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RELATIONSHIP BETWEEN BODY LENGTH OF GRAYFISH AND VITAMIN A IN LIVER

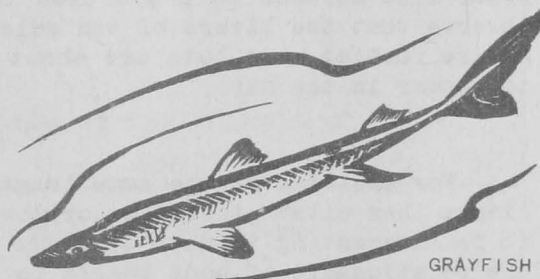
By F. Bruce Sanford* and Kelshaw Bonham **

ABSTRACT

The vitamin A potency of the liver oil of the grayfish (*Squalus suckleyi*) is correlated with sex, sexual maturity, and length of fish. The vitamin A potency of the small fish is relatively low and increases as the fish grows in length. In the case of both the male and female, the most rapid increase occurs as the fish matures sexually. The weight and oil content of the liver also increases and the color of liver darkens as the fish increases in length and matures. As a consequence, the small, immature fish are relatively valueless as compared with the larger fish which have reached maturity.

INTRODUCTION

In 1942, the Washington State Department of Fisheries and the Seattle Fishery Technological Laboratory began a joint study of the Washington grayfish (*Squalus suckleyi*) to determine whether measures were needed to protect this important source of vitamin A and, if so, how they might best be applied. A short summary at this time of the more important observations on the characteristics of the grayfish which are correlated with vitamin A content will be of value. In this paper is presented a summary of the relationships observed between the content of oil, vitamin A potency, weight and color of liver, and the sex, length, and state of maturity of the fish.



GRAYFISH

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EDITOR'S NOTE: Studies by the Bureau of Marine Fisheries, California Division of Fish and Game, revealed that immature soupfin sharks do not contain enough vitamin-laden oil to warrant their capture.

The nurseries and pupping grounds of the soupfin shark are located in shallow water along the California Coast.

To protect and perpetuate these prime producers of vitamin A, a regulation sponsored by the Bureau of Marine Fisheries and the fishing industry was enacted by the last legislature. The regulation, effective September 19, outlaws the taking of soupfin shark in less than 25 fathoms (150 feet) of water. The regulation applies to sportsmen and fishermen alike.

SUMMARY OF OBSERVATIONS AND DISCUSSIONS OF THEIR SIGNIFICANCE

Liver Color

In the study of color, the livers were classified visually into five groups: light, medium-light, medium, medium-dark, and dark. These groups were numbered from 1 to 5, the lightest-colored livers being rated 1 and the darkest-colored livers being rated 5. The classification was done visually as the use of photo-electric or similar devices was impractical under the working conditions.

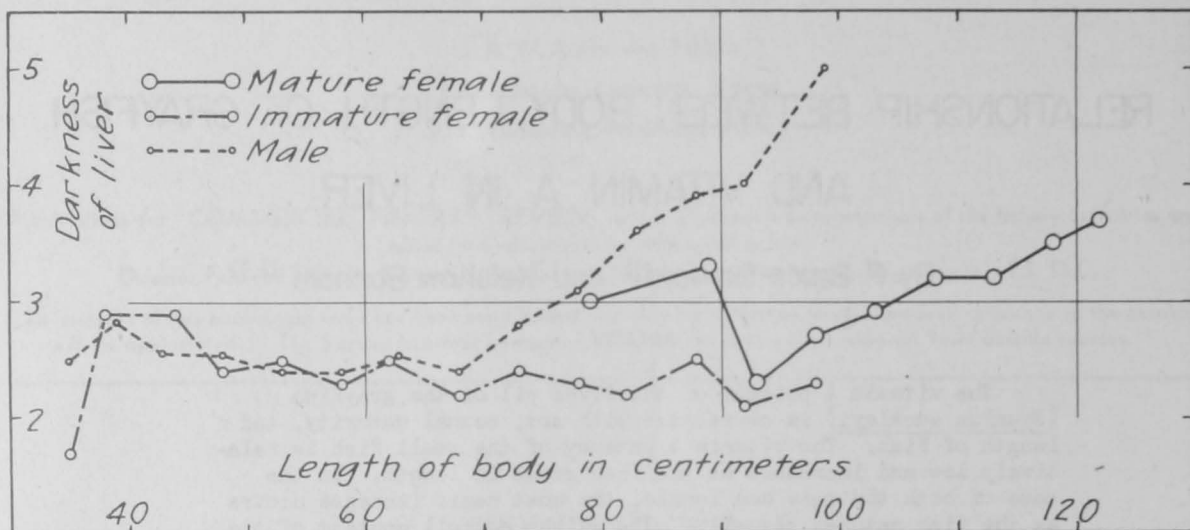


FIGURE 1 - RELATIONSHIP BETWEEN DEPTH OF LIVER COLOR AND BODY LENGTH

There seems to be a positive correlation between liver color and sexual development. Figure 1 shows that among females of the same size, those which were sexually mature¹ had the darker livers. Males start to mature at a length of 60 to 70 centimeters, and as the male grows larger than this, the average color of the liver darkens rapidly. This same trend occurs among the females. Almost all females longer than 100 cm. are mature; and, in this group, the color of the liver also darkens in proportion to the length of fish. It is interesting to observe that the livers of the males start to differ from the livers of the immature females when both are about the length at which signs of maturity begin to appear in the male.

Liver Weight

For the fish of the same length, the immature females tend to have heavier livers than either the males or the mature females (Figure 2, see p. 3). Again it is interesting to note that the male and immature female start to differ in the relationship of body length to liver weight at a length of fish of about 60 cm. The livers of the immature specimens are smaller in proportion to the size of the fish than is the case in the larger specimens. The livers constitute 8 percent of the weight of the small fish and about 12 percent of the weight of the large fish. The industry has found that a liver weight of 10 percent of weight of fish is a satisfactory rough average to use in calculations.

¹A female was judged to be sexually mature if it had eggs or embryos in the uteri. A male was judged mature if sperm was present in the seminal vesicle. Since sexual maturity was not determined for the earlier observations on the males, separate data for mature and immature males are not presented.

Liver Oil Content

The content of oil in the livers of the smallest grayfish is only 20 to 30 percent of the weight of the liver (Figure 3, see p. 4). As the small fish grow, the oil content of livers increases rapidly. By the time the fish have reached a commercial size (about 76 cm. or 30 in. in length), the oil content of the livers has increased to more than 60 percent. Further growth results in a slow increase in the oil content of the livers to about 75 percent. Thus, in the commercial fishery, oil yields below 60 percent and above 75 percent are seldom encountered. The average is about 68 percent.

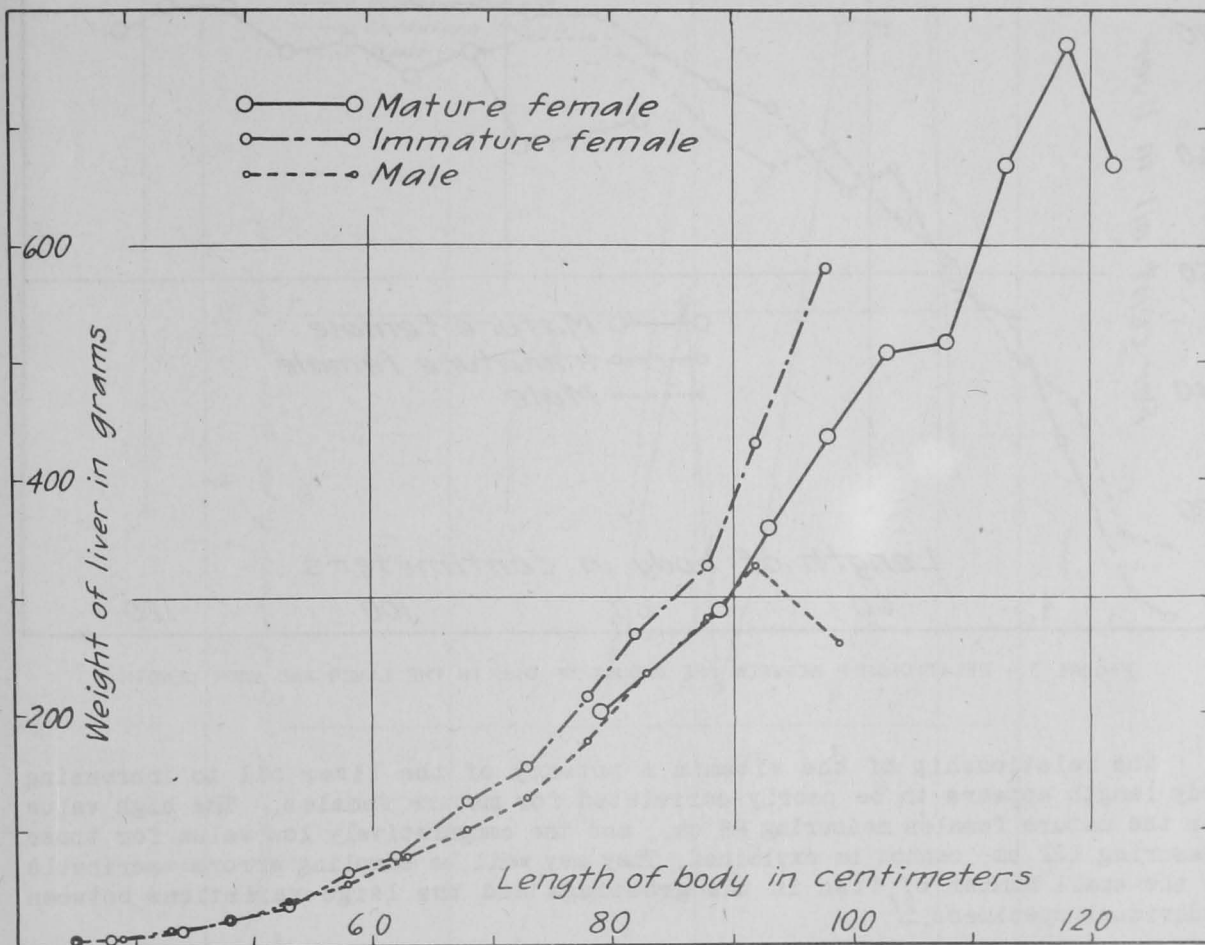


FIGURE 2 - RELATIONSHIP BETWEEN LIVER WEIGHT AND BODY LENGTH

For fish of the same length, the livers of the mature females contain less oil than the livers of the immature females. It will be noted, as is true for liver color and weight, that a difference in the oil content of the livers appears between the males and immature females at a length of fish of between 60 and 70 cm.

Vitamin A

The vitamin A potency of the liver oil appears to be correlated with sexual maturity. The immature fish of both sexes have liver oil of about equal vitamin

A potency and of a relatively low value (Figure 4, see p. 5). After signs of maturity appear in the male at a length of 60 or 70 cm., there is a large increase in the vitamin A potency of the male liver oil with further increase in the length of the fish. In contrast, the vitamin A potency of the liver oil of the immature female increases, but slowly. By the time a fish length of 90 cm. has been reached, the male liver oil contains about $4\frac{1}{2}$ times as much vitamin A as does that of the immature female.

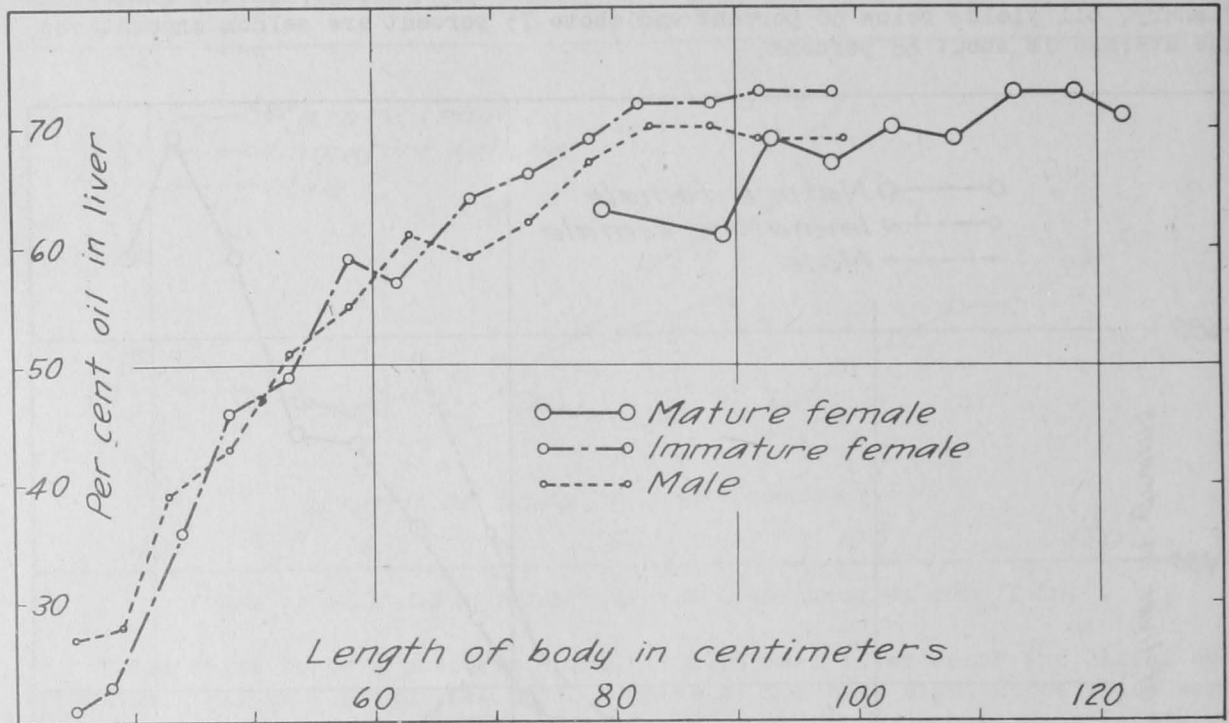


FIGURE 3 - RELATIONSHIP BETWEEN THE AMOUNT OF OIL IN THE LIVER AND BODY LENGTH

The relationship of the vitamin A potency of the liver oil to increasing body length appears to be poorly correlated for mature females. The high value for the mature females measuring 88 cm., and the comparatively low value for those measuring 122 cm. cannot be explained. They may well be sampling errors ascribable to the small number of fish in the groupings and the large variations between individual specimens.^{2/}

There is a marked difference in vitamin A potency of liver oil of the mature and immature female. Even for fish of the same length, the vitamin A potency of the mature female liver oil is considerably greater than that of the immature female. At a length of 100 cm., all or nearly all female grayfish are mature. As the female grows longer than this, the vitamin A potency of the liver oil increases greatly. Thus, the liver oil of both the male and female shows a rapid increase in vitamin A potency as the fish matures.

^{2/}The total number of specimens examined was 1,097, of which 555 were males, 364 were immature females, and 178 were mature females. With 14 length groups for the males, 14 for the immature females, and 9 for the mature females, each length group contained on the average, 40 specimens in the case of the male, 26 specimens in the case of the immature female, and 20 specimens in the case of the mature female. The length group for the mature females measuring 88 cm. contained only 7 specimens, and the length group for the mature females measuring 122 cm. contained only 3 specimens.

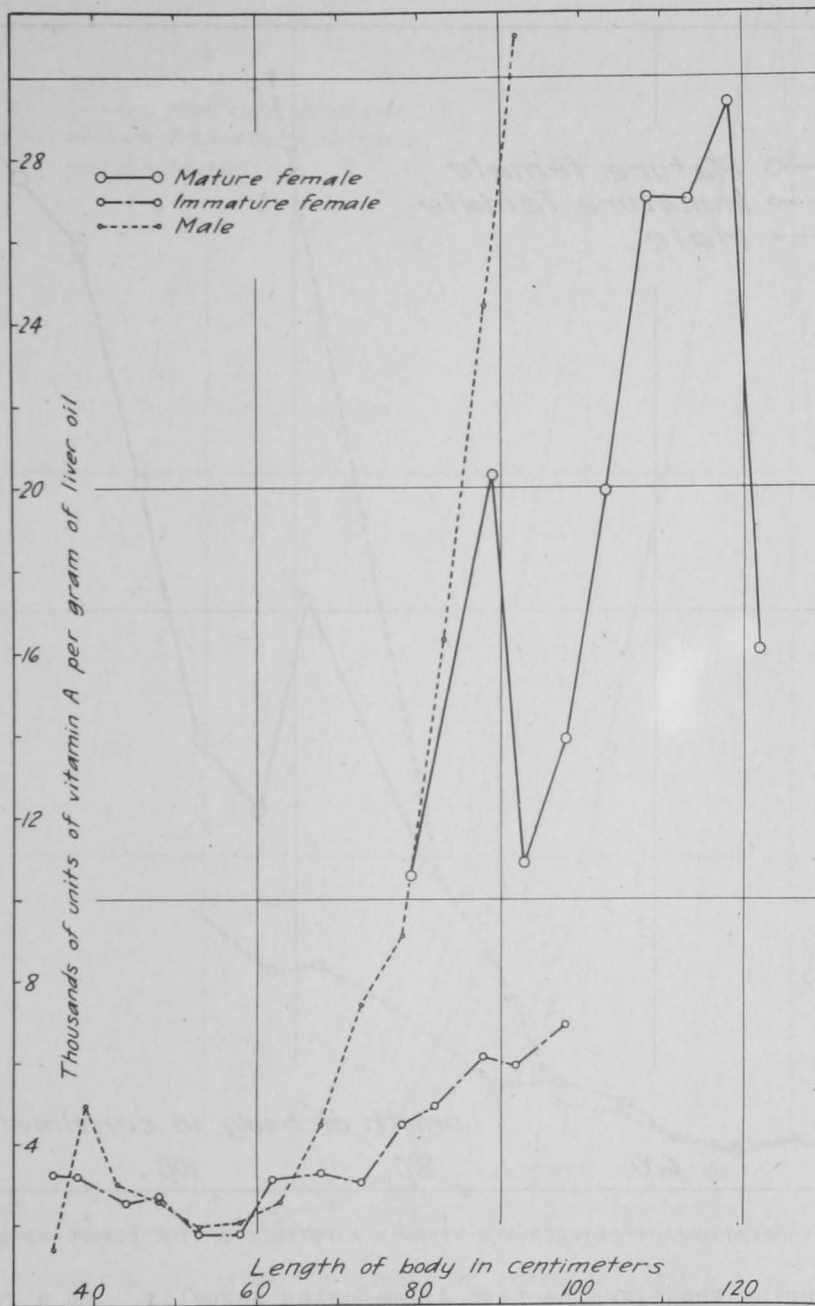


FIGURE 4 - RELATIONSHIP BETWEEN THE VITAMIN A POTENCY OF THE LIVER OIL AND BODY LENGTH

The commercial fisherman will be especially interested in the vitamin A potencies of the liver (Figure 5, see p. 6) since he is paid on this basis. As might be anticipated, the graph showing the relationship between this potency and the length of the fish is similar in appearance to that showing the relationship between the vitamin A potency of the liver oil and the length of the fish.

Of the various relationships studied in the investigation, the most important to the fishing industry is that between the vitamin A potency of the individual liver and the length of fish (Figure 6, see p. 7). The importance of the relationship depends upon the large increase in vitamin A potency of the liver oil which

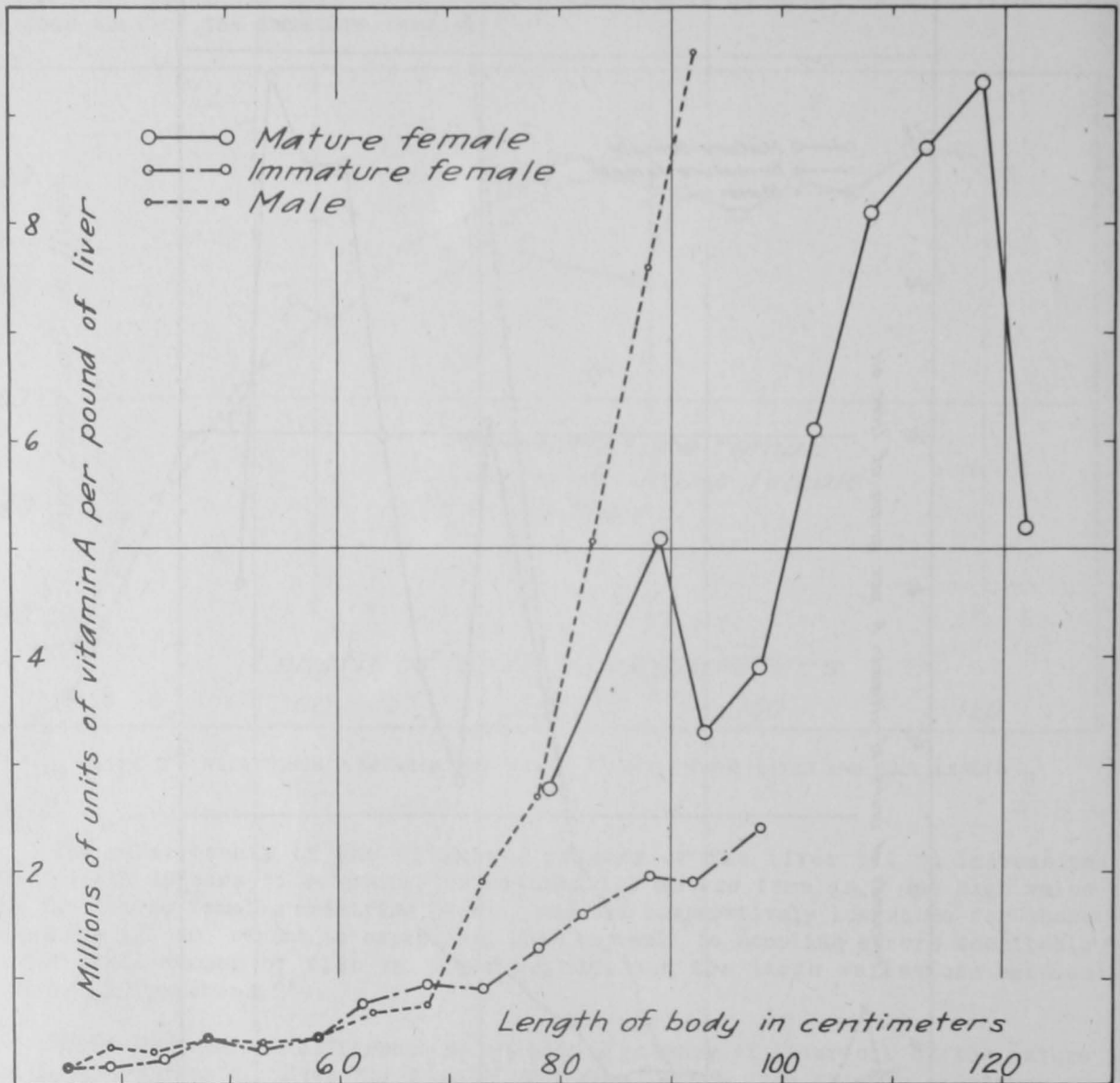


FIGURE 5 - RELATIONSHIP BETWEEN THE VITAMIN A POTENCY OF THE LIVER AND BODY LENGTH

takes place during the time the fish is maturing sexually. As a result of this phenomenon, the small, immature fish are relatively valueless as compared with the larger fish which have reached maturity. The implication is clear, of course, that to take the small fish is a waste not only of the fishermen's time but of a valuable resource. In recognition of this fact, the governmental agencies charged with the conservation of fish on the Pacific Coast have recommended that no male

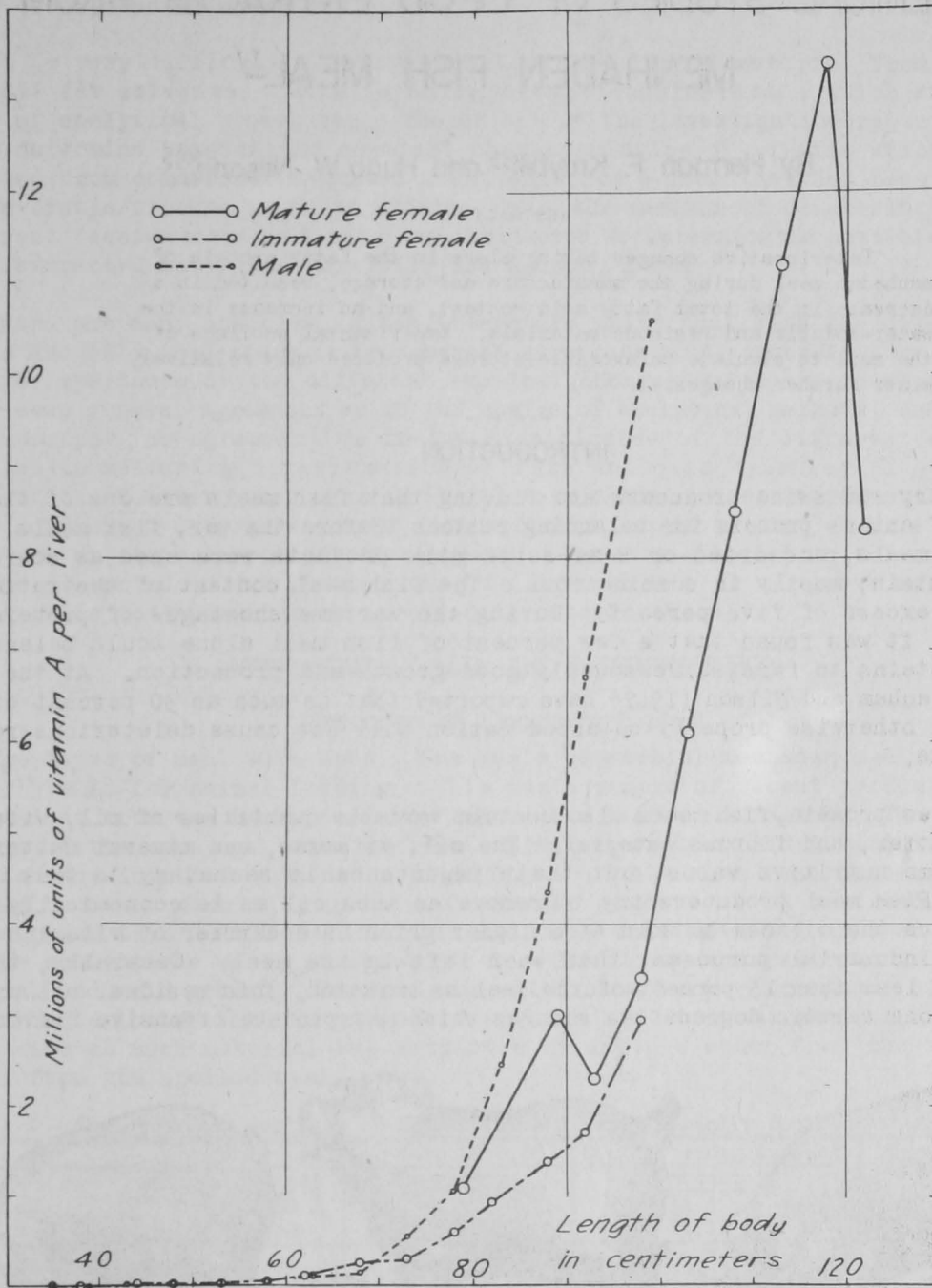


FIGURE 6 - RELATIONSHIP BETWEEN THE AMOUNT OF VITAMIN A IN EACH INDIVIDUAL LIVER AND BODY LENGTH

grayfish less than 30 in. long (76 cm.) and no female grayfish less than 36 in. long (91 cm.) be taken.

