

Original: For publication
cc: For publication
Fish Division ✓
Education-Game
Institute for Fisheries Res.
W. C. Latta
R. F. Sharkey
D. S. Shetter

Report No. 1661

March 20, 1963

FOOD CONSUMPTION OF THE AMERICAN MERGANSER¹

William C. Latta, Institute for Fisheries Research, Michigan Department of Conservation, Vanderbilt, Michigan

Reginald F. Sharkey, State Fish Hatchery, Michigan Department of Conservation, Oden, Michigan

Abstract: In the first experiment, two captive female mergansers required 9 or 10 ounces of trout per day (or about 30 per cent of body weight) to maintain body weight. They seemed to prefer 4- and 5-inch trout over 6- to 8-inch trout. Girth of the trout rather than length determined whether or not the merganser was able to consume the fish. When the digestive tract of merganser I was empty, the time from consumption of a trout to elimination was about 20 minutes. After being on a near starvation ration for 10 days, merganser I ate more than 100 per cent of her body weight in 24 hours. After being on a maintenance ration for several days, she was able to consume 50 per cent of her body weight in the first 24-hour period and 23 per cent of her body weight in the second 24-hour period. Small jaw tags passed through the digestive tracts of both mergansers.

In the second experiment estimates indicated that merganser II, weighing 2 pounds 3 ounces, consumed 13 brook trout weighing 1.3

¹ The junior author planned and conducted experiment no. 1 and the senior author was responsible for experiment no. 2. The second experiment is a contribution from Dingell-Johnson Project F-27-R, Michigan.

pounds or 59 per cent of her body weight per day in a natural environment. To obtain the estimate of food consumption, estimates of the trout population were made before the pinioned merganser was released and after she had been on the lake for 16 days. The 95 per cent confidence limits indicate that the minimum number of trout eaten in the 16 days was 95. This would be 0.6 pound or 27 per cent of her body weight per day.

Other predators or disease may have contributed to the total mortality, but while the merganser was on the lake, observations were frequent enough to detect any large amount of predation or deaths caused by disease. There was a period of six days between loss of ice cover on the lake and opening of fishing season in which there were no visits to the lake (except one night) and predators could have been active. (The trout for the first estimate were marked while ice still covered the lake.) The six-day period without observations was reduced to two days by making another estimate of the number of trout in the lake prior to release of the merganser. This estimate had broad confidence limits and was somewhat lower than the estimate made while ice covered the lake. However, using this estimate, it was calculated that in 16 days the merganser ate 0.8 pound or 38 per cent of her body weight per day.

INTRODUCTION

To evaluate the role of the American Merganser (Mergus merganser americanus) as a predator on trout populations, detailed knowledge of food consumption is needed. Salyer and Lagler (1940) estimated from observations and stomach samples that an adult merganser would consume from one to one and one-half pounds of fish daily or "one-third to one-half its body weight." White (1936) fed a tame immature male merganser for 19 days. Its daily consumption averaged 15.8 ounces or 38.5 per cent of its body weight. White (1957), in another experiment, held three immature American Mergansers in captivity for 219 days during which time they consumed an average of 10.93 ounces of fish per day.

Food consumption of the American Merganser was measured in two experiments. In the first experiment two female mergansers were held captive and the amount of food they required per day to maintain body weight was determined. Some miscellaneous observations related to food consumption were made, also. In the second experiment an estimate was obtained of how much food a merganser will eat under natural conditions. The number of brook trout (Salvelinus fontinalis) in a small lake was estimated, a pinioned female merganser was placed on the lake and left there for 16 days, and then another estimate of the trout population size was made.

We wish to thank H. L. Thompson for providing facilities for holding the mergansers at the Oden Hatchery. G. F. Myers, H. H. Brado, and D. E. Edson did most of the field work for the second experiment. G. P. Cooper, J. T. McFadden, and W. R. Crowe critically read the manuscript. P. M. Earl prepared the graph.

EXPERIMENT NO. 1

At the State Fish Hatchery, Oden, Michigan, regular patrols of the raceways are made to drive off bird predators. In late February, 1962, two female American Mergansers were captured after being slightly wounded. At capture they weighed 48 and 50 ounces, respectively (Table 1). They were placed in a cement fish tank, 12 feet long, 3 feet wide and 30 inches deep, located inside the hatchery building. The birds were separated by a vertical screen placed in the center of the tank. The bottom of the tank was covered with 3 inches of sand and fine gravel. The water level was kept at about 9 inches above the sand and gravel with enough flow to maintain live trout in good condition. The trout could not swim through the mesh of the screen divider. Each compartment was covered with a screen and partially covered with a canvas to provide some seclusion. Temperature of the water in the tank was 52° F. Temperature of the air above the water in the tank, at the height of a merganser, was 52° F. Temperature of the room was about 65° F.

Merganser I was not fed for 6 days; merganser II, for 3 days. The feeding program was initiated on March 2. Recovery from the

wounds was rapid and apparently the birds' appetites were not impaired. During the course of the feeding, it was found that the merganser would readily eat live trout and fresh, dead trout but they would not eat partially decomposed trout nor strips of trout flesh. Merganser I was fed for 25 days on live trout, 14 days on dead trout, and 7 days on a combination of live and dead trout. Merganser II was fed for only 16 days on live trout, 44 days on dead trout, and 4 days on a combination of the two. On 4 days neither bird received any food. Mostly brook trout were fed, but some rainbow trout (Salmo gairdneri) and one lake trout (Salvelinus namaycush) were used. Merganser I died April 20, presumably as a result of an injury to her leg caused 21 days earlier when an attempt was made to photograph her. Despite the injury her appetite seemed normal during the 21 days. Merganser II, after 60 days in captivity, was used in the second experiment.

Daily Ration Needed to Maintain Body Weight

The primary objective of the experiment at Oden was to determine the amount of trout mergansers must eat each day to maintain their body weight. Ounces of trout fed and ounces of gain or loss in body weight of the two birds are given in Table 1. For the first 10 days each bird received about 4 ounces of trout per day. On this ration, merganser I lost 17 ounces during the 10 days, and merganser II lost 18 ounces. When the average daily ration was increased to about 9 ounces per day, merganser I gained 8 ounces in 6 days, and merganser

II gained 6 ounces. Later, when the daily ration was lowered to 6.5 ounces, merganser I lost 7 ounces in 6 days, and merganser II lost 4 ounces. Increasing the daily ration to 11 ounces resulted in gains of 5 and 6 ounces in 9 days. Average gain or loss in weight per day plotted against average daily ration for the two captive mergansers indicates that about 9 or 10 ounces of trout per day (or about 30 per cent of body weight) were needed to maintain body weight (Fig. 1). However, these birds were confined in a small space at a temperature of about 52° F. In the wild, probably, maintenance ration would be higher.

Miscellaneous Observations

In five tests, during the course of the feeding, live trout 4 to 8 inches long were placed in the tanks with the mergansers. At the end of 2 hours, and at the end of 24 hours the number and size of trout that had been eaten were noted (Table 2). Apparently, these two mergansers preferred the smaller (4- to 5-inch) trout over the larger ones.

Two live and 5 dead trout, 8 to 10 inches long, were presented to merganser I to determine the largest size of trout she was able to consume (Table 3). Girth rather than length of the fish seemed critical. She was able to eat trout up to 5 inches in girth but was unable to consume two trout of 5.5-inch and 6.0-inch girths.

An attempt was made to determine the largest size trout that could be forced down the gullet of a merganser. Two female and one male mergansers, weighing 37 ounces, 40 ounces and 57 ounces,

respectively, were killed during patrols. A 9.3-inch brook trout with a girth of 5 inches was forced down the gullet of the smaller bird with firm pressure. Extreme pressure was needed to insert a 10.2-inch brook trout of 6-inch girth into the gullet of the largest female bird; a 10.8-inch brook trout with a 6.5-inch girth was inserted into the male's gullet. Size of the merganser and girth of the fish apparently limit the size of fish eaten.

Two observations of the elapsed time from consumption of trout to elimination of fecal remains were made for merganser I. On the first occasion, March 2, at the start of feeding, elapsed time was 22 minutes. She had been starved for the previous 6 days and it was assumed that her digestive tract was empty. In the second trial, April 2, after the merganser had not been fed for the previous 2 days, elapsed time was 20 minutes.

On March 12, merganser I was given a surfeit of trout. She had been fed only about 4 ounces of trout per day for the previous 10 days and had lost more than one third of her body weight. In 24 hours she ate 29 ounces of trout, more than 100 per cent of her body weight. On March 20 and 21, after several days on a ration of 9 or 10 ounces per day, she was again presented with a surfeit of trout. In the first 24-hour period she consumed 17.5 ounces of trout, or 50 per cent of her body weight, and in the second 24-hour period her consumption dropped to 11.5 ounces, or 23 per cent of her body weight.

A small jaw tag (No. 3, Monel metal, locked) was inserted into the gullet of each of two 6-inch trout. One trout was fed to merganser I and the other to merganser II. Six days later, when the sand and gravel from under merganser I was sifted, the tag was recovered; the sand and gravel from under merganser II was sifted after 8 days and the tag was recovered. Evidently jaw tags of this size easily pass through the digestive tract of mergansers.

EXPERIMENT NO. 2

Section 4 Lake, one of seven experimental lakes at the Pigeon River Trout Research Station, Vanderbilt, Michigan, has a surface area of 2.6 acres and a maximum depth of 59 feet. Geologists consider the lake to be a limestone sink. The lake is almost round, the banks are steep, and the water surface is 40 to 60 feet below the surrounding terrain. The 5-foot depth contour of the lake is only about 10 feet from the margin. Numerous logs and some tree tops, which over the years slid into the lake from the surrounding steep banks, provide considerable natural cover. Tanner (1960) described some of the chemical characteristics of the lake.

In 1950, the fish population in Section 4 Lake was eliminated with a toxicant. In 1952-1961, the lake was stocked each April with 3,000 brook trout fry. Anglers have removed 20 to 30 pounds of brook trout from this lake each year.

Population Estimates

The "mark and recapture" method was used to estimate the size of the trout population in Section 4 Lake. Waters' (1960) suggestion that one method be used to "capture" and a different method to "recapture" in making population estimates in small trout lakes was followed. Bailey's (1951) variation of the simple Petersen formula was used to compute the fish population size, and his variance formula was used to calculate the 95 percent confidence limits.

The first sample was taken by fishing through the ice from March 19, 1962 through April 3, 1962. A total of 165 trout were marked by removing the adipose fin. The recapture sample was taken at night, April 25, 1962, with underwater lights and a direct-current electric shocker (Latta and Myers, 1961).

For the second estimate, after the merganser had spent more than two weeks on the lake, trout were captured with the shocker on the nights of May 14 and May 17, 1962. The recapture sample was taken with two gill nets (125 feet long, 1 1/2-inch stretched mesh) the night of May 21 and by angling May 22 and 23, 1962. The fish were marked by clipping the tip of the upper or lower lobe of the caudal fin or the tip of the anal fin.

On May 14 and 17, when trout were marked for the second estimate of population size, the merganser was on the lake; however, the marking was done at night when the merganser was not active and

thus the fish had until daylight to fully recover from handling and to disperse before the merganser started to feed. It was assumed that marked and unmarked fish would have the same vulnerability to predation. Date of marking was considered to be midway between May 14 and 17. Estimates of population size and confidence limits are given in Table 4.

All fish captured were measured to the nearest 0.1 inch total length; and most of the fish taken by angling through the ice in March and April were weighed to the nearest 0.01 pound. Average total length and average weight for each inch group are given in Table 5. The length frequency distributions for each inch group of trout in the first sample taken by angling and in succeeding samples taken by shocker are given in Table 6. There does not appear to be any difference in size distribution between trout caught by angling and those caught with the shocker on April 25. The size distribution of the fish in shocker samples taken May 14 and 17 appears to reflect growth throughout the population but it does not indicate that the merganser ate trout of any particular size (in contradiction to behavior in captivity in first experiment). The angling on May 21 and 22 resulted in 21 six-inch trout and 28 seven-inch trout. The average lengths and weights were: 6.6 inches and 0.10 pound, and 7.3 inches and 0.14 pound, respectively. Compared with the average lengths and weights of these inch groups in the angling sample (Table 5) there appears to

have been some growth in weight, which would be expected at this time of year, but not enough to necessitate a correction in estimating food consumed by the merganser, in view of the precision of the experiment.

Food Consumption

Merganser II was released on Section 4 Lake at 1:00 PM, April 30, 1962. Before release on the lake, her left wing was pinioned. She weighed 2 pounds, 3 ounces at this time. Captivity had not tamed her.

At the conclusion of the experiment two attempts were made to capture her alive. On the night of May 14, an effort to locate her was made. It was hoped that she would remain immobile in a beam of light and could be easily caught in a long-handled dip net. We could not find her. The second attempt was made during the day of May 17. We harassed her continually until she tired but we could not catch her in a dip net. Finally in mid-afternoon she hid so well that three of us could not locate her. On May 21, she was killed with a shotgun. She weighed 2 pounds 4 ounces and had the remains of two trout, judged to have been six or seven inches long in her stomach.

The difference between the two population estimates on Section 4 Lake indicated a decrease in the population of 216 trout (Table 4). Loss of seven of the trout can be explained; one was caught by a fisherman, one, shorter than 7 inches, died after being hooked deeply and released, two died from unknown causes, and three

were killed during the population estimates. Size distribution of the 209 trout, apparently eaten by the merganser, was assumed to be the same as that of the first angling sample (Table 6). The summation of the number of fish consumed in each inch group times the average weight for each inch group equaled 20.8 pounds or about 21 pounds of trout consumed by the merganser. The merganser ate this amount during the 16 days from April 30 to May 16 (the midpoint of marking for the second estimate). This amounted to an average daily consumption of 13 trout weighing 1.3 pounds or 59 per cent of her body weight. She obtained this food in a natural environment which contained a considerable amount of cover for trout.

The 95 per cent confidence limits for the 216 trout, the difference between the two population estimates, was ± 114 trout. Applying these confidence limits, and allowing for the known loss of seven trout, the minimum estimate of daily consumption is 6 fish (0.6 pound) or 27 per cent of her body weight; and the maximum is 20 fish (2.0 pounds) or 91 per cent of body weight.

Other Possible Sources of Mortality

Angling pressure on this lake was very light during the time of the experiment, and anglers did not reduce the number of trout. Twenty anglers fished 30 hours during April 28 and 29 and caught only one trout. Presence of natural predators and the behavior of the merganser were checked by daily (one day missed)

visits to the lake. Most of the checks were made between 8:00 AM and 5:00 PM, but two visits were made at daylight between 4:00 and 5:00 AM. A total of 17 observations were made in 16 days. In addition, a photographer from the Michigan Department of Conservation spent about 8 hours (two mornings) in a blind watching the merganser and trying to obtain photographs of her feeding. Two Mallards (Anas p. platyrhynchos) and two American Goldeneyes (Glaucionetta clangula americana) were seen in the 16 days. Kingfishers (Megaceryle a. alcyon) were seen several times but they were not observed feeding; it is doubtful that they could take many fish of the size present in the lake. Salyer and Lagler (1949) found that the average length of fish eaten by kingfishers was less than 3 inches and that most of the fish eaten were less than 5 inches.

At dusk on April 25, a Great Blue Heron (Ardea herodias) was seen flying to the lake. This bird would be a likely suspect for extensive predation, except for the fact that the shoal area of this lake is so small that it is doubtful that a heron could feed effectively. General observations in the Pigeon River Research area indicated that few predatory birds were present during the spring of 1962.

No predators other than birds were observed on the lake during the experiment.

The marked fish were protected from bird predators at least through April 21 by the ice cover. Marking for the first estimate

was completed by April 3. Ice remained on the lake until April 21 when about three-quarters of the lake was still covered with ice. A strong warm wind probably removed most of it the next day, and the lake was completely open by April 25. In the 8-day period from April 21 to the release of the merganser on April 30, no regular observations were made, and predators could have been reducing the population. However, fishermen were on the lake April 28 and 29 and their activity would probably have discouraged most predators on those days, which would leave six days (April 22-27) without observations or people on the lake.

This period without observations or fishermen on the lake can be reduced from six to two days by estimating the population size as of April 25. Fish taken at this time (the recapture sample of the first estimate) were given a distinctive fin clip. Using the ratio of marked to total number of trout recovered in the gill nets and angling (same recapture sample as used in the second estimate) a population estimate of 321 ± 124 trout was obtained. The figure of 321 trout is considerably less than the 407 estimated for late spring under the ice. The difference of 86 trout might be actual mortality or it might be error in the estimate; the confidence limits of ± 124 are quite broad. Assuming that the reduction to 321 was due to early mortality, the estimate of merganser consumption becomes 130 (± 70) trout rather than 216. Calculated as before, in 16 days the merganser ate 8 trout per day, or 0.8 pound per day or 38 per cent of her body weight per day.

Disease or parasites could have caused loss of trout. All of the trout in Section 4 Lake are heavily infested with gill lice (probably Salmincola edwardsii). Two fish dead of unknown causes were observed (see above). Gill lice could have caused these deaths but there was no large, sudden mortality during the experiment or the dead fish would have been found.

Behavior of the Merganser

The merganser was usually inactive when observed between 8:00 AM and 5:00 PM. During the two early morning observations, she was seen diving and swimming but never coming to the surface with a fish. Salyer and Lagler (1940) stated that mergansers feed during the morning and evening hours, with a mid-day rest period and that, presumably, they swallow smaller fishes underwater. Lindroth and Bergström (1959) confirmed the underwater swallowing in observations of young mergansers in a stream tank.

Several observations were made of the merganser swimming underwater. She did not use her wings even though startled and trying to escape. Likewise, the mergansers studied by Lindroth and Bergström (1959) did not use their wings while swimming underwater.

LITERATURE CITED

- Bailey, N. J. J. 1951. On estimating the size of mobile populations from recapture data. *Biometrika*, 38: 293-306.
- Latta, William C., and Gerald F. Myers. 1961. Night use of a direct-current electric shocker to collect trout in lakes. *Trans. Am. Fish. Soc.*, 90(1): 81-83.
- Lindroth, Arne, and Eva Bergström. 1959. Notes on the feeding technique of the goosander in streams. *Rept. Inst. Fresh-water Res.*, Drottningholm, No. 40, pp. 165-175.
- Salyer, J. Clark, II, and Karl F. Lagler. 1940. The food and habits of the American merganser during winter in Michigan, considered in relation to fish management. *J. Wildl. Mgmt.*, 4(2): 186-219.
- _____, and _____. 1949. The eastern belted kingfisher, Megaceryle alcyon alcyon (Linnaeus), in relation to fish management. *Trans. Am. Fish. Soc.*, 76(1946): 97-117.
- Tanner, Howard A. 1960. Some consequences of adding fertilizer to five Michigan trout lakes. *Trans. Am. Fish. Soc.*, 89(2): 198-205.
- Waters, Thomas F. 1960. The development of population estimate procedures in small trout lakes. *Trans. Am. Fish. Soc.*, 89(3): 287-294.

White, H. C. 1936. The food of kingfishers and mergansers on
the Margaree River, Nova Scotia. Jour. Biol. Bd.
Canada, 2(3): 299-309.

_____. 1957. Food and natural history of mergansers on
salmon waters in the Maritime Provinces of Canada.
Bull. Fish. Res. Bd. Canada, No. 116, 61 pp.

INSTITUTE FOR FISHERIES RESEARCH

William C. Latta and

Reginald F. Sharkey

Report approved by W. R. Crowe

Typed by M. S. McClure

Table 1. Ounces of trout fed and ounces of gain or loss in body weight of two female American Mergansers held in captivity.

Date (1962)	Merganser I					Merganser II				
	Weight of bird	Weight of trout fed	Average weight of trout fed per day	Average weight gain or loss per day	Percent of body weight fed per day	Weight of bird	Weight of trout fed	Average weight of trout fed per day	Average weight gain or loss per day	Percent of body weight fed per day
Feb. 24, 27 [↓]	50	--	--	--	--	48	--	--	--	--
Mar. 2 ²	44	--	--	--	--	43	--	--	--	--
Mar. 12	27	44.0	4.40	-1.70	10.0	25	40.5	4.05	-1.80	9.4
Mar. 18	35	55.5	9.25	+1.33	34.3	31	52.5	8.75	+1.00	35.0
Mar. 24	36	65.5	10.92	+0.17	31.2	31	51.0	8.50	0.00	27.4
Mar. 30	29	39.0	6.50	-1.17	18.1	27	39.0	6.50	-0.67	21.0
April 8	34	101.5	11.28	+0.56	38.9	33	99.0	11.00	+0.67	40.7
April 15	33	71.4	10.20	-0.14	30.0	33	69.3	9.90	0.00	30.0
April 20	34	51.0	10.20	+0.20	30.9	--	--	--	--	--
April 29	--	--	--	--	--	33	147.0	10.50	0.00	31.8

[↓] Merganser I was captured February 24, merganser II, February 27.

² Feeding began.

Table 2. Size of trout preferred by two captive female American mergansers.

Merganser	Date (1962)	Time (hours)		Size (inches)				
				4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9
I	Mar. 19	24	Entered	37	--	11	--	--
			Consumed	20	--	5	--	--
			Percent	54.2	--	54.1	--	--
	Mar. 21	24	Entered	17	--	5	--	--
			Consumed	17	--	3	--	--
			Percent	100.0	--	60.0	--	--
I	Mar. 26	2	Entered	6	--	6	--	6
			Consumed	4	--	1	--	0
			Percent	66.7	--	16.7	--	00.0
II	Mar. 26	2	Entered	6	--	6	--	6
			Consumed	5	--	1	--	0
			Percent	83.3	--	16.7	--	00.0
I	April 15	2	Entered	4	4	4	4	--
			Consumed	3	3	2	1	--
			Percent	75.0	75.0	50.0	25.0	--
Average percent				75.8	75.0	39.6	25.0	00.0

Table 3. Size of trout merganser I was able to consume while held in captivity.

Date (1962)	Size of trout			Condition of trout	Able to consume	Remarks
	Length (inches)	Weight (ounces)	Girth (inches)			
Mar. 12	8.5	3.0	3.5	Dead	Yes	Consumed immediately
	9.5	6.2	4.5	Dead	Yes	Consumed one hour after smaller fish above
Mar. 15	9.0	4.5	5.0	Dead	Yes	Consumed immediately
Mar. 16	9.4	5.0	4.8	Live	Yes	3 hours to reduce fish to helplessness then consumed
Apr. 17	10.0	--	4.2	Dead	Yes	Three attempts to swallow fish; after swallowed caudal fin visible for 10 minutes
Mar. 14	9.6	4.5	5.5	Dead	No	Unable to consume in 24 hours
Mar. 27	10.8	7.5	6.0	Live	No	Unable to consume in 24 hours

Table 4. Estimates of the number of brook trout present in Section 4 Lake before and after predation by an American Merganser.

Mark sample			Recapture sample				Pop- ula- tion esti- mate	95 per cent confi- dence limits
Date (1962)	Method	Num- ber of fish	Date (1962)	Method	Number of fish Total Marked			
First Estimate								
Mar. 19- Apr. 3	Angling	165	Apr. 25	Shocker	105	42	407	±94
Second Estimate								
May 14, 17	Shocker	77	May 21-23	Angling, gill net	51	20	191	±62

Table 5. Average total length (inches) and weight (pound) for each inch group of a sample of brook trout taken by angling, March 19 through April 3, 1962, Section 4 Lake.

Length group in inches	Number of fish	Average total lengths (inches)	Average weight (pound)
4.0- 4.9	3	4.7	0.03
5.0- 5.9	21	5.6	0.05
6.0- 6.9	32	6.5	0.08
7.0- 7.9	20	7.4	0.13
8.0- 8.9	11	8.5	0.18
9.0- 9.9	2	9.5	0.28
10.0-10.9	1	10.7	0.29

Table 6. Number of brook trout in each inch group of three samples taken from Section 4 Lake.

Length group in inches	Method and date		
	Angling (Mar. 19-Apr. 13, 1962)	Shocker (Apr. 25, 1962)	Shocker (May 14, 17, 1962)
4.0- 4.9	4	2	2
5.0- 5.9	39	18	4
6.0- 6.9	74	63	31
7.0- 7.9	33	13	33
8.0- 8.9	19	7	6
9.0- 9.9	4	2	1
10.0-10.9	2	--	--
Total	175	105	77

Figure 1. --Average weight gain or loss per day (ounces) plotted against average weight of trout fed per day (ounces) for two female American Mergansers held in captivity.

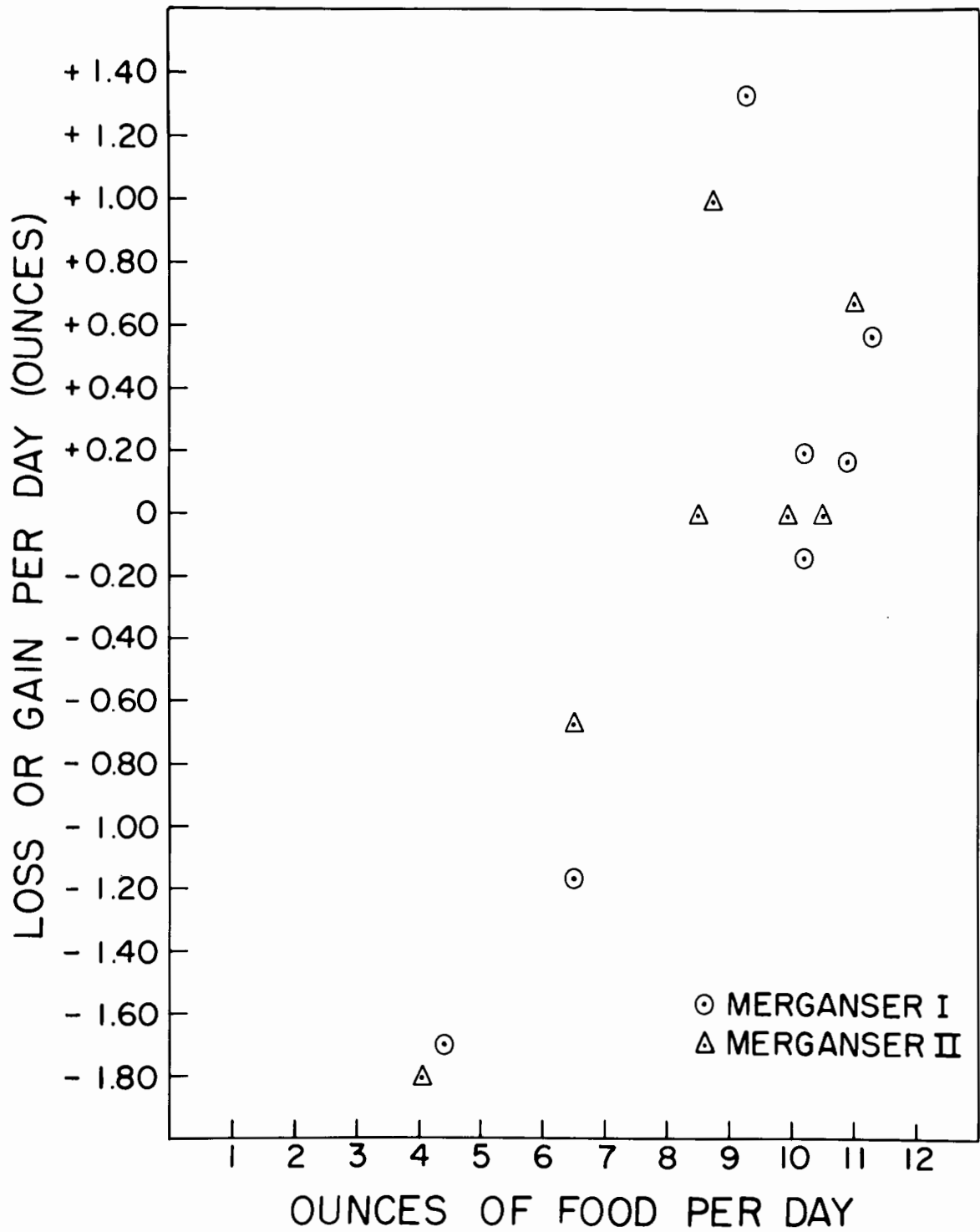


Figure 1