SEASONAL VARIATIONS in TOXICITY of BUTTER CLAMS from SELECTED ALASKA BEACHES

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SEASONAL VARIATIONS IN TOXICITY OF BUTTER CLAMS FROM SELECTED ALASKA BEACHES

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Introduction

The investigation of paralytic shellfish poison in the clams of Southeastern Alaska conducted by the Fishery Products Laboratory, Ketchikan,[1] was divided into three main projects. The one with which this report is concerned is the geographical and seasonal distribution of the toxin in butter clams, *Saxidomus giganteus*. The other two projects, the study of toxin reduction by processing methods and the study of sampling and testing methods, are to be reported in separate papers. Butter clams are the most important commercial clam resource in Southeastern Alaska. Therefore, the studies were devoted almost entirely to this species.

Investigations of an exploratory nature performed from 1946 to 1948 established the presence of toxin in butter clams from many of the Southeastern Alaska clam producing beaches during all seasons.

From May 1948 to September 1949, inclusive, a systematic monthly sampling of representative areas on certain commercially exploitable clam-producing beaches was carried out. The purposes of the survey were to determine the monthly fluctuations in the toxicity of the clams from the different areas and the variation in toxicity between the siphon and the body. Information on these factors is essential for intelligent regulation of this fishery and enables the processor to eliminate a major source of toxin from the canned product.

Collection of Clam Samples

The laboratory motor vessel *Researcher*, usually operated by a crew of three men, was used in collecting the clam samples. Shucking of the clams and preparation of the extracts were performed aboard the boat.

A wide knowledge of the clam beds in Southeastern Alaska, gained from the earlier general survey work, made it possible to select 10 representative clam beaches on which were laid out 22 plots. Nine of the beaches were known to produce clams of fairly high toxicity; whereas, the remaining one yielded clams of low toxicity. Preliminary toxicity tests on many individual clams from a single plot showed that there was considerable variation in toxicity between clams. These tests further showed that results significant within plus or minus 30 percent could be obtained from a sample of 25 clams. Therefore, the plots were made large enough to supply at least 18 samples of 25 clams each. To provide a thoroughly representative sample, not over 3 clams were taken from each hole dug, and the holes were distributed well over the entire plot. All the study plots were inundated at high water and completely exposed only at a minus tide. The collections were made, weather permitting, during one of the minus tide periods each month.

1/ Jointly operated by the Alaska Fisheries Experimental Commission and the U. S. Fish and Wildlife Service.

Extracting and Testing Procedure

The clams were opened with a shucking knife while they were still alive. The shucked clams were washed in fresh water to remove all foreign particles from the tissues, and then drained. The entire siphon (neck) was severed from the body, and the siphons and bodies were treated separately. These were minced using a hand operated meat chopper. The ground material was mixed thoroughly, and to 100 grams of the minced material was added 100 milliliters of 0.12 N hydrochloric acid (1 part concentrated hydrochloric acid to 99 parts distilled water). This mixture was boiled for 5 minutes while being stirred continuously. After cooling, the mixture was brought to its original volume by the addition of distilled water. A portion of the final mixture was bottled and stored in the ice box of the vessel until the boat returned to Ketchikan. At the laboratory the pH of the extract was determined with a pH meter, and, when necessary, it was adjusted to a range of pH 4.0 to 4.5 by adding 5 N hydrochloric acid or 0.1 N sodium hydroxide. The extract was centrifuged, and the supernatant liquid was placed in vials and stored at 0° to 3° C. until tests were performed.

The extracts were tested on white mice which weighed between 15 and 25 grams. The mice, obtained from a supplier in California, were a mixture of two strains. They were shipped air express and arrived at the laboratory in good condition.

The extracts were injected intraperitoneally by means of a two milliliter insulin syringe. The smallest practicable needle (27 gauge) was used to reduce leakage from the puncture. The volume of extract injected into each mouse was varied according to the weight of the mouse. One-twentieth of a milliliter of the extract - or diluted extract - for each gram of live weight was used. This procedure was found to be more satisfactory than the injection of a standard amount of extract and the application of a correction factor based on the weight of the mouse.

The lethal time was computed, in seconds, from the time that one-half of the volume of extract had been injected until the mouse took its final normal, rhythmic breath. This time of death, in almost every case, was accompanied by a complete relaxation of the body, followed by a series of reflex motions varying in intensity and duration. When necessary, with the highly toxic materials, the extracts were diluted so that the lethal time exceeded four minutes.

A table based on the toxicity curve of Sommer and Meyer (1937) was used to convert the lethal time to toxicity of the injected solution. The toxicity of the raw material, expressed as mouse units per 100 grams of raw material, was calculated by applying the appropriate dilution factors. A mouse unit (MU) has been defined as that amount of injected shellfish poison that kills a 20 gram mouse in 15 minutes (Sommer, et al., 1948). Since Sommer and Meyer (1937) constructed their curve from data obtained from mussels, a similar curve was developed from data obtained using butter clam extracts. A comparison of the two curves demonstrated that the data reported for mussel extracts could be used satisfactorily in the clam toxicity assay.

At least three mice were used to assay each extract. Extensive tests[2/] had proved that results based on the use of three mice gave an accuracy of better than plus or minus 42 percent. Errors due to variations in the mice, technique of injection, and determination of death-times were reduced by rejection of individual assay results differing from the average by more than one-third.

Location of Plots

The locations of the beaches and the distribution of the plots were based on extensive knowledge of the clam beds in Southeastern Alaska, acquired from the general survey. Nine beaches which past experience had shown would yield highly toxic clams, at least during some periods of the year, and one beach which had yielded essentially non-toxic clams, were selected. These beaches were distributed over as wide an area as it was practical to visit frequently with the laboratory's motor vessel.

It is to be noted that none of the beaches chosen was from so-called outside waters, since previous investigation had shown that clams from those areas were relatively non-toxic. However, all the beaches studied were on fairly wide channels which communicate directly with the ocean. The plots were on clam beds near the mouths of bays or passages which were readily affected by the currents in the large channels. None of the plots was located near the head of a bay or inlet. Throughout the entire clam research program it was found that clams decreased in toxicity as the sampling continued toward the head of the bays.

From one to three plots were laid out in each of the ten areas selected for study. The plots were outlined by four iron stakes bearing metal tags stamped with the alphabetic designation of the plot. The 22 plots were lettered, A through V, beginning with a beach near Ketchikan and ending with a location in Frederick Sound. Locations, descriptions and characteristics of the study plots are detailed in Table 1.

The unfavorable weather during the winter months and the considerable distance of some of the beaches from Ketchikan made it impossible to obtain a complete sequence of data from each plot. This was especially true in regard to the more northerly plots in Chatham Strait. Fortunately, it was possible to obtain fairly complete data from plots near Ketchikan.

Plot O was omitted after October because the float at Fanshaw, which was the only safe anchorage in foul weather, was destroyed by a storm.

2/ Unpublished data of report in preparation.

TABLE I. - IDENTIFICATION AND DESCRIPTION OF THE STUDY PLOTS

PLOT	LOCATION	SITE	TERRAIN	SLOPE[1/]	AREA [2/] YARDS
A	HAM ISLAND 55° 11' 54" N 131° 23' 10" W	WEST SIDE OF THE NORTHERN TIP OF HAM ISLAND, ALONG THE NARROW PASSAGE CONNECTING CASCADE INLET WITH REVILLAGIGEDO CHANNEL.	GRAVEL SAND SHELL	SHARP	10x3
B	HAM ISLAND 55° 11' 45" N 131° 23' 11" W	SOUTHWEST OF PLOT A, IMMEDIATELY NORTH OF A POINT FORMING THE HAM ISLAND SIDE OF THE NARROWEST PART OF THE PASSAGE.	GRAVEL SAND SHELL	SHARP	12x4
C	ANNETTE ISLAND 55° 11' 47" N 131° 23' 20" W	ACROSS THE PASSAGE, NORTHWEST OF PLOT B, JUST WEST OF THE ROCKY POINT FORMING THE ANNETTE ISLAND SIDE OF THE NARROWEST POINT IN THE PASSAGE.	GRAVEL SHELL	GENTLE	11X7
D	DALL BAY 55° 09' 02" N 131° 43' 55" W	ON A SINGLE REEF, AWASH AT HIGH TIDE, IN DALL BAY, GRAVINA ISLAND, WESTWARD OF THE NORTH END OF THE LARGE ISLAND OFF DALL BAY. PLOT WAS ON THE SUMMIT OF A WASH LYING NORTHEAST BY SOUTHWEST ON EASTERN END OF THE REEF.	GRAVEL SAND SHELL	MODERATE	10x5
E	DALL BAY 55° 09' 02" N 131° 43' 57" W	ON WEST SIDE OF SAME REEF AS PLOT D.	SAND SHELL BOULDERS	GENTLE	8x8
F	CARLTON ISLAND 55° 54' 55" N 132° 22' 00" W	ON A CONSPICUOUS WHITE BEACH, ON NORTHEAST SIDE OF THE ISLAND.	GRAVEL SHELL	SHARP	11x5
G	CARLTON ISLAND 55° 54' 50" N 132° 21' 50" W	MIDWAY BETWEEN PLOT F AND SOUTHEASTERN POINT OF THE ISLAND.	SAND SHELL BOULDERS	MODERATE	18x10
H	CARLTON ISLAND 55° 54' 30" N 132° 22' 00" W	ON A FLAT, EXPOSED AT MINUS TIDE, BETWEEN CARLTON AND ONSLOW ISLANDS, AND JUST NORTHEAST OF THE HIGHEST POINT ON THE RIDGE OF ROCKS RISING FROM THE FLAT.	GRAVEL SAND SHELL BOULDERS	NEARLY LEVEL	15x14
I	WRANGELL NARROWS 56° 49' 20" N 132° 56' 40" W	ON MITKOF ISLAND, JUST INSIDE NORTHERN ENTRANCE TO THE NARROWS, DIRECTLY EAST OF FLASHING RED BUOY NO. 42.	GRAVEL MUD BOULDERS	SHARP	15x5
J	SAN JUAN ISLAND 57° 17' 35" N 134° 00' 50" W	AT ENTRANCE TO PYBUS BAY, 0.8 MILE SOUTHWESTWARD OF POINT PYBUS, ADMIRALTY ISLAND. AT MINUS TIDE THE TWO ISLANDS ARE CONNECTED BY A GRAVEL BAR AT THEIR WESTERN ENDS. PLOT LIES BETWEEN ROCKY OUTCROPPINGS, FORMING A POCKET, AT SOUTHWEST END OF NORTHERN ISLAND, ON THE EAST OR FREDERICK SOUND SIDE OF THE GRAVEL BAR.	GRAVEL SAND SHELL BOULDERS OVER BEDROCK	MODERATE	10x5
K	SAN JUAN ISLAND 57° 17' 35" N 134° 00' 55" W	MIDWAY ON EAST SIDE OF GRAVEL BAR, IMMEDIATELY SOUTH OF A WELL-DEFINED SANDY AREA.	GRAVEL SAND SHELL BOULDERS	GENTLE	22x6
L	SAN JUAN ISLAND 57° 17' 37" N 134° 01' 10" W	ON WEST OR UP-BAY SIDE OF GRAVEL BAR, NEAR WEST END OF SOUTH ISLAND IN A POCKET FORMED BY THE GRAVEL BAR AND A SMALL REEF.	GRAVEL SAND BOULDERS OVER BEDROCK	GENTLE	12x5

TABLE 1. - IDENTIFICATION AND DESCRIPTION OF THE STUDY PLOTS (CONTINUED)

PLOT	LOCATION	SITE	TERRAIN	SLOPE 1/	AREA 2/ YARDS
M	ROBERTS ISLAND 57° 18' 05" N 133° 27' 50" W	ON LARGEST OF ROBERTS ISLANDS WHICH FORM THE SOUTH POINT AT THE ENTRANCE TO PORT HOUGHTON, WHICH MAKES OFF FROM STEPHENS PASSAGE. PLOT WAS ON WEST OR STEPHENS PASSAGE SIDE OF A SPIT CONNECTING EASTERN END OF THIS ISLAND TO A WOODED ISLET IMMEDIATELY TO THE SOUTH.	GRAVEL SAND SHELL SMALL ROCKS	GENTLE	10x8
N	ROBERTS ISLAND 57° 18' 00" N 133° 27' 30" W	ON EAST OR UP-BAY SIDE OF THE SPIT ACROSS FROM PLOT M.	GRAVEL SAND SHELL	GENTLE	12x7
O	FANSHAW 57° 13' 00" N 133° 30' 10" W	ON MAINLAND AT SOUTHERN END OF CLEVELAND PASSAGE, WHICH LIES BETWEEN MAINLAND AND WHITNEY ISLAND. PLOT WAS APPROXIMATELY 1000 YARDS NORTHWEST OF FANSHAW POST OFFICE. WAS DISCONTINUED AFTER OCTOBER BECAUSE OF UNSAFE ANCHORAGE IN FOUL WEATHER.	GRAVEL MUD BOULDERS	GENTLE	20x7
P	CHAIK BAY 57° 19' 55" N 134° 33' 40" W	ON A BARE LEDGE 0.5 MILE FROM NORTH SHORE OF CHAIK BAY, INSIDE VILLAGE POINT, ADMIRALTY ISLAND. PLOT WAS ON SOUTHEAST OR UP-BAY SIDE OF THE LEDGE.	GRAVEL SAND SHELL	MODERATE	13x5
Q	CHAIK BAY 57° 19' 59" N 134° 33' 50" W	ON CHATHAM STRAIT SIDE OF LEDGE ACROSS FROM PLOT P, BETWEEN ROCKY OUTCROPPINGS.	GRAVEL SAND BOULDERS	GENTLE	17x11
R	HOOD BAY 57° 26' 35" N 134° 32' 55" W	ON EAST SIDE OF THE SOUTHERN END OF SAND ISLAND, WHICH IS A SMALL ISLAND OFF THE EAST SHORE OF HOOD BAY, ADMIRALTY ISLAND, AND ABOUT 1.5 MILES SOUTHEAST OF KILLISNOO ISLAND. PLOT WAS ON EAST END OF A Y-SHAPED WASH.	GRAVEL SAND SHELL BOULDERS	GENTLE	9x7
S	HOOD BAY 57° 26' 35" N 134° 33' 10" W	ON WEST END OR CHATHAM STRAIT SIDE OF THE Y-SHAPED WASH, ON SOUTHERN END OF SAND ISLAND, ACROSS FROM PLOT R.	SAND SHELL	GENTLE	13x6
T	HOOD BAY 57° 26' 25" N 134° 32' 55" W	ON END OF SOUTH ARM OF THE Y-SHAPED WASH, BETWEEN PLOTS R AND S ON SOUTHERN POINT OF SAND ISLAND.	GRAVEL SAND SHELL	GENTLE	8x8
U	SECURITY BAY 56° 50' 45" N 134° 20' 10" W	ON REEF, AWASH AT HIGH TIDE, JUST WEST OF SHALLOW BIGHT ON WEST SIDE OF CLEFT ISLAND, IN SECURITY BAY, KUIU ISLAND. PLOT WAS ON EAST END OF A DEPRESSION BISECTING THE REEF. HAS AN ODOR OF HYDROGEN SULPHIDE.	MUD SHELL OVER BEDROCK	GENTLE	5x10
V	SECURITY BAY 56° 51' 50" N 134° 21' 05" W	ON THE EAST SIDE NEAR THE SOUTHERN END OF HARBOR ISLAND, WHICH IS NORTHWEST OF CLEFT ISLAND, IN SECURITY BAY.	GRAVEL SAND BOULDERS	GENTLE	8x6

1/ SHARP SLOPE : A DROP OF 1 FOOT IN 10 FEET.
MODERATE SLOPE: A DROP OF 1 FOOT IN 25 FEET.
GENTLE SLOPE : A DROP OF 1 FOOT IN 40 FEET.

2/ AREA: FIRST FIGURE IS DISTANCE PARALLEL TO WATER'S EDGE.

Discussion of Experimental Results

The results of the monthly toxicity tests for each plot are presented in Table 2. The data represent the toxicity in mouse units per 100 grams of siphons or bodies. The graphic interpretation of this information is shown in Figures 1 to 9. The toxicities of bodies and siphons from the same sample have been placed in the same figure. Toxicity curves from plots in the same locality have been combined in one figure.

The plots studied were typical of the clam beds in Southeastern Alaska in terrain and clam population. However, as was mentioned previously, nine of the plots were located on beaches of known high toxicity in order to provide clams containing determinable quantities of toxin throughout the year. This was done so that any fluctuations in toxicity could be determined from month to month.

The reactions of the mice which died when injected with the extracts of clam materials (either bodies or siphons) were identical to the reactions described for deaths due to the injection of mussel poison. Two investigators who had worked extensively with mussel poison confirmed this observation. In post-mortem examinations immediately after death, the chambers of the heart were noted to beat rhythmically; this so-called heart block is a characteristic of mussel poisoning.

The seasonal toxicity characteristics of butter clams are very definitely different from those of mussels, *Mytilus californianus*, and Washington clams, *Saxidomus nuttallii*, of California (Sommer and Meyer 1937) and of mussels, *Mytilus edulis*, and soft shell clams, *Mya arenaria*, of New Brunswick (Medcof, et al., 1947). Studies of the California and New Brunswick species indicate that there are short periods in the summer months when they become highly toxic. The toxicity increases rapidly and then diminishes rapidly within a few weeks. During the winter months these species are normally relatively free of toxin. In the present survey, except for Plot I, which had relatively non-toxic clams throughout the year, the butter clams from all the beaches showed some degree of toxicity at every sampling.

From a study of dinoflagellates in these waters made during the summer of 1949, the report of which has not yet been published,[3/] it is known that dinoflagellates of the genus *Gonyaulax*, a member of which is the causative organism of mussel poison, do abound in the waters along the Alaskan beaches studied.

The toxicity of the siphons was regularly much greater than that of the bodies. However, the ratio of toxicities of siphons to bodies is not constant. The toxicity of the siphons varies greatly from month to month, while the toxicity of the bodies does not display a similar degree of change. The ratio of the weight of siphons to bodies depends upon the care with which the siphons are removed. The data from three laboratory

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3/ A study of dinoflagellates in the waters of Southeastern Alaska carried out by Lucile Foster of the George Williams Hooper Foundation in cooperation with the Fishery Products Laboratory.

experiments using 25 clams each show that the siphons were 14.3 to 16.4 percent of the total clam meats. The siphons were cut from the bodies after the manner of commercial shucking, in which approximately 3/4 of the siphon is removed. In two additional experiments using 25 clams each, the entire siphons were pulled from the bodies. Separated in this manner, the siphons constituted 18.5 to 19.9 percent of the total clam meats. In a semi-commercial operation in which 290 bushels of clams were shucked raw by a regular shucking crew, who were instructed to cut off all the siphon carefully, the siphons were 18.5 percent of the total clam meats. The separation of the siphons in the present survey followed the latter method.

The results of the survey do not show uniformity in the fluctuation of toxicities of the clams. Even those from plots in the same locality do not always display the same trend.

There is no evident correlation between the degree of toxicity and the terrain of the beach, the magnitude of the tides, temperature of the water, or amount of daylight. However, the data do suggest a recurring fluctuation in the toxicity during the year.

Conclusions

A 16 month survey of representative clam beds in Southeastern Alaska verifies the earlier findings that a toxin or toxins, which cause reactions in mice similar to those produced by toxin frequently present in mussels (paralytic shellfish poison), is present in the butter clams of Southeastern Alaska from certain areas during every month.

The toxicity of the siphons is usually several times greater than that of the bodies.

The toxicity of the bodies does not vary greatly from month to month, while the toxicity of the siphons shows marked fluctuations.

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TABLE 2. - MONTHLY TOXICITY SURVEY OF BUTTER CLAM SAMPLES FROM PLOTS ON SELECTED SOUTHEASTERN ALASKA BEACHES

PLOT NO.	LOCATION	TOXICITY, IN MOUSE UNITS PER 100 GRAMS OF MEAT							
		MAY 1948		JULY 1948		AUG. 1948		SEPT. 1948	
		BODIES	SIPHONS	BODIES	SIPHONS	BODIES	SIPHONS	BODIES	SIPHONS
A	HAM ISLAND	1,200	4,600	2,400	23,000	3,800	28,000	-	-
B	HAM ISLAND	1,500	2,900	1,400	18,000	790	18,000	-	-
C	ANNETTE ISLAND	2,700	4,900	1,800	24,000	1,600	25,000	-	-
D	DALL BAY	2,400	3,200	2,100	17,000	2,600	14,000	-	-
E	DALL BAY	1,700	2,900	3,200	13,000	1,600	11,000	-	-
F	CARLTON ISLAND	1,300	LOST	800	6,400	1,100	3,600	1,300	6,200
G	CARLTON ISLAND	1,200	2,100	950	3,100	460	3,600	1,000	3,700
H	CARLTON ISLAND	1,200	2,000	660	2,900	830	4,100	630	3,500
I	PETERSBURG	200	180	NEG.	220	NEG.	230	NEG.	210
J	PYBUS BAY	1,900	6,200	1,100	9,200	930	21,000	960	12,000
K	PYBUS BAY	1,300	6,700	1,300	14,000	1,400	14,000	1,300	10,000
L	PYBUS BAY	540	2,600	620	14,000	1,100	14,000	1,200	15,000
M	ROBERTS ISLAND	210	2,100	1,800	17,000	900	17,000	660	13,000
N	ROBERTS ISLAND	3,500	6,300	2,800	4,700	2,300	5,700	3,200	15,000
O	FANSHAW	2,700	7,900	1,900	5,400	1,400	10,000	1,900	12,000
P	CHAIK BAY	-	-	760	13,000	1,800	22,000	940	17,000
Q	CHAIK BAY	-	-	350	11,000	620	14,000	360	7,200
R	HOOD BAY	-	-	1,100	16,000	440	9,100	710	11,000
S	HOOD BAY	-	-	530	6,700	630	7,400	900	4,900
T	HOOD BAY	-	-	370	5,000	470	7,000	350	5,000
U	SECURITY BAY	-	-	-	-	580	5,600	360	7,000
V	SECURITY BAY	-	-	-	-	620	9,100	510	13,000

TABLE 2. - MONTHLY TOXICITY SURVEY OF BUTTER CLAM SAMPLES FROM PLOTS ON SELECTED SOUTHEASTERN ALASKA BEACHES - CONTINUED

PLOT NO.	LOCATION	TOXICITY, IN MOUSE UNITS PER 100 GRAMS OF MEAT							
		OCT. 1948		NOV. 1948		DEC. 1948		JAN. 1949	
		BODIES	SIPHONS	BODIES	SIPHONS	BODIES	SIPHONS	BODIES	SIPHONS
A	HAM ISLAND	2,500	5,100	-	-	1,400	12,000	1,600	19,000
B	HAM ISLAND	1,600	5,700	-	-	920	5,800	550	11,000
C	ANNETTE ISLAND	2,000	4,900	-	-	780	6,900	1,000	18,000
D	DALL BAY	-	-	1,700	5,400	2,600	19,000	2,300	14,000
E	DALL BAY	-	-	3,600	16,000	3,400	12,000	3,100	12,000
F	CARLTON ISLAND	1,100	6,500	670	1,600	1,000	6,600	-	-
G	CARLTON ISLAND	1,000	4,300	970	1,100	1,200	4,100	-	-
H	CARLTON ISLAND	780	LOST	820	2,100	970	4,800	-	-
I	PETERSBURG	NEG.	220	NEG.	210	-	-	NEG.	210
J	PYBUS BAY	1,100	19,000	760	11,000	-	-	-	-
K	PYBUS BAY	2,000	13,000	840	10,000	-	-	-	-
L	PYBUS BAY	1,300	17,000	930	11,000	-	-	-	-
M	ROBERTS ISLAND	1,700	18,000	1,500	18,000	-	-	-	-
N	ROBERTS ISLAND	3,900	16,000	1,700	8,700	-	-	-	-
O	FANSHAW	1,600	13,000	OMITTED FROM FURTHER SAMPLING AFTER OCTOBER					
P	CHAIK BAY	760	14,000	-	-	-	-	-	-
Q	CHAIK BAY	400	5,900	-	-	-	-	-	-
R	HOOD BAY	1,100	9,500	-	-	-	-	-	-
S	HOOD BAY	590	7,900	-	-	-	-	-	-
T	HOOD BAY	860	8,300	-	-	-	-	-	-
U	SECURITY BAY	1,100	13,000	810	5,000	-	-	-	-
V	SECURITY BAY	1,000	13,000	400	6,200	-	-	-	-

Table 2. - Monthly toxicity survey of butter clam samples from plots on selected Southeastern Alaska beaches - Continued

Plot No.	Location	Toxicity, in mouse units per 100 grams of meat							
		Feb. 1949		Mar. 1949		Apr. 1949		May 1949	
		Bodies	Siphons	Bodies	Siphons	Bodies	Siphons	Bodies	Siphons
A	Ham Island	1,500	24,000	2,000	21,000	2,200	22,000	3,000	20,000
B	Ham Island	1,000	12,000	1,100	7,900	670	11,000	2,100	10,000
C	Annette Island	1,100	17,000	2,200	18,000	1,300	14,000	2,400	16,000
D	Dall Bay	-	-	-	-	2,600	10,000	3,500	13,000
E	Dall Bay	-	-	-	-	2,400	11,000	3,800	10,000
F	Carlton Island	-	-	670	5,500	700	4,800	870	3,000
G	Carlton Island	-	-	1,100	4,400	1,400	4,700	630	4,200
H	Carlton Island	-	-	650	3,200	800	3,900	690	3,700
I	Petersburg	-	-	Neg.	200	Neg.	200	Neg.	Neg.
J	Pybus Bay	-	-	1,100	13,000	1,500	16,000	1,800	16,000
K	Pybus Bay	-	-	1,300	8,300	1,600	10,000	1,700	9,600
L	Pybus Bay	-	-	1,300	12,000	920	11,000	1,400	14,000
M	Roberts Island	-	-	1,600	15,000	1,200	14,000	1,400	11,000
N	Roberts Island	-	-	2,600	16,000	3,200	13,000	2,300	9,200
O	Fanshaw	Omitted from further sampling after October							
P	Chaik Bay	-	-	640	10,000	700	11,000	590	8,300
Q	Chaik Bay	-	-	970	8,100	750	6,400	600	6,800
R	Hood Bay	-	-	1,100	11,000	540	3,300	680	9,500
S	Hood Bay	-	-	480	4,200	760	5,800	660	4,200
T	Hood Bay	-	-	560	4,600	750	6,300	840	3,900
U	Security Bay	-	-	470	6,500	400	5,600	240	3,900
V	Security Bay	-	-	690	9,300	540	7,900	790	7,600

Table 2. - Monthly toxicity survey of butter clam samples from plots on selected Southeastern Alaska beaches - Continued

Plot No.	Location	Toxicity, in mouse units per 100 grams of meat							
		June 1949		July 1949		Aug. 1949		Sept. 1949	
		Bodies	Siphons	Bodies	Siphons	Bodies	Siphons	Bodies	Siphons
A	Ham Island	-	-	1,400	15,000	2,100	12,000	1,800	13,000
B	Ham Island	-	-	620	5,600	1,500	7,900	1,500	11,000
C	Annette Island	-	-	1,500	11,000	2,700	12,000	1,900	12,000
D	Dall Bay	-	-	-	-	1,800	6,800	1,900	9,700
E	Dall Bay	-	-	2,800	4,100	3,100	4,100	3,300	8,800
F	Carlton Island	2,100	5,500	1,600	7,500	1,400	11,000	-	-
G	Carlton Island	1,300	5,400	1,800	Lost	1,400	7,600	-	-
H	Carlton Island	1,000	3,400	Lost	8,300	1,400	13,000	-	-
I	Petersburg	Neg.	Neg.	Neg.	Neg.	-	-	-	-
J	Pybus Bay	1,400	12,000	1,900	9,100	1,100	7,300	-	-
K	Pybus Bay	1,700	8,800	1,600	9,500	1,100	11,000	-	-
L	Pybus Bay	1,300	15,000	1,200	16,000	1,200	13,000	-	-
M	Roberts Island	1,900	10,000	2,700	14,000	1,100	12,000	-	-
N	Roberts Island	2,000	13,000	2,500	14,000	1,400	9,700	-	-
O	Fanshaw	Omitted from further sampling after October							
P	Chaik Bay	850	11,000	1,500	16,000	560	11,000	-	-
Q	Chaik Bay	760	7,700	1,200	9,600	750	10,000	-	-
R	Hood Bay	1,100	9,300	1,400	8,000	480	11,000	-	-
S	Hood Bay	800	6,500	1,100	9,600	580	6,500	-	-
T	Hood Bay	770	4,800	1,000	8,100	280	6,000	-	-
U	Security Bay	760	5,200	1,200	10,000	350	6,600	-	-
V	Security Bay	810	9,100	1,100	7,800	540	7,800	-	-

Figures 1 to 9 show graphically the monthly variation in toxicity of the bodies and siphons of butter clam samples from plots on selected Southeastern Alaska beaches.

Interior--Duplicating Section, Washington, D. C. 82763

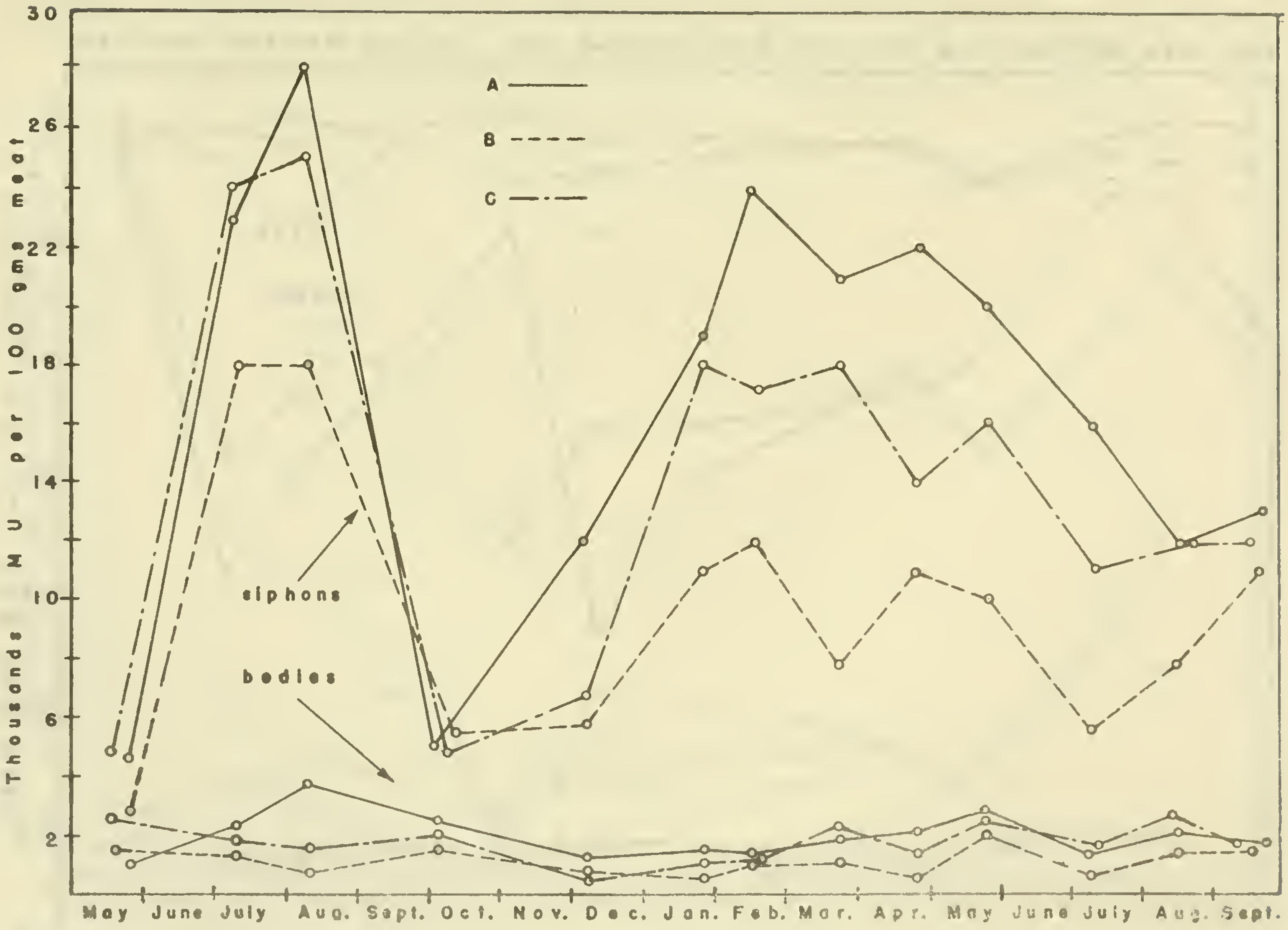

Figure 1.--Ham Island, plots A and B; Annette Island, plot C.

Figure 2.--Dall Bay, plots D and E.

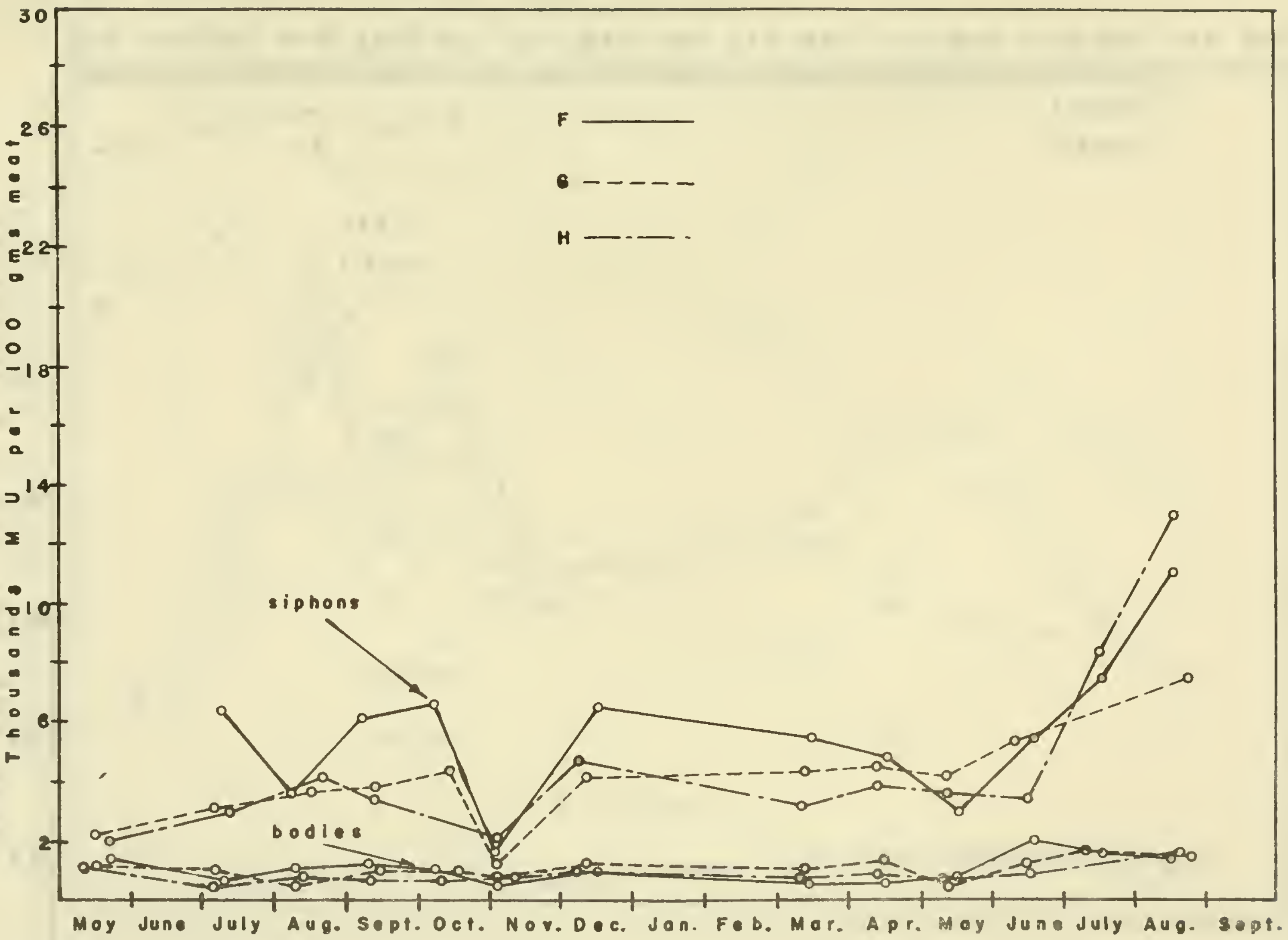

Figure 3.--Carlton Island, plots F, G, and H.

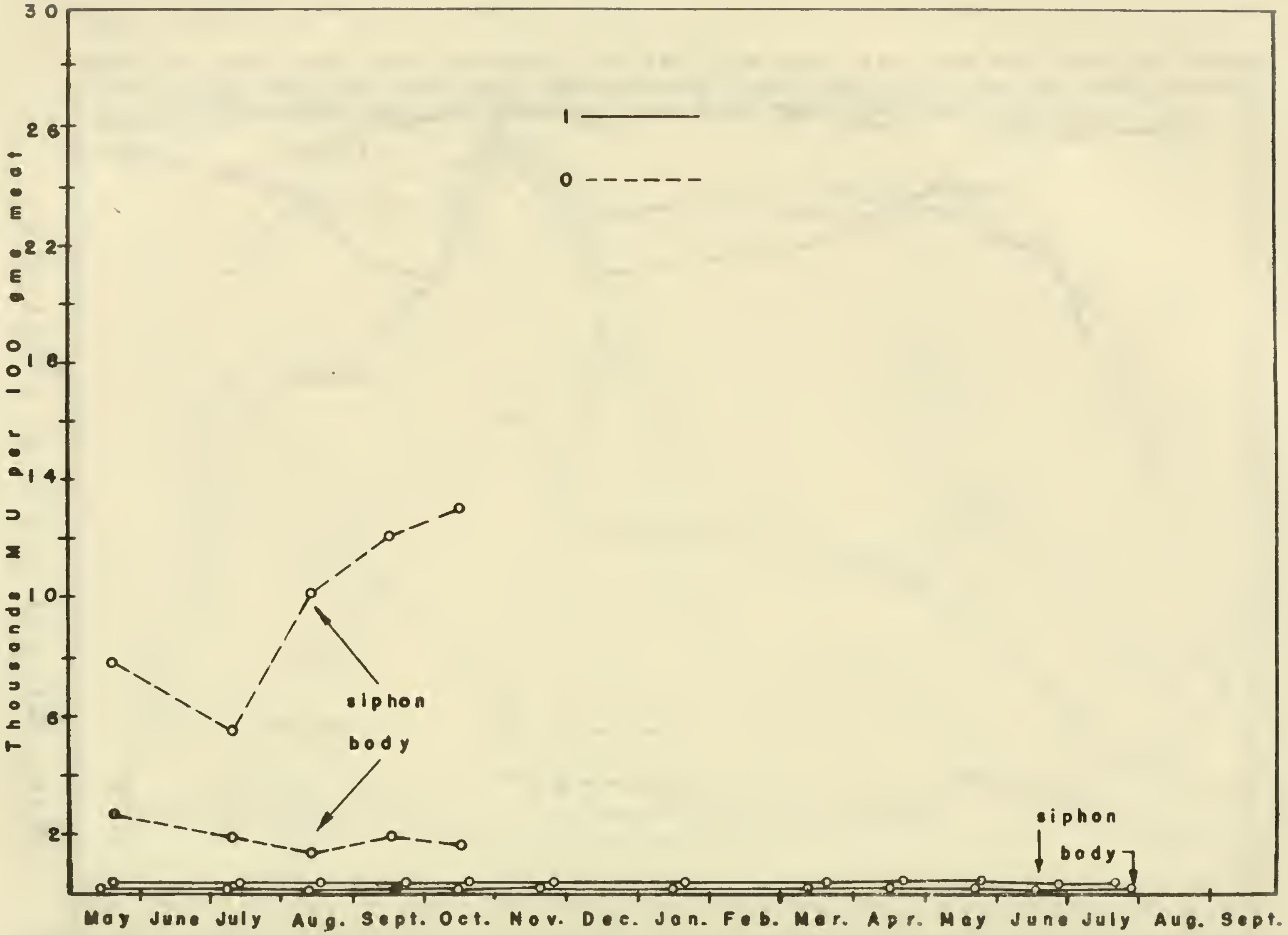

Figure 4.—Wrangell Narrows, plot I; Fanshaw, plot O.

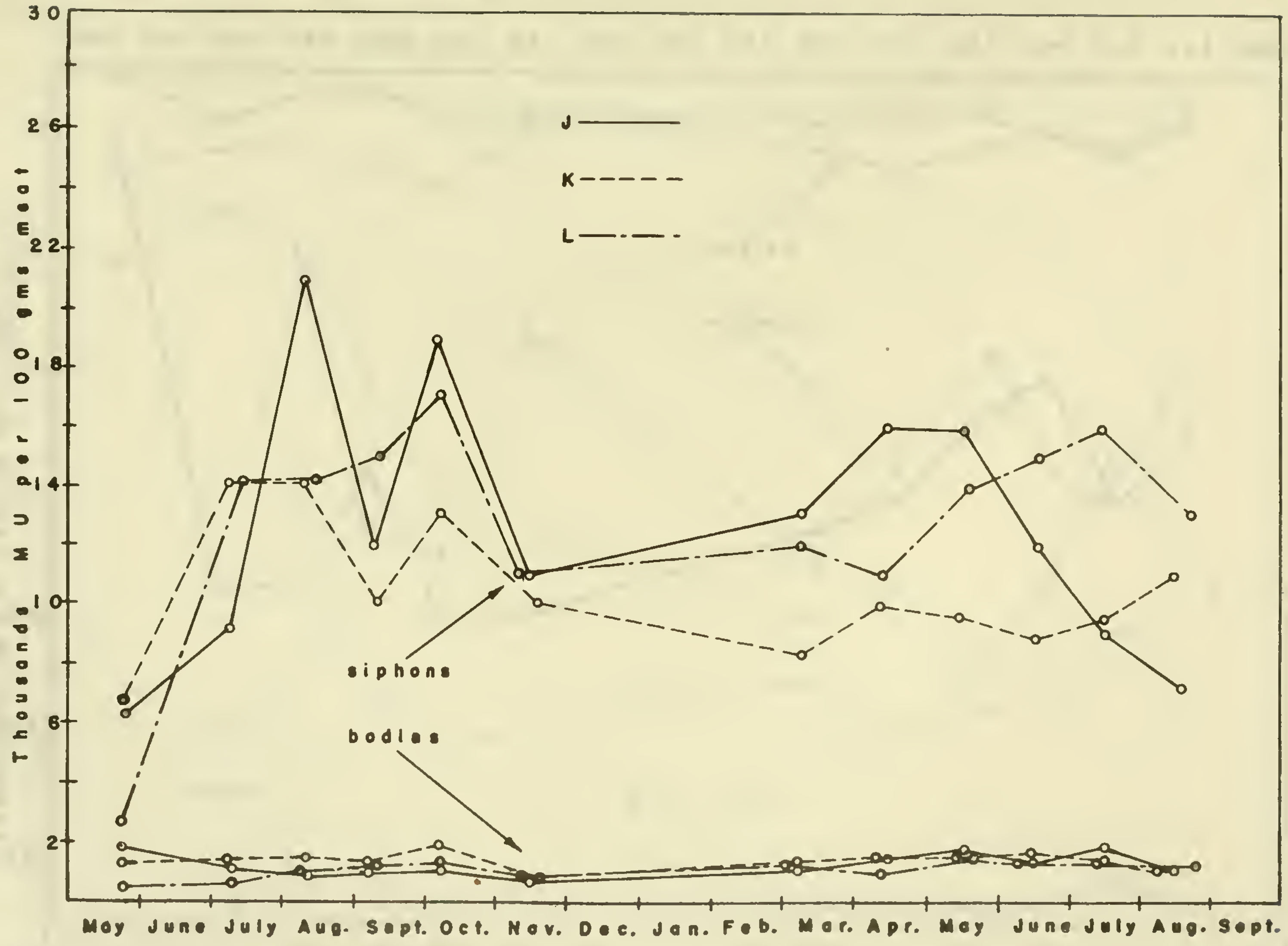

Figure 5.--San Juan Islands, plots J, K, and L.

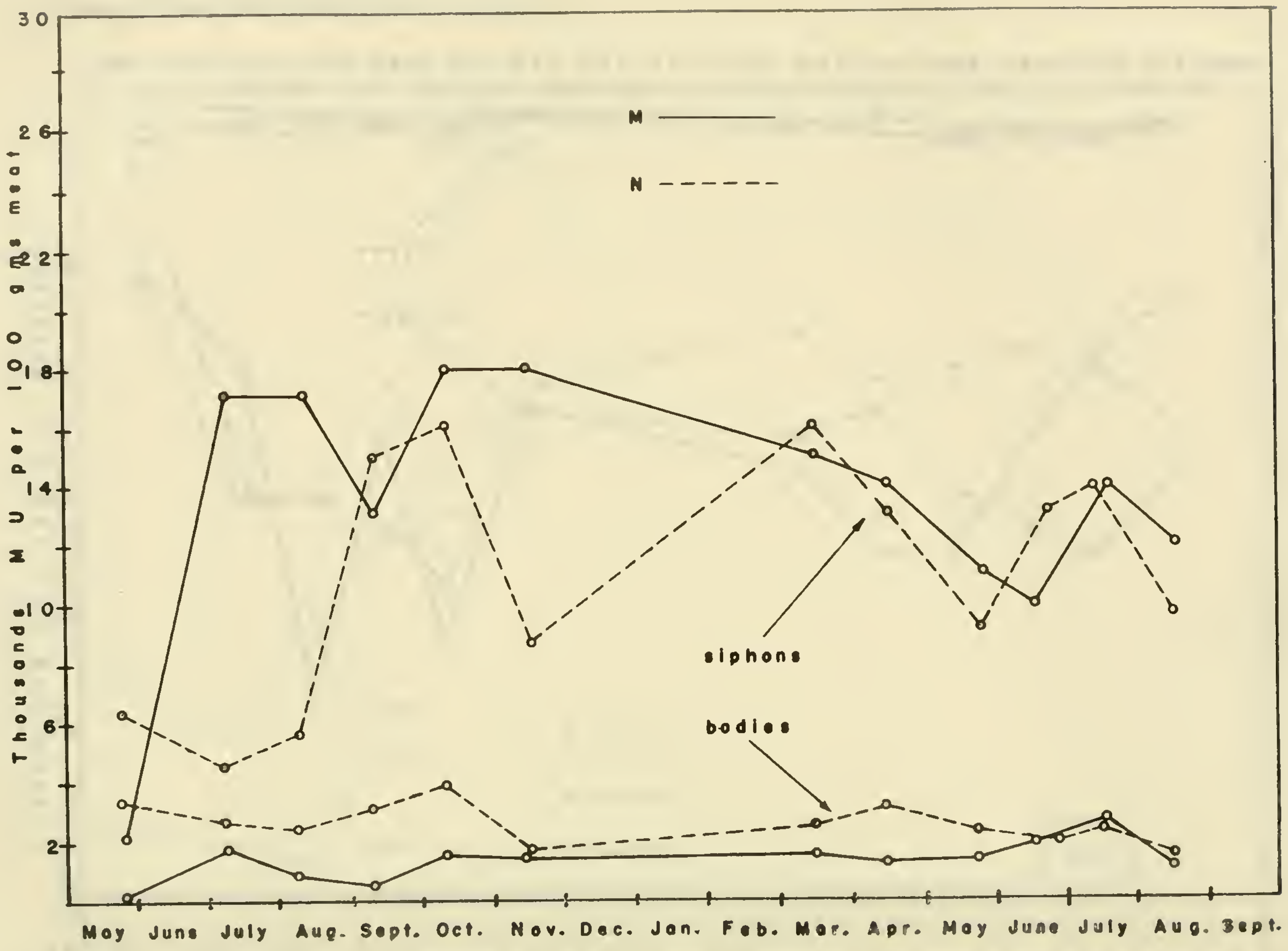

Figure 6.—Roberts Islands, plots M and N.

Figure 7.--Chaik Bay, plots P and Q.

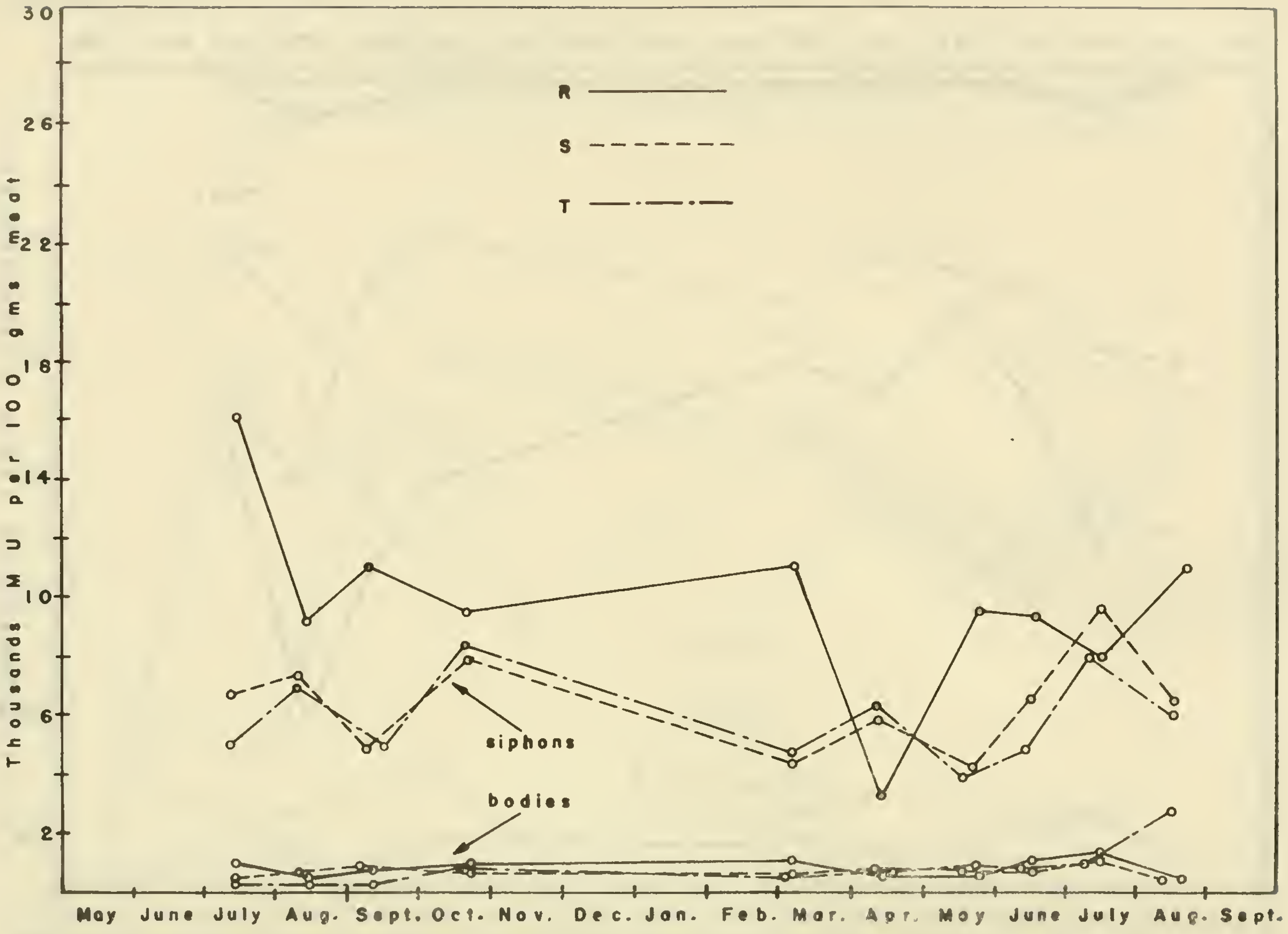

Figure 8.--Hood Bay, plots R, S, and T.

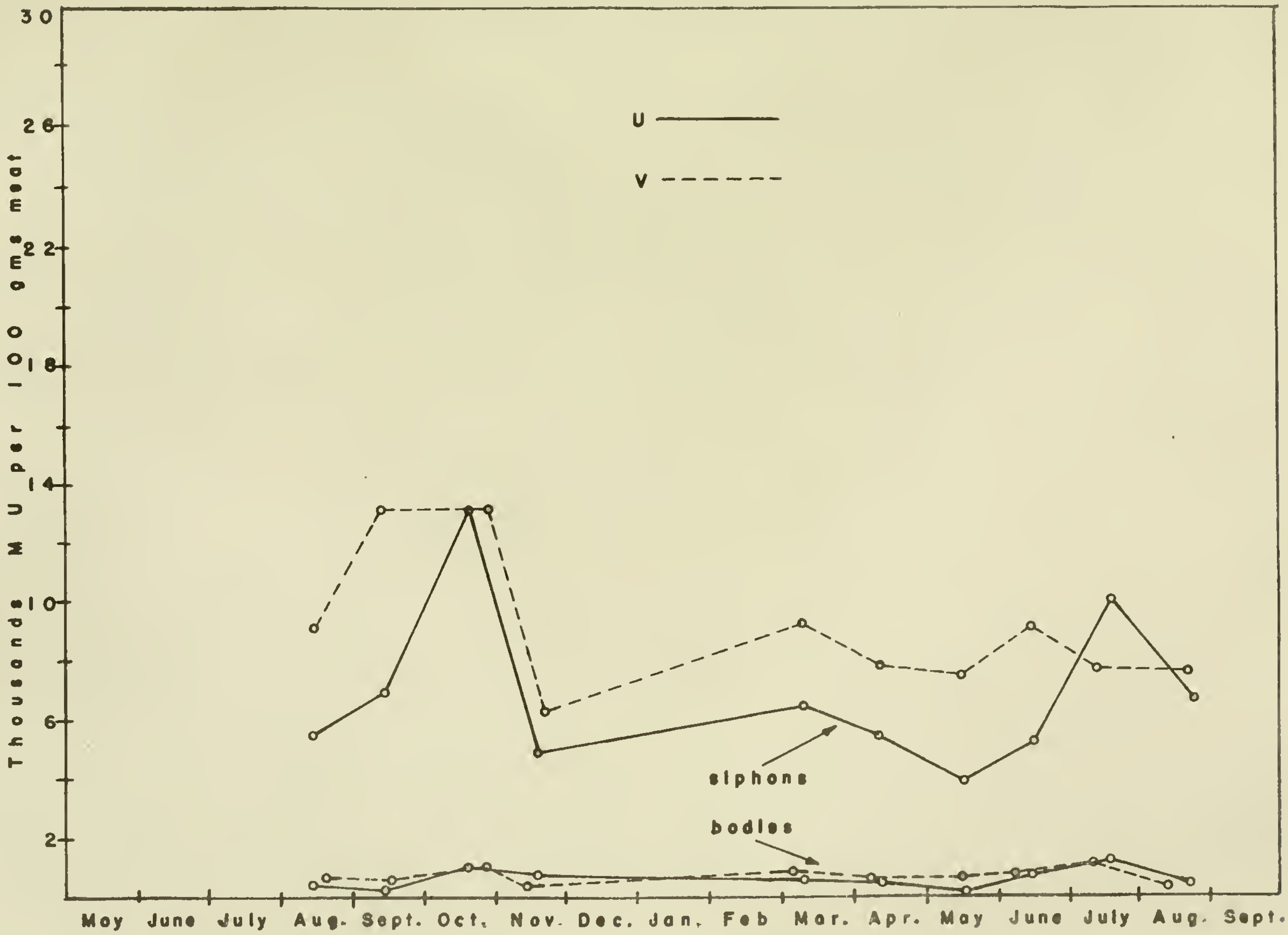

Figure 9.—Security Bay, plots U and V.