STATUS REPORT: BELUGA STUDIES

by

Calvin J. Lensink
Division of Bio-Research
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Division of Biological Research
Alaska Department of Fish and Game
Juneau, Alaska

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Studies of the life history and ecology of the beluga, Delphinapterus leucas, were initiated by the Department of Fish and Game in 1954 under the direction of James W. Brooks. These studies have been confined to the Bristol Bay Region, particularly Kvichak Bay, where belugas were considered by local fishermen to be serious predators of salmon. Brooks collected approximately 165 animals between 1954 and 1958 from which he took measurements, preserved reproductive organs, and made detailed analysis of stomach contents. The results of stomach analyses for 116 belugas taken in the months of May to August, 1954 and 1955 have been discussed by Brooks (1954, 1955), but information on food habits collected between 1956 and 1958, or the data on growth, reproduction etc., is not yet available.

Beluga studies were continued on a reduced scale in 1958, and 1959, by Lensink who worked in Kvichak Bay during late May and early June of both seasons and September of 1959. The general program of investigations during the 1959 and 1960 field seasons followed that of Brooks with primary emphasis on control of depredations by beluga upon red salmon smolts. Twenty additional animals were collected and representative specimens are available for the months of May, June and September. Longevity and migration studies were initiated with the tagging of 46 animals. This report is confined primarily to a summarization of information gathered by Lensink since 1959.

Distribution of Belugas in Alaska

In Alaska, belugas are found in Cook Inlet, Bristol

Bay, and along the entire mainland coast of the Bering Sea and the Arctic Ocean. Major concentrations are found in the estuaries of large rivers flowing into Cook Inlet, Bristol Bay, Hooper Bay, Norton Sound, and Kotzebue Sound. The Cool Inlet population, and at least a part of the Bristol Bay population, are resident throughout the year, but in the coastal waters of the northern Bering Sea and the Arctic Ocean belugas are migratory summer residents which move to ice free portions of the Bering Sea or to leads in the pack ice during winter. Movements of belugas in northern waters are undoubtedly related to the freezing of bays or estuaries and perhaps to movement, distribution and density of pack ice. Average ice conditions are given for selected localities below.

Waters	Average Breakup	Average Freezeup
Kuskohwim Bay (Kwinhagak)	May 1	November 15
Hooper Bay (Hooper Bay)	May 26	November 12
Norton Sound (St. Michael)	June 9	November 10
Kotzebue Sound (Kotzebue)	May 31	October 23
Bering Strait (Wales)	June 8	December 3

Pack ice reaches as far south as the Pribilof Islands, in the central Bering Sea, and further east to the Alaska Peninsula.

Nelson (1887) found belugas from Bristol Bay north to Pt. Barrow as common summer residents. He considered them to be migratory over much of their range, moving south with the pack ice in October and north in spring. At St. Michaels, the first ones seen in spring usually arrived between the 5th and 10th of June, soon after the ice moves off shore or leaves

the inner bays, but movement here may not be a part of the northward migration but rather from offshore open water.

Large numbers of belugas have been observed in leads in the pack ice north of Bering Straits as early as April (F. Fay, 1960: in lit.). Fay (1959: in lit), also reported that Gambell eskimas saw a herd of approximately 1,000 belugas follow the north coast of St. Lawrence Island from Gambell to Savoonga and then go southwest toward the Gulf of Anadyr in late November or early December, 1957. The first pack ice did not arrive until one to two weeks later.

Harbo (letter of April 14, 1961) reported that several hundred belugas were seen in narrow leads south of the Diomedes and west of King Island in late March, 1961. He also indicates that in early April polar bear guides were reporting sightings of belugas north of the Diomedes, and that a few belugas had been seen by eskimas at Point Hope. Harbo believed that "the sequence of reports seem to indicate a movement northward through the (Bering) Straits in spring."

Nelson (1887) believed that belugas were much more abundant on the shallow American shores of the Bering Sea than in the deeper waters of the Siberian coast, noting also, that on the American shore belugas are particularly abundant at the mouths of large rivers which they frequently ascended far above tidewater. Nelson (1887) specifically cited reports of belugas at Anvic and Nulato, 300 and 450 miles from the mouth of the Yukon River respectively, and Tomlin (1957) says that early Russian settlers were able to obtain belugas there. Current reports of beluga

ascending the Yukon are also available. C. Fiscus (Letter to F. Fay, May, 1960) stated that he had heard reports in 1954 and 1955 of belugas as far up the Yukon as Koyukok. Steve Pennoyer (letter of September 15, 1959) reported that belugas are occasionally observed at Mountain Village, 60 miles from the mouth of the Yukon, and that one was killed at Nulato in 1959.

Association of belugas wiht estuarian environments is not restricted to Alaska nor are movements into the larger rivers. A worldwide distribution chart prepared by Vladyhov (1944) shows that nearly all major concentrations occur in shallow bays or the estuaries of large rivers. Tomlin (1957) indicates upstream movements of beluga in Siberian rivers, some as much as 1,000 - 2,000 kilometers. He states also that in the shallow rivers, movements are influenced by tides (as in the Kvichak River), but that in larger rivers (as the Yukon), the dependence on tides is not observed.

The association of belugas with estuarian environments and their movements into large rivers may result from frequent concentrations of food offered migratory fish such as smelt or salmon which ascend rivers to spawn. It is possible also, if foraging and orientation of the beluga is by sonic means as in other porpoises (Kellogg 1959), that the beluga has an advantage over its sight oriented prey in the turbid waters of rivers that it does not have in other environments.

Utilization of Belugas in Alaska

There is presently no commercial utilization of belugas

in Alaska, although they provide an important food source for many coastal eskimas. Estimates by teachers of Bureau of Indian Affairs schools for the amount of beluga meat gathered by eskimos in villages under their jurisdiction are provided in Table 1. The estimates given are rough approximations but probably represent a take of 300 to 400 animals. In addition, Pennoyer (in lit.) reports that on the area of the Yukon Kushokwim Delta about 25 are taken at Kwiguk, 20 at Sheldon's Point, 6 at Hooper Bay, and an unknown number at Skammon Bay. Belugas are used at Kotzebue and other villages on the Bering and Chukchi Seas but the size of the take is unknown. Information on the size and location of the beluga harvest should be collected, but for the present, an estimated total harvest of 400 - 500 animals seem reasonable.

Bristol Bay Populations

In Bristol Bay the primary concentrations of belugas are round in the Kvichak and Nushagak Bays. Accurate counts are impossible in the turbid waters of this area, but the population probably numbers between 1,000 and 1,500 animals.

During the winter belugas are confined to the outer parts of the bays, but with spring breakup of ice (about mid May) they begin foraging in the Kvichak River. Movements into the Kvichak follow a tidal pattern. Belugas actively forage as they move upstream on the flood tide, but then return more directly to the bay on the ebb. Because the period of high tide is progressively later as belugas move upstream, their upstream movements may exceed the duration of a normal flood; conversely,

their return to bay must be rapid because the bay is well into the ebb before high tide occurs upstream.

Twice daily movements of 20 to 30 miles above the bay are common on the Kvichak River, and occasionally on big tides belugas may reach Kaskanak Flats which are more than 40 miles above the mouth of the river, and at the extreme limit of tidal influence.

Belugas also forage in the Naknek River during early spring but cease doing so when boat traffic on the river becomes extensive. Belugas also forage in the Nushagak and Wood Rivers, but not as commonly as the Kvichak. Movements between Nushagak and Kvichak Bays are common, perhaps in relationship to varying abundance of food between the two areas (Brooks, 1955). Westward, along the Alaska Peninsula, belugas occasionally reach Ugashik Bay, but to the north at Togiak Bay, eskimos report that belugas are rarely observed.

The Cook Inlet beluga population appears to be completely isolated from the population in Bristol Bay, but Bristol Bay animals may mix with northern herds. Such mixing is most likely to occur in winter when northern animals are forced from bays and estuaries by ice.

Food Habits

Studies of the food habits of belugas by Vladykov (1944), Tomlin (1957) and Brooks (1954, 1955, 1957) indicate that a wide variety of foods are taken including freshwater and marine fishes, various crustaceans, molusks and annelid worms. Arsienev (1939)

(quoted by Tomlin, 1957) showed that in the western Bering Sea summer food habits varied with age; grey animals (yearlings) taking primarily shrimp, cragon, and navaga, Eleginus navaga, light blue animals (2 to 3 or 4 years old) taking primarily navaga and dogsalmon, and white animals (5 years or older) taking primarily dogsalmon (Table 2).

Brooks (1954, 1955) found adults of all Alaskan salmons in stomachs of belugas from Kvichak and Nushigak Bay. He believed, however, that predation by beluga on red salmon smolt during the time they are migrating in the Kvichak River to be the most serious problem in regard to the commercial fisheries.

The pattern of foraging in the Kvichak River seems to have followed a consistent pattern since initiation of studies by Brooks in 1954. At the time of breakup (about mid May) belugas are attracted to the river where large numbers of smelt, Osmerus dentex are returning to the bay after spawning. By the end of May the smelt run is declining, but is replaced by migrating red salmon smolt. The peak of the smolt run is short in the Kvichak River, and by the second week of June there are only insignificant numbers present (fig. 1). During the period when smolt are in the river they are highly vulnerable to predation by belugas, and Brooks (1955) estimated that in 1954 and 1955 the smolt loss was roughly 3,000,000 fish. If only 5 percent survived, these would represent a return of about 150,000 adult fish. The number of fish taken declined in years with smaller smolt migrations, but Brooks suspects that the proportion of smolt taken may increase under these conditions.

As smolt move into Kvichak Bay, they apparently scatter and become less vulnerable to predation. Belugas take relatively few. Thus, of 6 belugas taken in the bay between June 6, and 15, 1959 and 1960, none had eaten smolts and most had only a few shrimp fragments in their stomachs.

Adult red salmon appear in the Kvichak and Nushagak Bays during mid June and may be taken by beluga. Brooks (1955) from examination of 78 belugas taken between July 1, and August 18, estimated that belugas took approximately 2.7 and 1 percent of the total runs which were of 3 million and 4 million fish respectively in 1954 and 1955. In years with large returns, such as in 1960 (36 million), the proportion of the run taken by belugas is insignificant. Only small quantities of shrimp, a few small flounders and a single lamprey were present in the stomachs of 8 belugas taken between September 11, and 25, 1959 and 1960 by Lensink.

The results of the various stomach analyses seems to indicate that in Bristol Bay belugas are dependent on migratory fishes (smelt and salmon) for the bulk of their food, and that they fare rather poorly at times when migratory fish are not available. There seems also to be a marked difference between the belugas success in obtaining food within the confines of the river where prey fishes are concentrated and in the bay where they are dispersed.

Tagging Studies

A total of 46 belugas were marked in 1959 and 1960 with homemade dart tags similar to those described by Yamashita and Waldron (1958) or the F-1 dart tag made by the Floy Tag and

Manufacturing Co., 2909 Blakeley St., Seattle 5, Washington. The over-all length of the tag was approximately 9 inches and when inserted in a belugas about 7 inches hung free externally. The free end could frequently be seen when the beluga porpoised.

The tags were applied by means of a stainless steel needle 10 inches long inserted into the end of a harpoon pole for all but 2-3 inches of its length. The end of the harpoon served as a stop and insured that the tag was not inserted too deeply. The most suitable material for making the needle was stainless steel aircraft tubing, Type 304, distributed by Tubesales, 2211 Tubeway, Los Angeles 22, California, with an outside diameter of .25 inches and walls of .058 inches. Lighter tubing that was tried in 1959 was not satisfactory because it frequently bent and would bind on the tag which would not then pull free.

Animals were usually tagged only after they were clearly observed, so in most instances, the sex and approximate age could be determined by size, color, and association with other animals. Tagged animals are listed in Table 3.

Only a single return is so far available. Tag No. 4, placed in a light grey animal (2 or 3 years old) on May 20, 1959 in Kvichak Bay, was caught in a gillnet near the mouth of the Naknek River. The exact date of capture is unknown, but is probably after June 20. Another animal was observed with a tag on September 13, 1959 which could not have been tagged later than June 10. These two observations are not sufficient to definitely establish the success of the tagging method, but does suggest that the method is worth further consideration. Too few belugas have

been tagged (46 in a population of over 1,000) to permit many recoveries without extensive collections. A minimum of 200 animals should be tagged in Bristol Bay to insure recoveries there, and at least 500 seems necessary for tracing the possible movement of Bristol Bay belugas to other areas.

Reproduction

Belugas of all ages and sexes are represented in the Bristol Bay population and although the available specimens are few, they provide a fairly good idea of the reproductive pattern. In spring and summer, when our observations have been made, there appears to be at least a partial sexual segregation of the population. Thus, all five animals, 2 years or older taken in the Kvichak River since 1959 were adult males. Of 17 animals taken in Kvichak Bay, only four were adult males, five were adult females, two were 2-year old females and one was a two year old male. Whether the segregation extends beyond foraging activities is unknown, but the numerous bite marks observed on belugas suggest the existence of some social strife which may result from harem maintenance by dominant males. It is possible that aggressiveness extends to yearling males because 4 of 5 yearling specimens obtained were females and the sex of the fifth was uncertain. As the ease with which a young animal is caught frequently depends on its association with its mother, the lack of yearling males in our sample may mean that the association no longer exists. If the apparent segregation of males is not an illusion caused by our sampling, the data imply that belugas are polygamous.

The peak of calving in Bristol Bay occurs about mid June. Near term foetuses have been collected on June 11 and 17, and a newly born calf on June 14. In 1958 no

calves were observed until June 14 when a large herd composed almost entirely of females was discovered in lower Kvichak Bay. Several of the females were accompanied by newborn calves. A calf that was collected had a fresh umbilicus still dangling. The females without calves seemed lethargic and could not be herded with the skiff in the manner of foraging animals. This behavior suggests that these females were pregnant and very near to time of parturition.

All adult males taken between May and September have had epididymes filled with sperm and were capable of reproduction. However, the short peak in calving suggests that most reproductive activity is confined to a relatively short period - perhaps in May or June. A foetus of about 2 inches was taken from a female on June 17, 1958.

The youngest mature female known is one which may have been bred at 2 years of age and had a near term foetus when killed. The size of this animal suggested that she was 4 years old when killed, but tooth rings (which may be from the wrong tooth) are for a 3 year old animal. Two 2 year old females taken in June and September respectively were nuliparous. Both showed some active development of follicles, but estrous was not likely to occur. A 3 year old female was taken with an early foetus and was probably primiparous although the ovaries were not examined. A 4 year old female taken in September was accompanied by her first calf and was not then pregnant. A 6 year old female taken in September

was also accompanied by a calf, her second, and was not then pregnant. My best guess with present data is that most females are first bred at 3 years of age and deliver their first calf at 4 years. Mating does not occur in the year of parturition and subsequent calves are born at intervals of two years.

Two males of age 2 were not sexually mature. Specimens of 3 and 4 year old males are not available but all males (8) older than 5 years were mature.

Age Determination and Growth

The raw measurements and comments on the repro-status of 25 belugas autopsied by Lensink since 1958 are provided in Table 4. Frequency distributions of body length, snout length, fluke length and weights of testes and ovaries are illustrated in Figs. 2 to 5 respectively, and growth curves based on straight line (standard) length measurements and total weights in Figs. 6 and 7.

The modal patterns of the various distributions of measurements (Figs. 2-5) suggest that animals can be distinguished as calves, yearlings and probably two-year-olds on the basis of size, but that measurements of animals older than three years overlap too much to be precise indicators of age. The age classes as indicated by measurements are verified by their color and behavior. Belugas are dark grey at birth and gradually fade to almost white at 4 years, and a creamy white in still older animals. Both calves and yearlings are with their mothers during the summer but can readily be distinguished in the water by the larger size and better swimming ability of the yearling. Two year old animals are usually, if not always, independent of their mother and may be lighter in color than yearlings. They can not, however, be distinguished from older animals under field conditions.

Belugas, as other Odontecete whales and Pinnipeds have sharply defined laminations in both the cementum and

dentine portions of their teeth. Age determinations based on size, color, and behavior served to establish the sequence and number of tooth layers deposited annually. In counting laminations the combination of a light and dark area visible on sagittal sections was counted as one. Teeth from all animals taken in May or June from which no layers had been lost by wear, had lamination frequencies falling into multiples of four. Thus, a newborn animal had no layers below the natal tooth, 5 yearlings each had 4 complete layers, two grey, immature males and a grey, nuliparous female each had 8 layers, one primiparous female had 12 layers and another had 16 while an old, white, male had 32 layers. A calf taken in September (3-4 months old) had only one layer, and a grey, nuliparous female 10. It seems certain, therefore, that four complete laminations are deposited each year and that counts of these laminations will provide a precise index to age.

In several animals tooth wear had obliterated an undeterminable number of laminations. Minimum ages for these animals were established by taking the next multiple of 4 above that of the lamination count, or in the case of severely eroded teeth, the second multiple (e.g. lamination count of 14+ = age 4+, and count of 14++ = age 5+). Thus, ages given for several of the older animals may be too low. Errors in aging caused by tooth wear can be much reduced from the proportion experienced here (37%) by collecting all teeth from one mandible or preferably all teeth. Despite exten-

sive wear on most teeth, one or more are usually vestigal and unworn, but show normal characteristics in all other respects and provide a complete series of laminations.

The distributions of various measurements (Figs. 2-5) and growth curves (Figs. 6-8) show that the male is larger than the female at all ages, and, although there are too few specimens to be certain, that growth of males may continue longer than of females, ie. the modal character of distributions of measurements continue to a greater age in males, and growth curves for males do not appear to level off to the extent of those for females. In general growth is rapid but at a constantly declining rate from birth to at least 4 years for females and 5 years for males. The growth of testes differs from that of external body features in that growth is slow for at least two years, is accelerated for 3 or 4 year old animals, and practically ceases for animalsof over 5 years age.

Regressions of weight, fluke length, and snout length on body length (Figs. 9-11) suggests that body proportions remain relatively constant at all ages and do not differ greatly between the sexes. Among older animals males may be slightly heavier in proportion to length than females, and the length of the snout seems somewhat greater than females at all ages. The differences are not sufficiently large to permit accurate separation of the sexes.

Control of Beluga Depredations in Bristol Bay

Because belugas are potentially serious predators of salmon in Bristol Bay, a consideration of control measures is warranted. Brooks (1957) reported that chasing the beluga from the river with a fast motor boat proved quite effective, but pointed out that in stormy weather or during hours of darkness it was often impossible to detect and chase belugas.

The continued harassment of belugas over several seasons has apparently resulted in a much increased wariness. It seems also that belugas are able to detect and identify the boat or motor used to harass them and in 1960 belugas when approached, even from downstream and on a flood tide, would turn and start for the bay. The greater than usual wariness in 1960 may have been partially caused by tagging operations of 1959 which left the most frightened animals in the population, as opposed to collection of animals for food habit studies in former years. In neither 1959 or 1960 did belugas consistently enter the river as in previous years, and much of the time were not even present in the upper portion of Kvichak Bay.

In 1960 harassment of belugas with small charges of dynamite, as suggested orally by Brooks, proved far more effective than chasing them with a boat. The charges were made from 0.5 pound sticks of 40 percent dynamite fastened together with string or heavy rubber bands. The bombs were

primed with a No. 6 blasting-cap and waterproof safety fuse ignited by expendable fuse lighters of the pull-wire type.

On May 19 twenty-one charges of 1 or 2 pounds were dropped, four to five a time, near a herd of belugas that had ascended the river to several miles above Levelock. On May 20 only 8 charges were dropped and seemed somewhat more effective than those of the previous day. Some belugas entered the river again on May 21 and were again bombed. Charges were increased to 2.5 pounds each and has fuses shortened so they could be timed to go off in close proximity to the animals. No belugas were observed at Levelock on May 22, but on May 23 about 10 reached a point about 2 miles below Levelock and on May 24 100-200 belugas were encountered at Sea Gull Flats below Koggiung. Both groups were bombed. Belugas were not seen in the river again until May 30 when a few were reported to have been at Sea Gull Flats at the mouth of the river. On June 4 several animals were observed above Koggiung on the night tide. Neither of the latter groups was bombed because of the presence of smolts. Belugas were not again observed in the river prior to our departure from Bristol Bay on June 17.

Although the control program in 1960 was believed to be highly successful, several changes in technique may increase effectiveness of the bombing. Two or three charges of 2.5 pounds timed to explode when belugas were near seemed much more effective than many smaller, less well timed charges.

After the initial bombing the animals should be followed to the bay with occasional persuasion in the form of single small charges. The major change in operations should involve the locations of attack. In 1960 belugas were permitted to ascend far up river before they were bombed. On successive days belugas were found progressively further downstream and it is probable that in each instance the harassment of uppermost groups did not disturb those lower in the river. It seems likely therefore if all work was carried on between Koggiung and Nakeen near the entrance to the river, that in 2 or 3 days all belugas entering the river would have been subjected to harassment.

No fatal injuries were definitely attributed to the harassment with explosives, but 2 animals were killed by harpoon subsequent to bombing and one was stranded at low water. Both of those that were harpooned seemed to have had their oriantation mechanisms distrubed and were more easily captured than was usual. The stranded beluga was trapped behind a bar after a charge had gone off almost beneath it. Inury to the orientation mechanism may have prevented this beluga from finding deeper water. No evidence of injury could be found in any of the three animals.

Although some belugas may be injured by harassment with explosives, the proportion is very low. Such control of depredations seems more effective and humane than destruction of animals which may be important to the eskimo economy, and have much aesthetic appeal.

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Table 1. Beluga Meat and Oil Gathered by Eskimos Living in Villages Served by Bureau of Indian Affairs Schools[1]

Village	Pounds of Meat and Oil	Area Hunted
Alakanuk	14,550	So. mouth of Yukon River
Buckland	15,500	Eschscholtz Bay, Kotzebue Sound.
Deering *	6,000	Kotzebue Sound
Elim	10,000	Norton Bay
Hooper Bay	3,000	Hooper Bay
Manakotak	12,000	Igushic River, Nushagak Bay.
Mountain Village *	500	Yukon River
Point Hope	32,000	Chukchi Sea
Saint Michael *	44,000	Norton Sound
Savoonga	9,000	St. Lawrence Island
Shaktoolic	500	Norton Sound
Stebbins *	35,300	Norton Sound
	182,350	

1. Estimates are for the period of October 1, 1959 to September 30, 1960 except for those localities marked with an asterisk.

Table 2. Summer Food Habits of Belugas in the Western Bering Sea (after Arsuniv, 1939).

Food Species	Percent of Food by Belugas of Different Age Classes		
	Grey (Yearling)	Light Blue (2-4 years)	White (over 5 years)
Crustacea	43.5	8.8	4.5
Eleginus navaga	30.4	20.6	11.1
Oncorhinchus gorhuscha	4.4	55.9	60.0
Miscellaneous fish & Crustea	21.7	14.7	15.5

Table 3. Belugas Tagged in Kvichak Bay, 1959 and 1960.

Tag No.	Date	Location	Remarks
1	5/20/59	Kvichak Bay	F. grey, accompanied by yearling calf.
2	"	" "	White, probably M.
3	"	" "	Light grey F. accompanied by yearling calf.
4	"	" "	Light grey (2-3 ?) yrs. old Hit with motor twice though did not appear to be injured.
5	6/3/59	" "	Yearling calf (very dark and appeared quite small).
6	5/17/60	" "	White (M) Severely wounded by harpoon and rifle fire.
7	6/3/59	" "	F. light grey. Mother of calf tagged #5.
8	6/3/59	" "	Sex unknown, light grey but not very large so probably F.
9	6/8/59	" "	White or very light grey.
10	6/5/59	" "	Yearling calf with a white mother.
11	6/5/59	" "	Yearling calf.
12	6/5/59	" "	Light grey to white F - the mother of #11.
13	6/8/59	" "	Yearling calf - Dark grey.
14	6/5/59	" "	Light grey.
15	6/10/59	" "	Grey.
16	6/10/59	" "	In same animal as #15.
17	6/28/59	" "	Grey, yearling.
18	6/10/59	" "	Animal not seen
19	Void		
20	6/28/59	" "	Grey, yearling.

Table 3 (contd)

Tag No.	Date	Location	Remarks
21	6/5/59	Kvichak Bay	Grey calf, see 22 - not certain this tag got into animal.
22	6/5/59	" "	Same animal as 21.
23	6/8/59	" "	Large & white - probably M- hid low on side about amidship.
24	5/25/60	" "	Sex? Grey.
25	6/9/59	" "	Cow or calf.
26	6/9/60	" "	Sex? Yearling.
27	6/9/59	" "	In either animal tagged 25 or 28, probably the F.
28	6/9/59	" "	Cow or calf.
29	9/13/59	" "	Grey (2 years).
30	6/14/59	Kvichak River	Grey (quite small).
31	6/10/59	" "	Animal not seen.
33	6/10/59	" "	" " "
34	6/10/59	" "	" " "
35	6/28/59	Kvichak Bay	Grey (yearling).
36	9/15/59	" "	Large white (M). Tag visible.
37	6/9/60	" "	White. Mother of No. 39.
39	6/9/60	" "	Yearling.
40	9/18/59	" "	Grey (yearling). Head getting light.
41	9/16/59	" "	Large white (M).
43	9/17/59	" "	White (1500)
44	9/18/59	" "	Yearling or calf w white F
46-7	9/19/59	" "	Large white (M). Both tags visible.

Table 3 (contd)

Tag No.	Date	Location	Remarks
48	9/19/59	Kvichak Bay	Light grey.
50	9/19/59	" "	Calf, Mother was white.
52	9/19/59	" "	Calf, Mother was grey.
53	9/20/59	" "	Calf
56	9/20/59	" "	Calf
57	9/20/59	" "	Almost white F.
58	9/20/59	" "	Light grey.
59	9/26/59	" "	Calf, Mother was light grey.
61	9/26/59	" "	(F) Color about white (1500)
69	9/26/59	" "	White (M).

TABLE 4. Measurements and Reproductive Condition of Belugas from Kvichak Bay.

Number	Date	Sex	Color	Tooth Rings	Probable Age	Length	Weight	Fluke Length	Snout	Ovary or Testes Wt.	Reproductive Condition	Remarks
1-58	6/11/58	F	Grey	(12)*	3	10'8"	--	16.8	18.0	--	Had near term foetus. Probably primiparous.	= JWB 14-58
2-58	6/11/58	M	G	--	0	4'5"	97	7.2	9.0	--	Foetus from No. 1-58	= JWB 15-58f
3-58	6/17/58	F	White	--	5+	11'8"	--	18.0	19.5	--	Had near term foetus.	= JWB 161
4-58	6/17/58	M	G	--	0	5'3"	--	9.2	11.0	--	Foetus from 3-58	= JWB 162
5-58	6/17/58	F	G	--	3+	9'11"	--	15.0	18.0	--	Foetus about 2 inches long. Primiparous?	= JWB 163
1072	5/17/59	M	W	14++	5+	--	--	--	--	--		
1074	6/14/59	M	G	0	0	4'8"	99	8.0	9.5	9	Immature	Newborn
1077	9/7/59	F	G	16	4	10'8"	--	15.5	18.0	22	Primiparous, 2-3 months post-partum, not pregnant.	
1078	9/7/59	M	W	19++	6+	12'6"	--	19.5	23.0	740	Sperm present.	
1079	9/13/59	M	W	19+	5+	12'2"	--	18.0	24.5	800	Sperm present.	
1080	9/13/59	M	G	8	2	9'10"	--	17.2	19.2	82	No spermatogenesis.	
1081	9/13/59	M	W	23+	6+	13'0"	--	19.5	24.0	824	Sperm present.	
1082	9/14/59	F	W	23+	6+	10'6"	820	14.5	17.5	48	Multiparous, 3-4 months post-partum; not pregnant.	
1083	9/14/59	M	G	1	0	5'6"	233	8.2	10.5	12	Immature.	3-4 months old.
1084	9/19/59	M	W	18+	5+	12'10"	--	19.5	25.0	1020	Sperm present.	
1085	9/25/59	F	G	10	2	9'1"	750	14.0	17.5	23	Small follicles (1 mm). Nuliparous	
1-60	5/17/60	M	W	24+	6+	12'1"	--	17.5	21.0	800	Sperm present.	
2-60	5/21/60	M	G	8	2	9'9"	821	14.5	18.5	115	No spermatogenesis.	
3-60	5/21/60	M	W	32	8	13'9"	1721	17	24.5	900	Sperm present.	

TABLE 4. Measurements and Reproductive Condition of Belugas from Kvichak Bay. (continued)

Number	Date	Sex	Color	Tooth Rings	Probable Age	Length	Weight	Fluke Length	Snout	Ovary or Testes Wt.	Reproductive Condition	Remarks
6-60	5/25/60	M	W	15*	5+	12'0"	--	18.2	21.0	550	Sperm present.	
10-60	5/12/60	(M)	G	4	1	--	--	--	14.0	--		
20-60	6/6/60	F	G	4	1	7'8"	492	10.8	13.2	8	Nuliparous; ovary inactive.	
27-60	6/13/60	F	G	8	2	9'1"	--	13.8	16.5	15	Nuliparous; active follicle development.	
28-60	6/14/60	F	G	4	1	7'10"	549	12.5	14.5	13	Nuliparous; ovary inactive.	
29-60	6/15/60	F	G	4	1	--	--	--	--	--		

* Tooth specimen may be numbered in error.

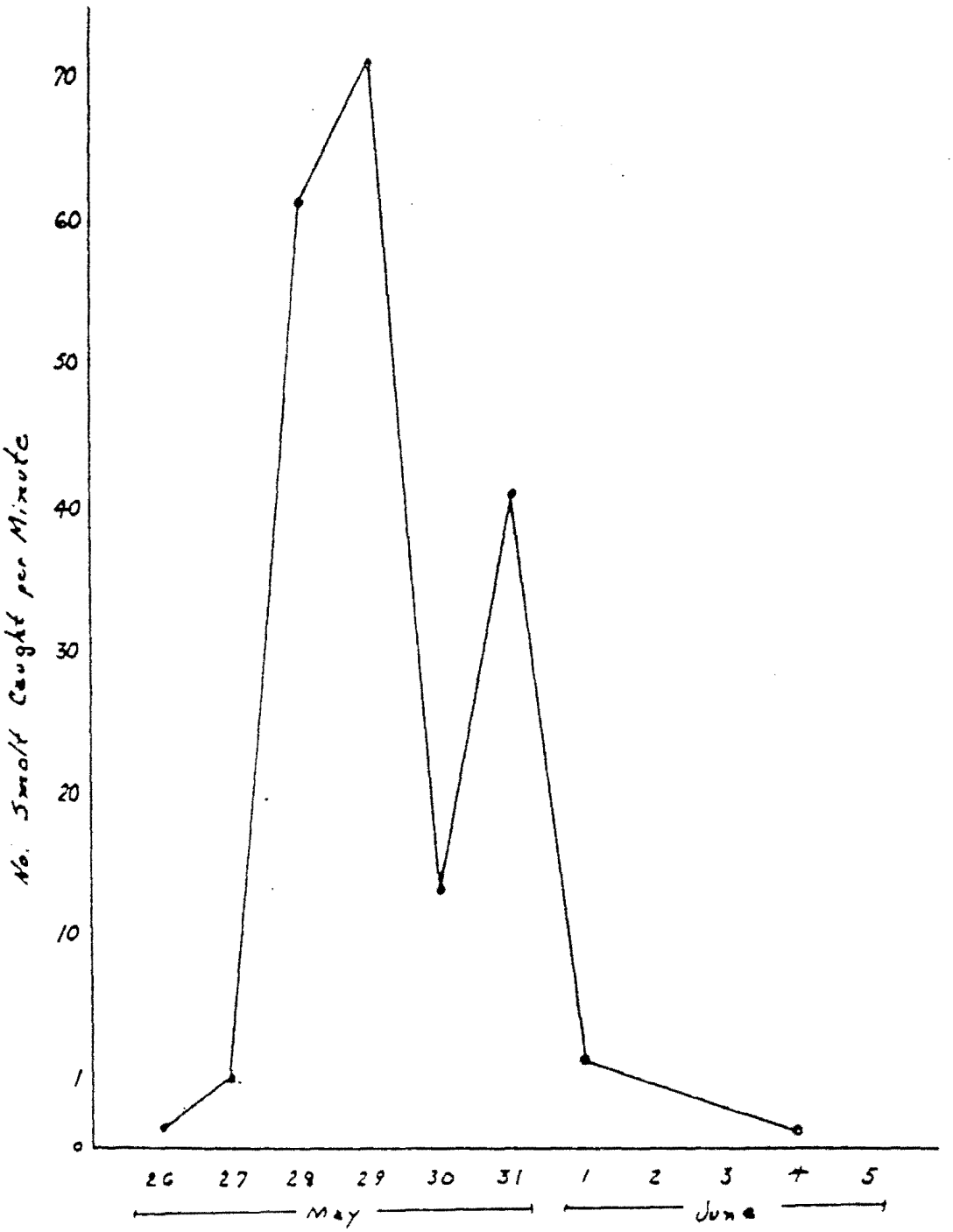

Figure 1. Smolt Present at Levelock, Kvichak River, 1959, as Indicated by Number Caught per Minute in Fyke Trap with Effective Diameter of 33 inches.

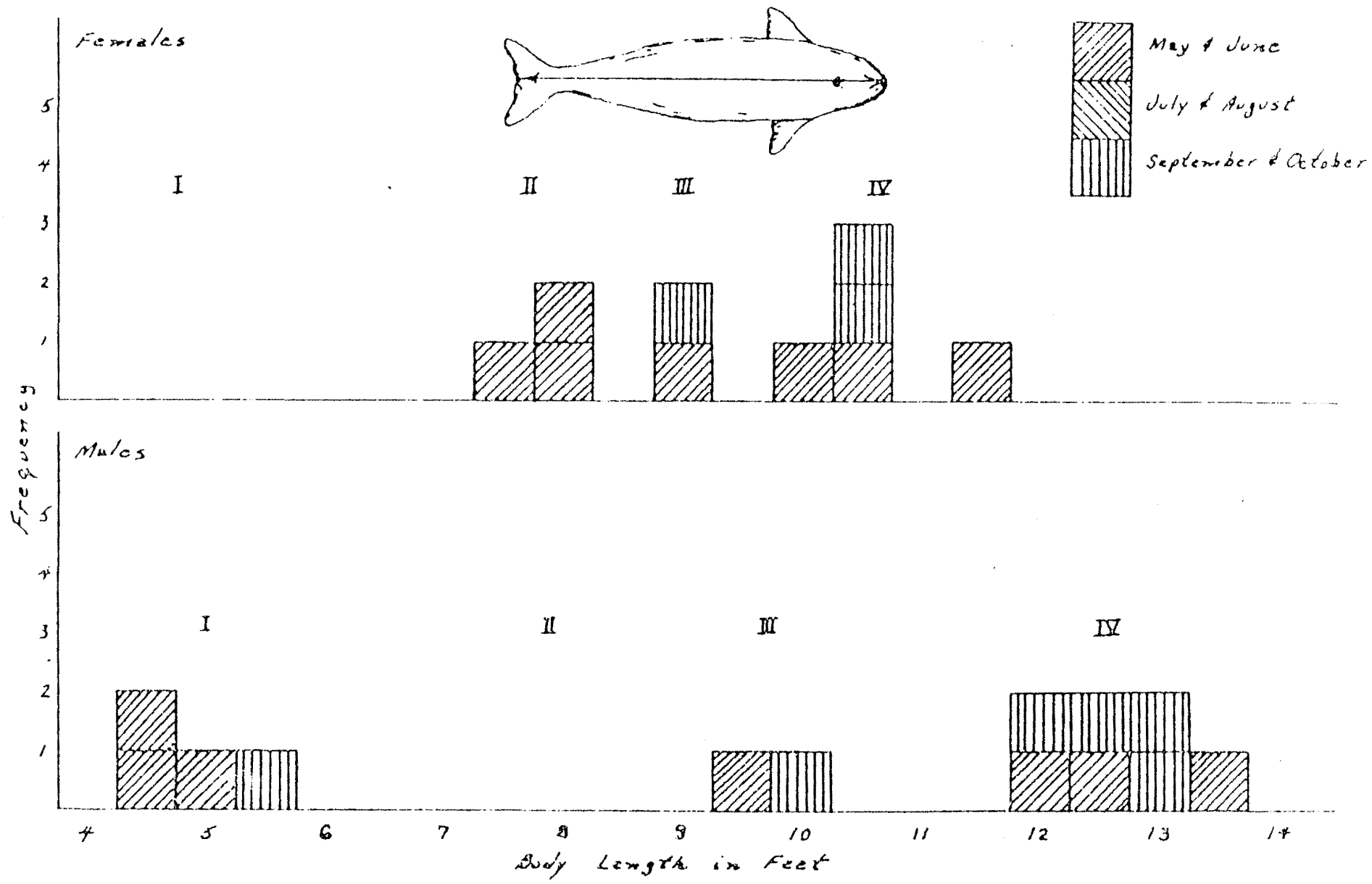

Figure 2. Distribution of Standard Length Measurements. Roman Numerals suggest Probable Age Classes with Class I as Calves, II as Yearlings, III as Two Years, and IV as 3 years or Older.

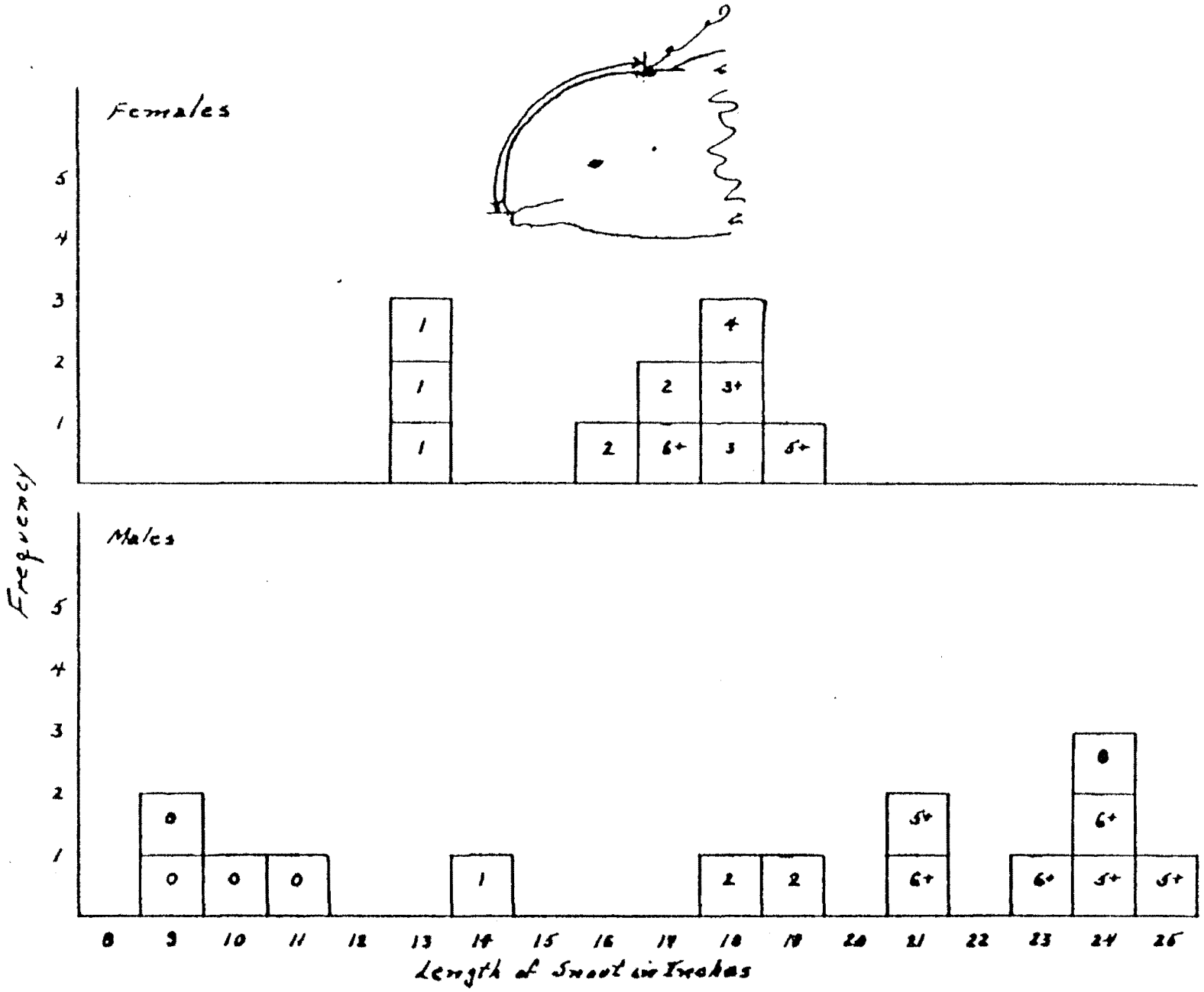

Figure 3. Distribution of Snout Lengths. Numbers within bars indicate probable age of animal as determined from tooth rings.

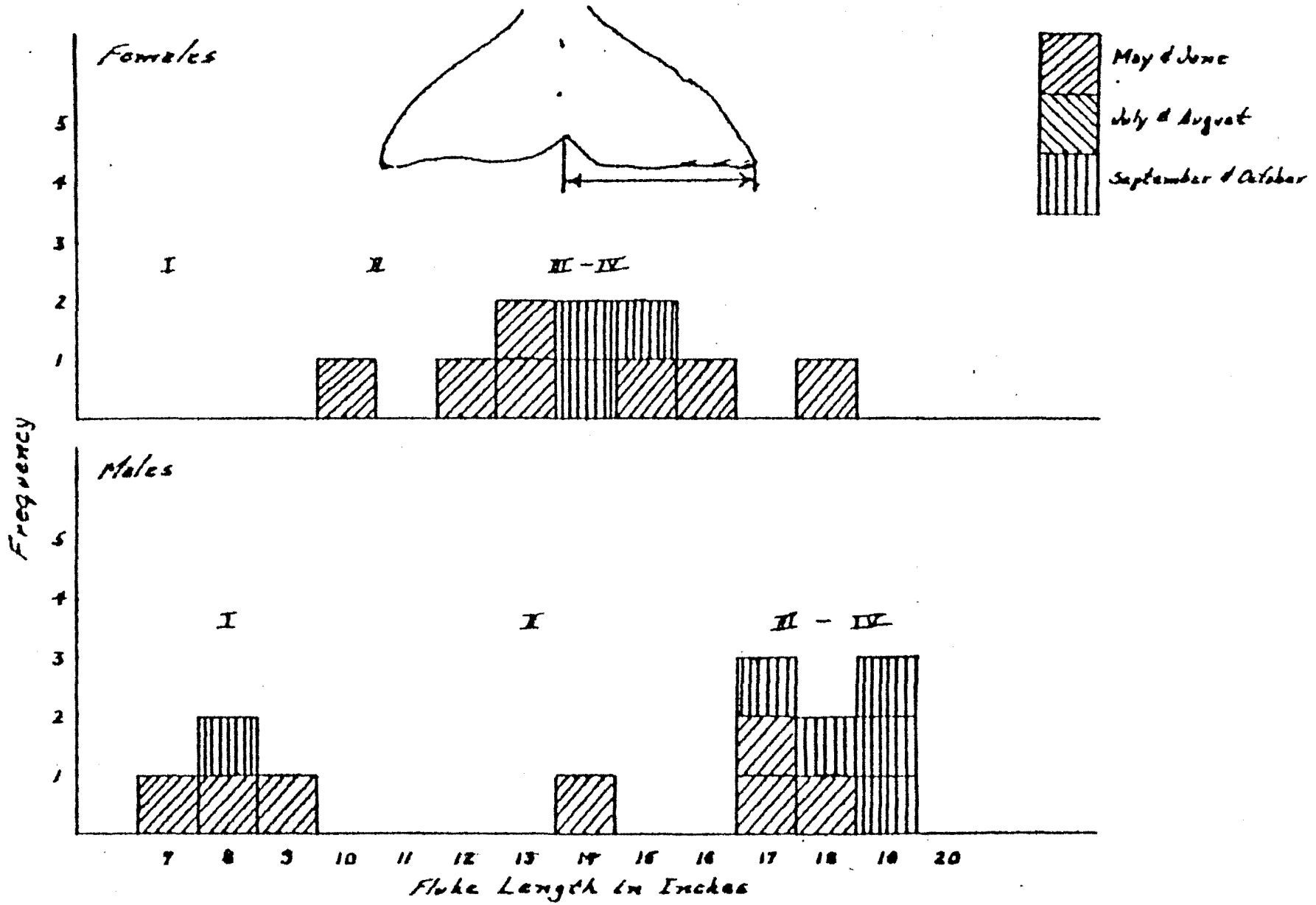

Figure 4. Distribution of Fluke Lengths. Roman Numerals suggest Age Classes as in Figure 2.

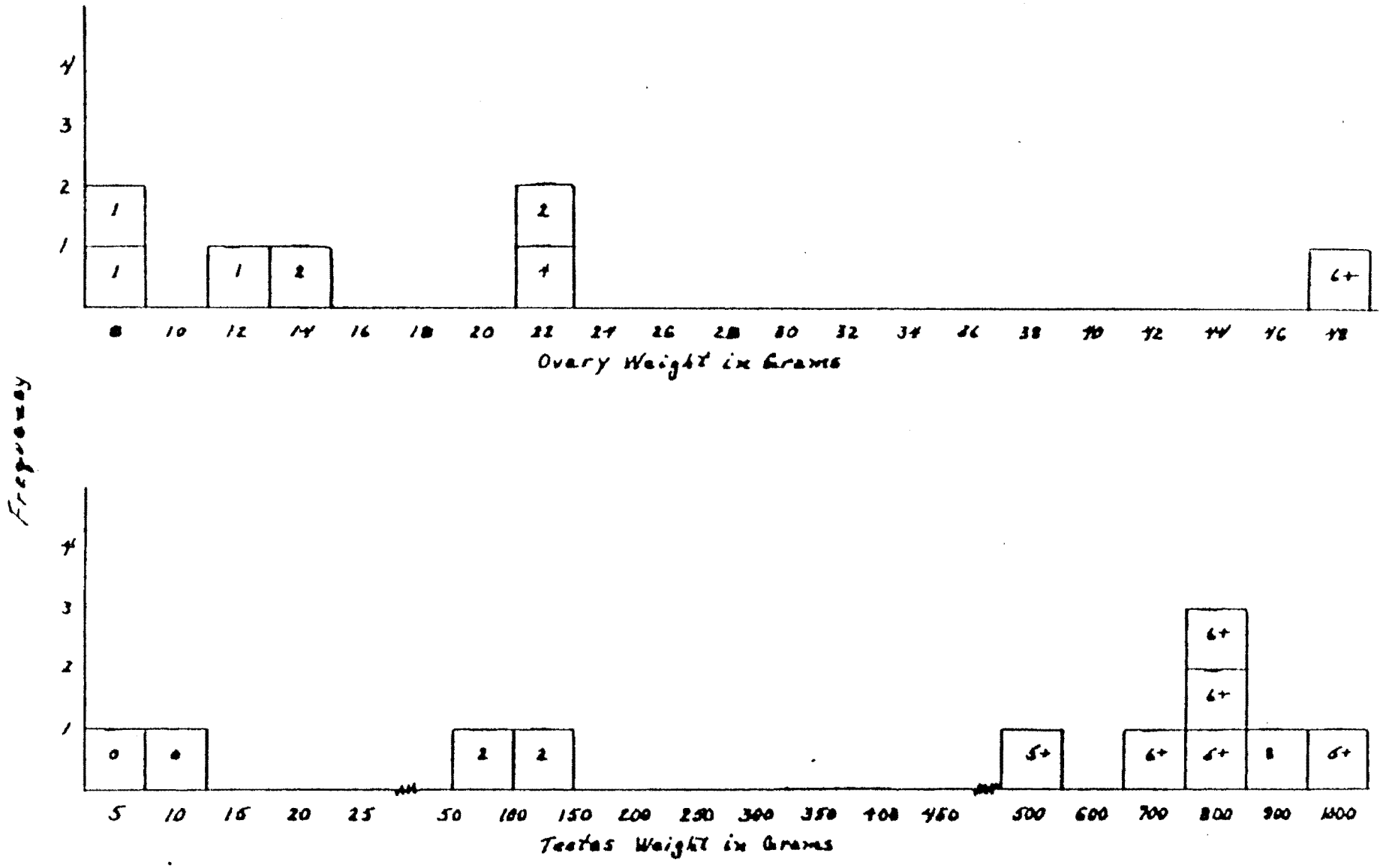

Figure 5. Distribution of Ovary and Testes Weights. Note change in scale for Testes. Numbers within bars indicate probable age of animal as determined from tooth rings.

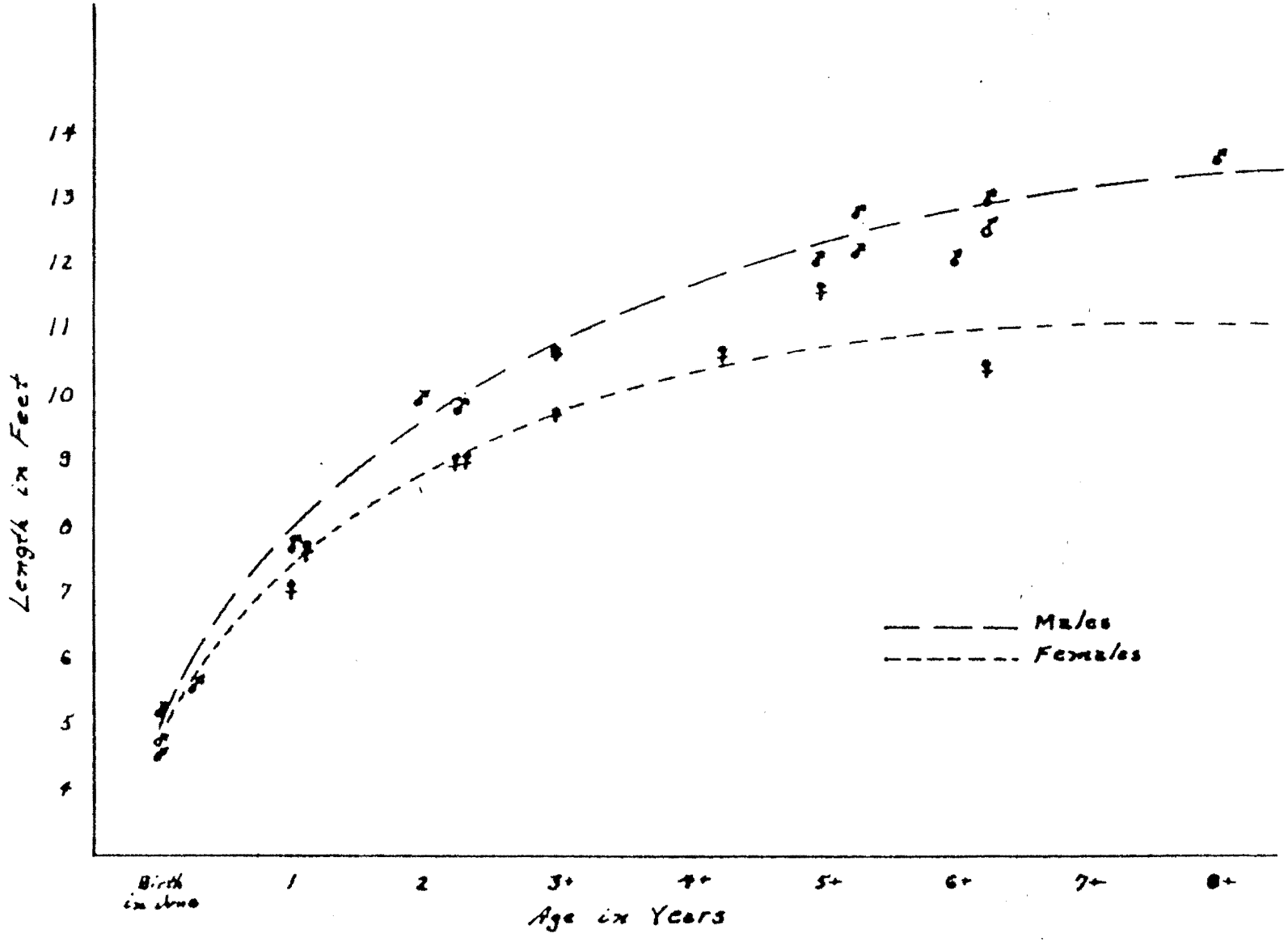

Figure 6. Growth Curve For Increase of Length with Age.

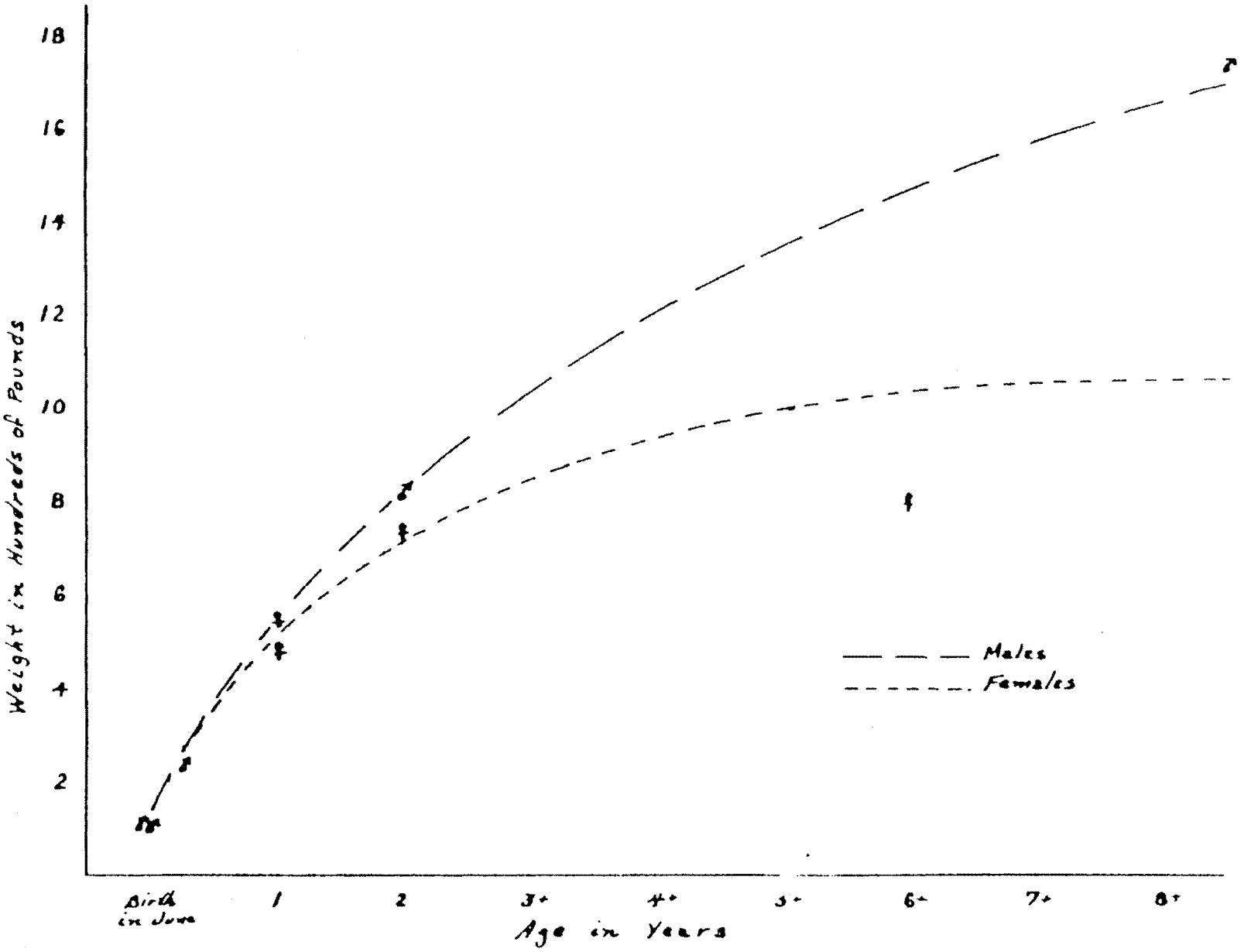

Figure 7. Growth Curve for Increase of Weight with Age.

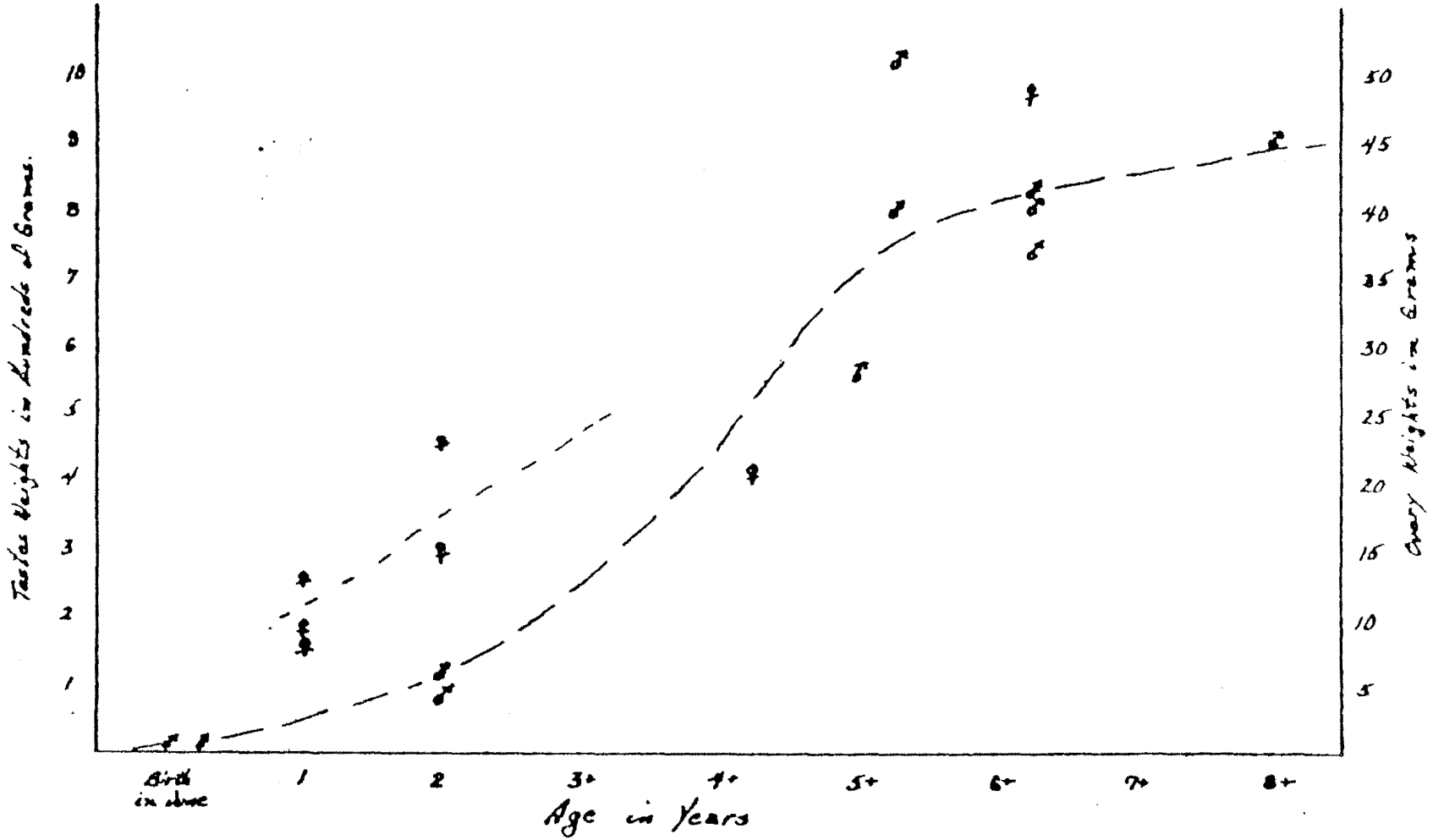

Figure 8. Growth Curve for Increase in Testes and Ovary Weight with Age.

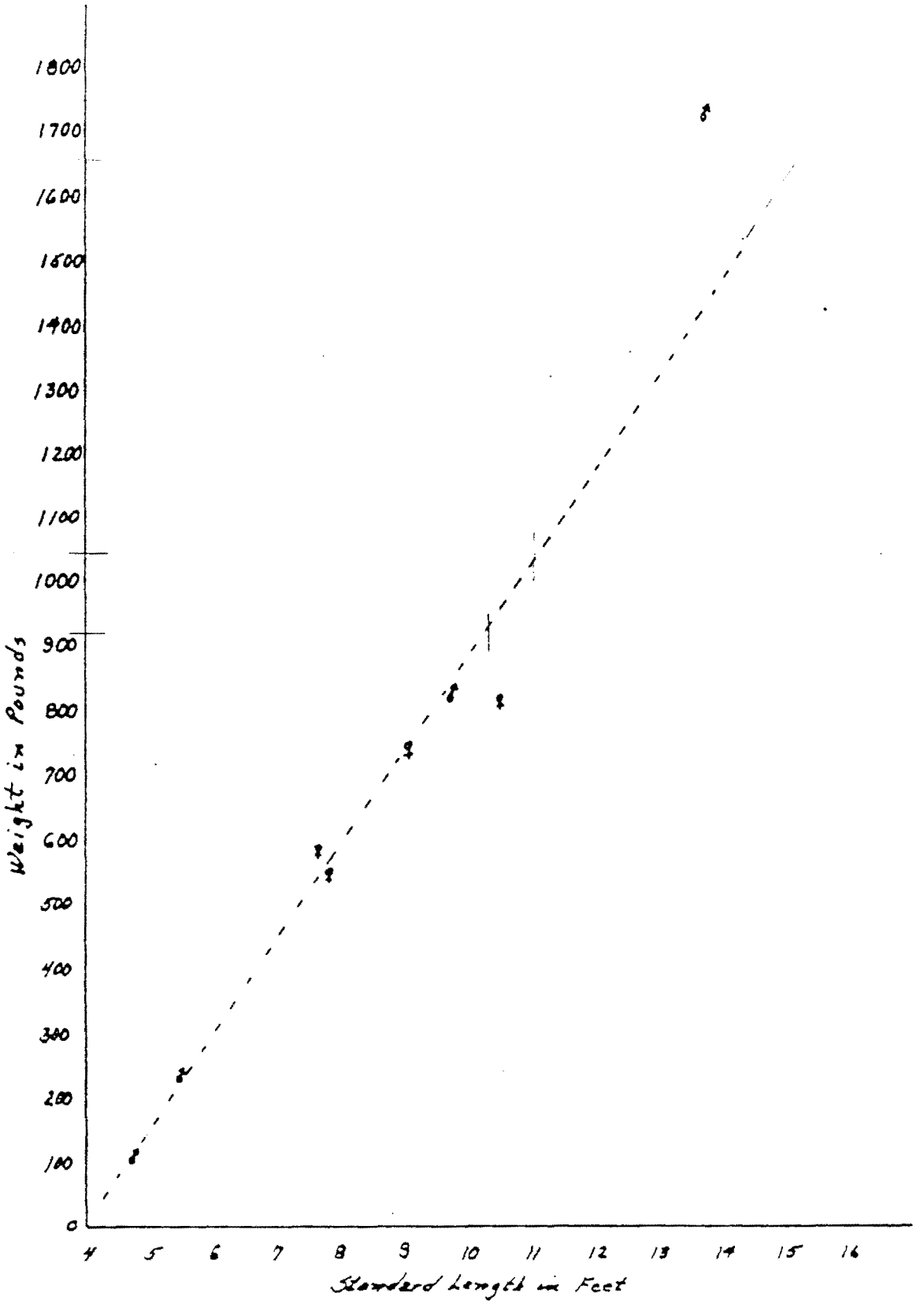

Figure 9. Regression of Body Length on Weight. Curve is fitted to the three youngest Males.

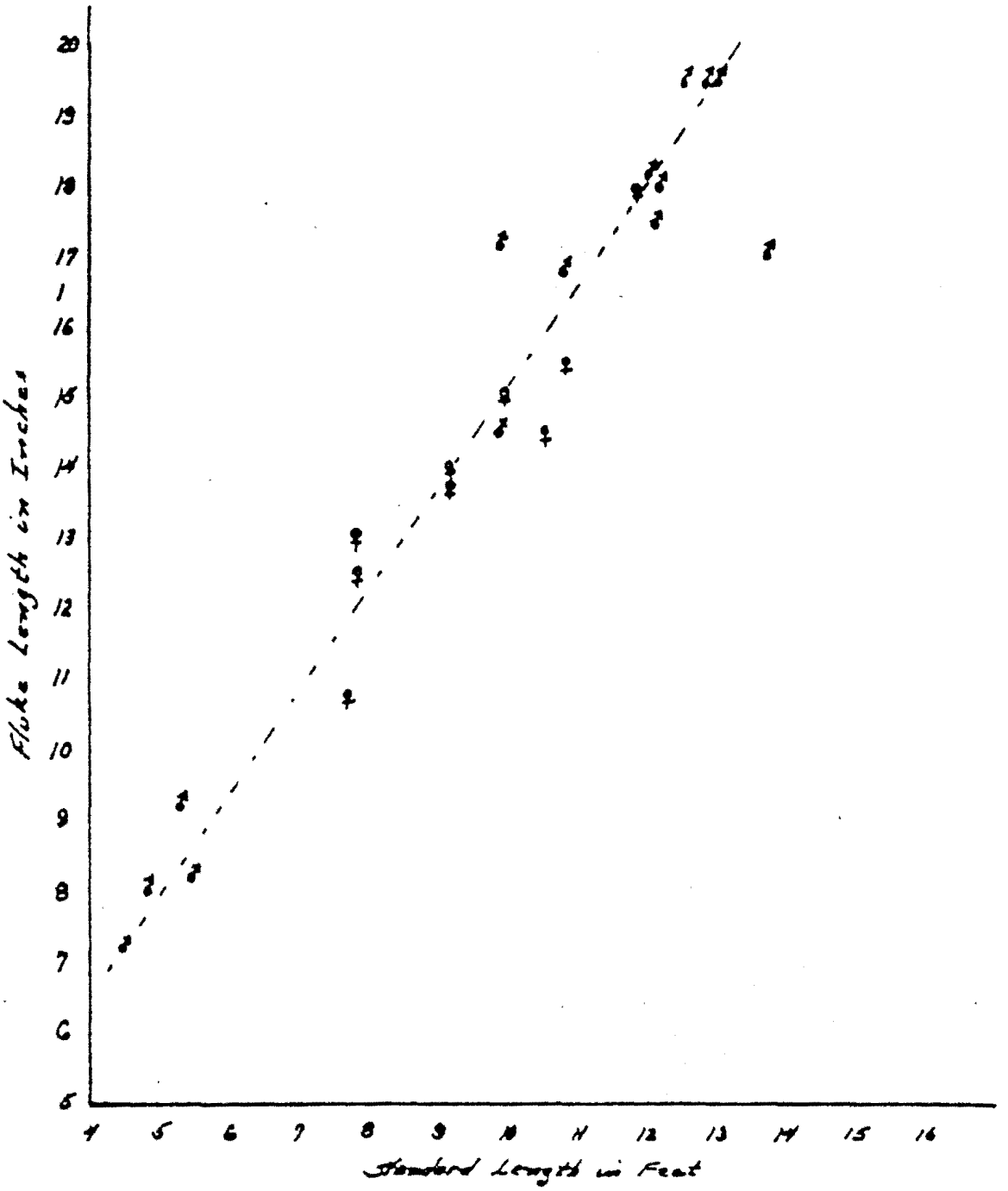

Figure 10. Regression of Body Length on Fluke Length.

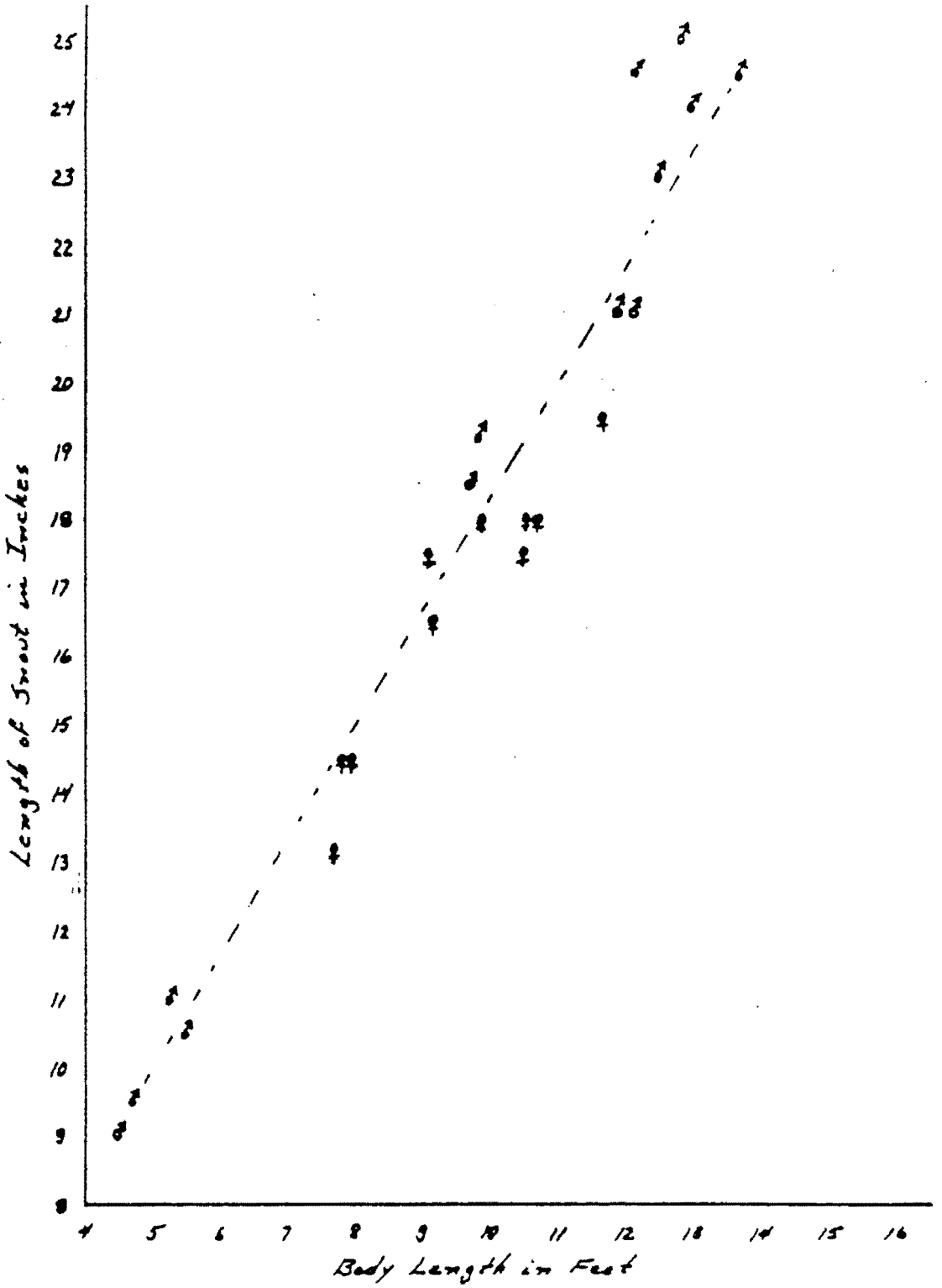

Figure 11. Regression of Body Length on Snout Length.