

The other flea species collected from *P. m. gracilis* are commonly found on this mouse, and widely distributed (Table 1). However, two fleas common on this host in the U. P., *Peromyscopsylla catatina* (Jordan) and *Megabothris quirini* (Rothschild)

Table 2. — Flea species collected from *Tamias striatus* (L.) on Lake Michigan Islands. Islands arranged from south to north, east to west and with numbers corresponding to Figure 1.

FLEA SPECIES	ISLAND*				
	2	3	4	6	8
Ctenophthalmus pseudagyrtes Baker			X		
Megabothris acerbus (Jordan)	X	X	X	X	X
Tamiophila grandis (Rothschild)	X		X		

* 2 – South Manitou Island; 3 – North Manitou Island; 4 – South Fox Island; 6 – Beaver Island; 8 – Garden Island;

are notably absent from the Lake Michigan island mice (Lawrence et. al 1965, Scharf and Stewart 1980, Scharf et al. 1991).

The distribution of fleas from *P. m. gracilis* on the Lake Michigan Islands contradicts both the distance effect, which predicts that on islands of similar size the number of species vary inversely with the distance from the mainland, and the size effect which predicts that species numbers vary directly with the area avialable for immigration as proposed by the island biogeography theory of MacArthur and Wilson (1967). First, the non-conformity with the distance effect is illustrated in Table 1, by Marion Island, a relatively small island within 3 km of the mainland having as few species of fleas from this host as Squaw and Whiskey Islands, which are similar sized islands, but which are more than 15 km from the mainland. This is further shown by Gull Island, which is the most isolated of the islands, and has one more flea species than the three previous islands. Trout Island, of about the same size and distance from the mainland, is tied for the greatest number of flea species from this host for any of the 13 Lake Michigan islands studied.

Second, the size effect shows a lack of conformity with the theory because the largest islands, North and South Manitou Islands, North and South Fox Islands, and Beaver Island have only three and four species each. This is fewer species than the 5 species of either Hog Island or Trout Island which are considerably smaller. In addition, Garden Island with only 2 species, and one of the largest islands studied has only 2 recorded species of fleas and is within 4 km of Trout and Hog Island which have the most flea species.

I recognize several reasons for caution in using these data from the mouse flea species and islands to measure the validity of the island biogeography theory of MacArthur and Wilson (1967). These are: (1) I have no certainty that I have collected all the flea species from each island; (2) I have no indication of what levels of equilibrium between extinction and immigration are in these islands, much less whether those levels have been reached or not; (3) the area effect, where an increase in area lowers extinction, seems to be unrelated to the sizes of the islands in this study; and (4) the distance effect, lowering immigration in direct proportion to the distance from the mainland, varies depending on whether a person hypothesizes immigration from the Wisconsin side, the Upper Peninsula or the Michigan Mainland.

The distribution of flea species from the Eastern Chipmunk *Tamias striatus* (L.) is given in Table 2. *Megabothris acerbus* (Jordan) is found on all 5 islands where *T. striatus* was collected. *Tamiophila grandis* (Rothschild) is found only on this host on South Manitou Island and South Fox Island, and was recorded from the Fox Squirrel *Sciurus niger* (L.) from North Manitou Island. The only other Michigan records of this flea are from chipmunks on the mainland of Leelanau County (Scharf and Stewart 1980). This indicates that the colonization route may have been from the adjacent mainland for this host on the southern islands of the archipelago. Chipmunks are absent from most of the islands where we failed to collect them with the exceptions of Beaver, Marion, and North Fox islands.

The other four hosts and their fleas are listed here as unremarkable occurrences both because of the limited number of islands inhabited by each mammal species,

and the ubiquitous distribution of their fleas. The Red-backed vole, *Clethrionomys gapperi* (Vigors), harbored *Ctenophthalmus pseudagyrtes* Baker on North Manitou Island, and *Peromyscopsylla h. hesperomys* (Baker) on Beaver Island. The Meadow Vole, *Microtus pennsylvanicus* (Ord) was parasitized by *C. pseudagyrtes* on Marion Island (Scharf 1984). The Fox Squirrel *Sciurus niger* (L.) had *Orchopeas howardii* (Baker) on North Manitou Island in addition to the chipmunk flea noted above. I also collected *Corrodopsylla c. curvata* (Rothschild) from the Masked Shrew, *Sorex cinereus* Kerr, on North and South Manitou Islands.

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