Direct Observations on *Mysis relicta* from a Submarine[1]

Between 17 and 30 June 1967, the two-man research submarine *Star II* carried out a number of exploratory biological and geological dives in Lake Michigan. During this program, we were able to make certain observations on the opossum shrimp, *Mysis relicta* Lovén. This crustacean superficially resembles the true shrimps of the order Decapoda, but there are sufficient differences to necessitate placing it and its relatives in a separate order, Mysidacea. Living individuals are almost transparent in natural light except for the stalked, pigmented eyes and the chromatophores. In the lights from the submarine, however, the animals, which reach lengths of up to 30 mm, were white and easily observed.

While some aspects of the biology of *Mysis relicta* are well studied (Thienemann 1925; Juday and Birge 1927; Holmquist 1959; Beeton 1960; Segerstråle 1962), direct observations on it in the natural environment are scarce and are completely lacking for deeper waters beyond the range of SCUBA. Yet *Mysis* is an important part of the trophic system of the Great Lakes, and information on its biology is vital to gaining an understanding of the ecosystems of these lakes.

During dives at six locations in Lake Michigan (Fig. 1), biological observations were carried out through viewports affording a view of the environment in front of and below the submarine. Mysids were easily identified during these dives because they are much larger than most of the other crustaceans in the lake. The only possible source of confusion was the amphipod *Pontoperia affinis* (Lindström), which occurred almost entirely on or near the bottom. This organism could be easily distinguished from the mysids by its general shape and mode of movement. One dive was made at each location except Sta. 4 where three dives, one by each of us, were made. The dives lasted between 1 and 2 hr with most of the time spent on or near the bottom. Descents and ascents were made at approximately 7.5 m/min—slow enough to allow reasonably detailed observations. The visibility at the different stations varied greatly from a maximum estimated as about 3 m at Sta. 4 to no more than 0.6 m at Sta. 1.

The depth to bottom for each dive and an estimate of the relative abundance of the mysids in the water column and on

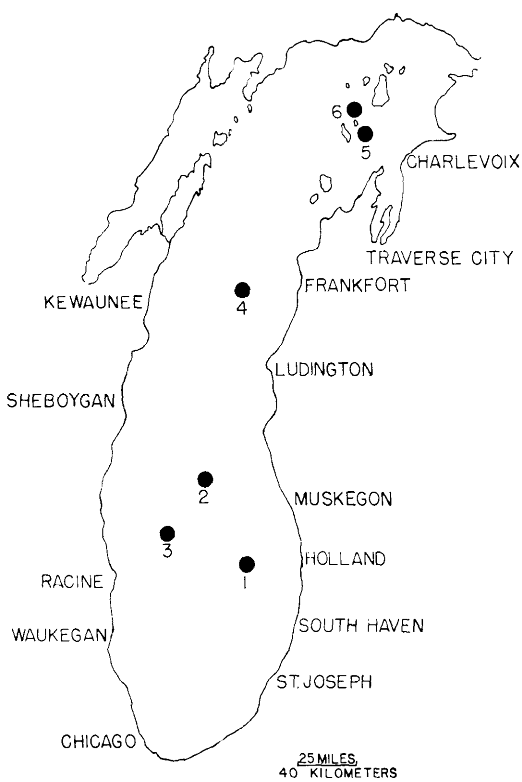

Fig. 1. Stations in Lake Michigan where biological observations were made from *Star II*.

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TABLE 1. *Relative abundance of mysids at a series of stations in Lake Michigan*

Station	Date of dive (1967)	Approx depth (m)	Abundance of mysids	
			Off bottom	On bottom
1	17 Jun	91	A few	Common
2	22 Jun	42	None	A few
3	20 Jun	84	None	A few
4	26 Jun	262	Abundant	Abundant
5	27 Jun	17–31	None	None
6	28 Jun	144	A few	Abundant

TABLE 2. *Numbers of mysids observed in 50-ft (15.2 m) layers from the submarine at Sta. 4 in Lake Michigan*

Depth (m)	Dive 1 0925 EST (ascent)	Dive 2 0950 EST (descent)	Dive 3	
			1146 EST (descent)	1130 EST (ascent)
125–141	2	0	0	0
141–156	8	2	0	2
156–172	45	11	1	Very numerous
172–187	51	45	9	Very numerous
187–203	*	60	30	38
203–219	*	27	8	43
219–234	*	32	3	28
234–250	11	19	8	11
250–262	(Concentrated near and on bottom where they were too numerous to count)			

* In all, 132 animals were observed between 187 and 234 m, but the 203 and 219 depths were not recorded. The observer verifies that the greatest number was between 187 and 203 m.

the bottom are presented in Table 1. Depth in feet was measured aboard the submarine as a function of water pressure by a gauge calibrated for salt water; consequently, the values obtained slightly underestimate actual depth. The depths given here have been corrected to take the density difference between salt water and freshwater into account and have been converted to meters.

At the shallowest station (5) no mysids were seen; depth to bottom varied from 17 to 31 m as the submarine moved over the irregular substrate. Ambient light at bottom was relatively strong. At the next two shallowest stations (2 and 3), a few mysids were seen on the bottom only. Depth at Sta. 2 was relatively shallow, and ambient light was strong enough to permit major topographic features to be discerned for a distance of about 1.5 m without the use of artificial illumination. Sta. 3 was deeper, but there was sufficient ambient light to permit a horizontal visibility of 0.3 to 0.6 m. At the three deepest stations, no light was discernible at the bottom, but mysids were seen both on the bottom and in the water immediately above it. However, only at the deepest station (4) were large numbers of individuals seen far above bottom. At that station, animals were observed over 100 m above the substrate. Both the abundance of the mysids and their tendency to occur above the bottom apparently increase with depth.

Most of the animals on the bottom were resting with their appendages lightly touching the substrate, but a few partially buried individuals were also noted where the sediments were sufficiently soft to permit this. As the submarine approached, many individuals darted away, while others did not. If the submarine remained resting on the bottom for a few minutes, the number of mysids decreased greatly, suggesting avoidance. The organisms seen during descent and ascent seemed to be very little affected by the passing of the submarine. At Sta. 2, there were strong bottom currents, estimated at 5–10 cm/sec, and the mysids often had to swim actively to maintain their position. They oriented themselves into the current and appeared to cling to the hard bottom whenever possible. At the three deepest stations, currents were absent or very slight, and some individuals were observed to leave bottom and swim as much as 2 to 3 m up into the water. Those in the water alternated short periods of swimming with periods of slow sinking. They usually sank with their long axis oriented vertically and either the head or caudal end uppermost. Sometimes an individual would sink to the bottom and stay there.

During the initial dive at Sta. 4, mysids were seen continuously from about mid-depth to bottom (262 m), and there were apparent variations in population density with depth. Consequently, during the ascent we made an attempt to study the depth distribution of those individuals that were off bottom. Approximate counts were made of the number of animals in each of a series of 50-ft (15.2 m) depth increments (on the gauge), as seen through the forward viewport in the zone illuminated by the floodlights of the submarine. The counts were recorded on a portable tape recorder. During two subsequent dives the same procedure was followed on both the descent and ascent. The tape recorder temporarily malfunctioned during the second dive, which precluded counts during most of the ascent.

The results, while sketchy and subject to a number of inherent errors, are interesting. Table 2 indicates striking similarities. Only two mysids were seen above 141 m during dive 1, and none during the other dives. A rapid increase in numbers of mysids occurred below 156 m. Maximum numbers were found at the 187–203-m level in all cases except the ascent for dive 3, where the maximum was probably at the 172–187-m level. There was a gradual tapering off in the counts below 203 m, continuing until quite near bottom, where the numbers of mysids increased so greatly that counting was impossible. As an approximation, half the population was in the water column and half in the bottom and near-bottom zone. Most of the mysids in the bottom zone were actually on the bottom, but some were also swimming just above the sediment as mentioned earlier. Although diving began at 0748 EST and ended at 1330 EST, no difference in the depth of light penetration was discernible to us. In each case, a low level of ambient light could be distinguished at the 125-m depth (after the floodlights were off for about 1 min) when one looked toward the surface, but at 147 m no light could be detected under the same conditions.

Our observations can be summarized as follows. Few individuals were seen at depths less than about 85 m and abundance increased with depth. Almost all individuals found at depths less than about 85 m were directly on the bottom, but in deeper water some animals were seen swimming a short distance off bottom. At the deepest station, the population was divided into two parts—one on or near bottom, the second quite a distance off and most dense around the 187-m level.

Generalizations are not meaningful until many more observations at other times of day and other times of year are made. However, our results do agree closely with the vertical distributions found by Beeton (1960) through analyses of series of horizontal net hauls. The only major difference is our observation of a concentration quite far off bottom at our deepest station. Beeton's deepest station was at about 150 m, so he probably did not sample any location where this phenomenon distinctly occurs.

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