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PROGRESS REPORT ON DEVELOPING A SAMPLING METHOD USING PHOTOGRAPHIC TECHNIQUES

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I. Introduction

The ICCAT Secretariat initiated biological sampling at transshipment ports of tunas unloaded from the longliners. It was found that measuring fish at the ports of Las Palmas and Tenerife, Canary Islands, is quite difficult, since the sampler cannot gain access to the fish with ease. (See Document SCRS/75/09)

The authors started some preliminary experiments of measuring fish using photographic techniques. The experiments are not yet completed, but the method looks promising. Progress made during 1975 is here reported. The program will be continued in 1976 and a more definite report will be prepared later.

II. Materials

Photographs are taken using a Minolta camera (Model SRT-101) with a "Vivitar" zoom lens (F = 75 ~ 160 mm/f = 4.5) and a standard lens (F = 55 mm/f = 1.4).

The camera is a single lens reflex 35 mm, which provides the advantage of non-parallax and easy handling, although enlarged prints were required for calibrating fish. The film used was Kodak Verichrome Tri-X (black and white), and regular processing (D-76) was adopted.

III. Methods

The sampler stands on the deck of a longliner from which fish are being unloaded. A scale is placed on the edge of the fish well opening. When the fish are brought up by a hauler and come out of the opening, a photo is taken together with the scale. The sampler remains at the same spot and therefore, if the scale is out of the picture, the other photos which include the scales can serve for the measurement when the photos are processed.

The film is then processed and enlarged on paper of approximately 18 cm x 25 cm. All the pictures taken at one sampling should be enlarged at the same rate to permit the comparison. (See Fig. 1 for an example of such a photo).

Using a divider, the fish are then measured to a scale in the photo (A) and then adjusted (D), assuming that all the fish are in the center of the opening of the fish well. The adjustment is done by calculating the ratio of reduction of the length (C/B) from the edge where the scale is placed (B) to the center of the openings (C). (See Fig. 1) This is necessary because of the perspective view effect of the photos.

The fish are measured manually at the same time that the photos are being taken. This is carried out by using a measuring tape (straight measures) on the truck to which those fish are transferred. Unfortunately, comparison of the measurements of the same fish is done only once. On that occasion, the fish are tagged with numbers to make it possible to compare the measurements of the same fish by both methods. This is hereafter referred to as Experiment 1. On the other hand, in the other experiment (Experiment 2), the measurements are not directly comparable, since fish cannot be identified in the picture nor by the manual measurements. However, the same lot of fish is always measured by both methods, assuming that they represent a single group of fish.

IV. Results

Experiment 1

This Experiment was conducted only once (yellowfin tuna). Thirty-seven (37) fish were measured by the photo method and forty-nine (49) fish by the manual method. Out of these, twenty-seven (27) fish were measured by both methods. The resulting measurements are directly comparative.

The relation of the results of the two measurements is shown in Fig. 2. At least in this sample, photo measurements show a value lower than that of the manual measurements. The correlation ($r = .64879$, d.f. = 26) is highly significant. There is a clear tendency that the larger a fish is, the photo measurements tend to be larger than the results obtained by the manual method, and vice versa. However, we cannot claim these results to be conclusive based on just one sample.

Experiment 2

Thirteen (13) samplings were conducted employing both the manual and the photographic methods (six yellowfin samples and seven albacore samples). Figs. 3 and 4 compare the size frequency of measurements between the two methods for yellowfin and albacore, respectively.

Size distributions of the two methods are more similar for albacore samples than for yellowfin. This may be explained by the fact that albacore is smaller in size than yellowfin and with less standard deviations. Assuming that the albacore frequencies represented normal distribution, the significance of the difference in the distribution between the two sampling methods was tested with t-value. No significant differences were observed in any of the seven comparisons.

In the case of yellowfin, a comparison by any statistical method seems meaningless, since distribution is quite widespread while the sample size is rather small.

It is interesting to note that there is no consistent relation between the results by photo and manual measurements. The situation varies greatly from sample to sample. When the photos are carefully studied we can generally see the cause of the biases in photo measurements. Mostly these are attributable to optical illusions which vary from case to case depending on the position of the photographer in relation to the fish. The causes of errors thus analyzed are discussed in the following chapter.

V. Sources of errors

The sources of errors in the photo technique method are very easy to understand. Fig. 5 shows most of the optical sources of errors.

Case a: The fish are not on the plane crossing at a right angle to the axis of the lens - This is very often observed since 10-15 fish merge together at the tail. As a result, the fish located on the outside are always suspended outwards. (The whole lot forms a conical shape). Unfortunately, the fish in the middle, which are more or less vertically suspended, are not totally visible in the picture.

Thus, there is the tendency to measure only the outside fish. The magnitude of error is approximately equivalent to cos θ. Generally, maximum value observed for θ was about 20°, thus, cos θ being 94% of of the true figures.

Cases b and c: The fish in the picture are not positioned in the center of the fish well. This is the largest source of error. In the picture taken by a standard lens at a distance of 7 m, if the fish are actually at the front or back edge of the opening - instead of the center - the error is about ±15% of the actual length. On the other hand, using a long focal lens at a distance of 20 m, the error is reduced to 5 ~ 7%. The reason for this is very obvious as shown in Fig. 6.

The focal length of the lens is not a matter of importance, but the distance of the camera from the fish is. The farther the camera is located from the fish, the less perspective distortion is introduced. However, when the camera is far, the fish which have been photographed with a standard lens, become so little that the accuracy is lost. For this reason, a long focal lens is very useful. The problem lies in the fact that the ship deck is not really large enough to allow the sampler the necessary distance from the fish. In our experience, a zoom lens (75 mm ~ 160 mm) is very handy.

Generally, the fish in the foreground of the picture are more available for measurements. Therefore, fish thus measured would tend to be larger than they actually are.

Case d: When the scale is not at a right angle to the axis of the lens of the camera - As in case a, this would produce the scale in the picture reduced. Therefore, fish measured on that scale would be larger than they actually are.

Case e: Fish are bent - If fish are bent on the same plane as the picture, it can be easily detected. If they are bent in the direction of the plane parrallel to the axis of the lens (or depthwise rather than crosswise from the sampler). those defects do not appear in the photo. In such cases, the fish are not rejected, but are measured shorter than they are.

Case f: Distortion of a scale - This occurs when the scale is placed horizontally while the camera is not directly in front (but positioned to the side) of the fish. The scale in the picture is reduced in size. This is the same effect as in case d. This can, however, be corrected by placing the scale vertically, if possible.

Case g: When the fish are not on the same level as the camera - If the photo is taken when the fish are hauled up high, the same effect as in cases a and d would occur.

Case h: Inaccuracy of calibrating fish on the picture - Since the photo provides a rather small image, a small error in calibration could produce a rather important error. (e.g. 120 cm fish are 6 cm in the picture; thus a 2 mm error in calibration means an error of 4 cm in size). However, this is not really serious compared to other sources of error.

Case i: Species identification - If mixed species are unloaded, yellowfin and bigeye are difficult to identify in the photo, especially when they are small. This is particularly true since these fish from the longline catch are always gilled and gutted.

Fortunately, the longline catches rather large fish and generally two species are not hauled up together. Albacore is very easy to identify in the photo.

Case j: Bias by the size of the fish - When 10-15 fish are suspended together at caudal peduncle, the lot forms a conical shape, and larger (heavier fish) could tend to remain in the center while the smaller (lighter) fish tend to hang on the outside.

Also, many fish in the center of the photo are not valid for measurement because they are partly hidden behind the outside fish. Therefore, a smaller fish may have more of a chance to be measured than the larger fish.

VI. Future program

The preliminary experiment and analysis showed that the photo method could be practical, particularly where the manual method proves difficult. There are a few optical and non-optical sources of errors- cases a, b and c are the most important among all of them; in particular, cases b and c could produce quite serious errors.

A device illustrated in Fig.7A is now being considered for use. The idea is to measure the fish to the closest scale in the photo. Since the photos are not stereographic, the position of the fish will not be very accurately located, but at least this would provide better measurements. The practicability has to be tested in the field.

Also, enlarging the pictures is expensive. A microfilm reader can be used for the purpose.

VII. Recommendations

If the photo techniques are to be used, the following are suggested:

1) The scale should be placed at a vertical position closest to the fish. It would be even better if the scale could be attached to the fish on the line holding the fish, so that the scale and fish move together. (Fig. 7 B and C)

2) In a series, only one species should be photographed.

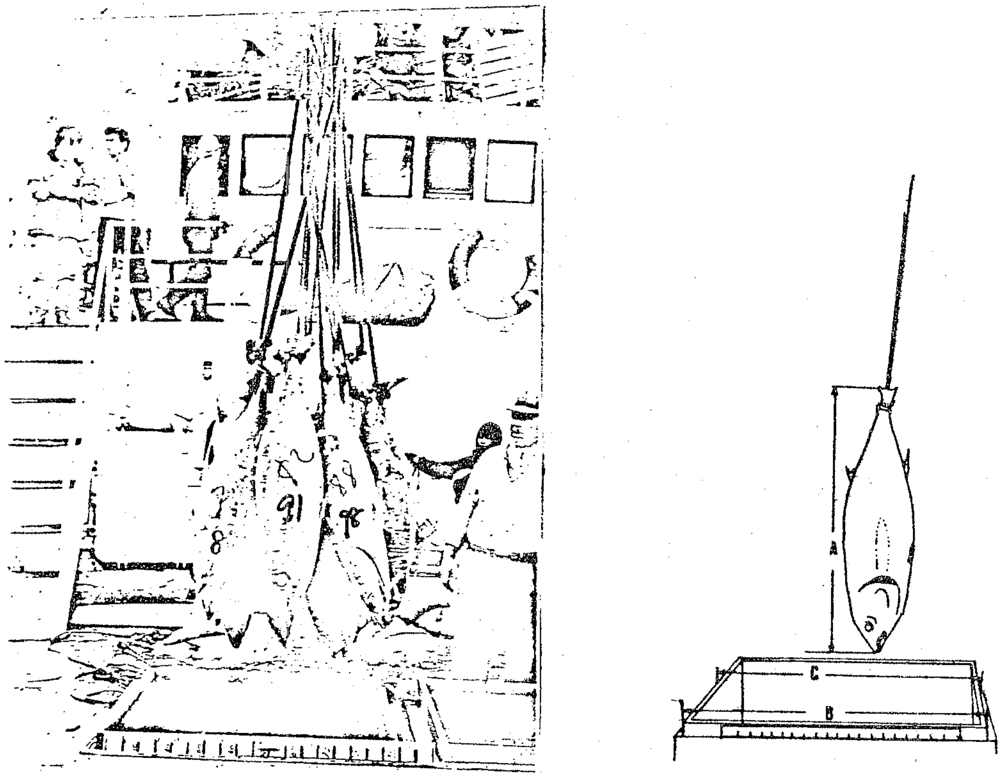
3) The camera should be aimed at fish directly in front so that fish are on the plane (as much as possible) crossing at a right angle to the axis of the lens.

4) The farther the distance between objects and the camera, the less optical errors would be caused by the perspective effect of the photo. A long focal (zoom) lens is very effective.

5) When many fish are hauled up together, those fish are not suitable for photo sampling. Photos must be taken only of a small lot, which will produce not only as many measurements as a big lot, but more accurate ones as well. A big lot causes the type errors as explained in cases a, b and c, i and j.

VIII. Acknowledgement

Acknowledgement is made to Mr. A. Fonteneau who is actively engaged in the sampling program and who has offered us excellent advice. His collaboration has been an asset to our experiments. Gratitude is also expressed to the boat captains, fishermen, shipchandlers and shoremen, whose cooperation is essential in carrying out the sampling program.



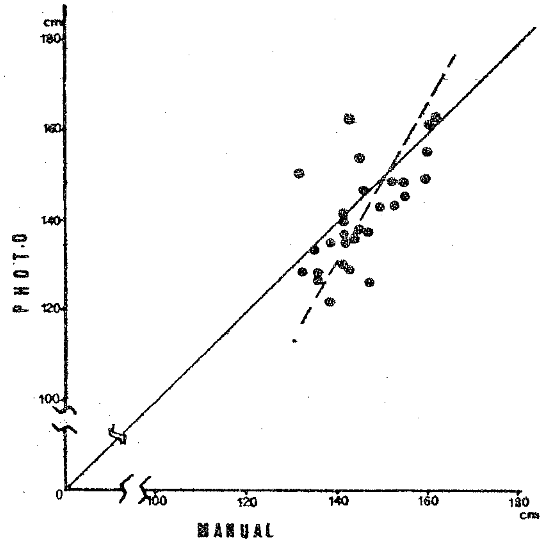


Fig. 2. Relationship between the two sets of measurements by manual and photographic methods.

Fig. 1. Actual picture taken (left) and measurements of the fish on photo.

A) Measurement of fish against the scale in the photo.

B) Width of the edge of the opening where the scale is placed, as measured on the photo.

C) Width of the opening at the middle of the well, as measured on the photo.

D) = A x $\frac{B}{C}$ = adjusted measurement of the fish.

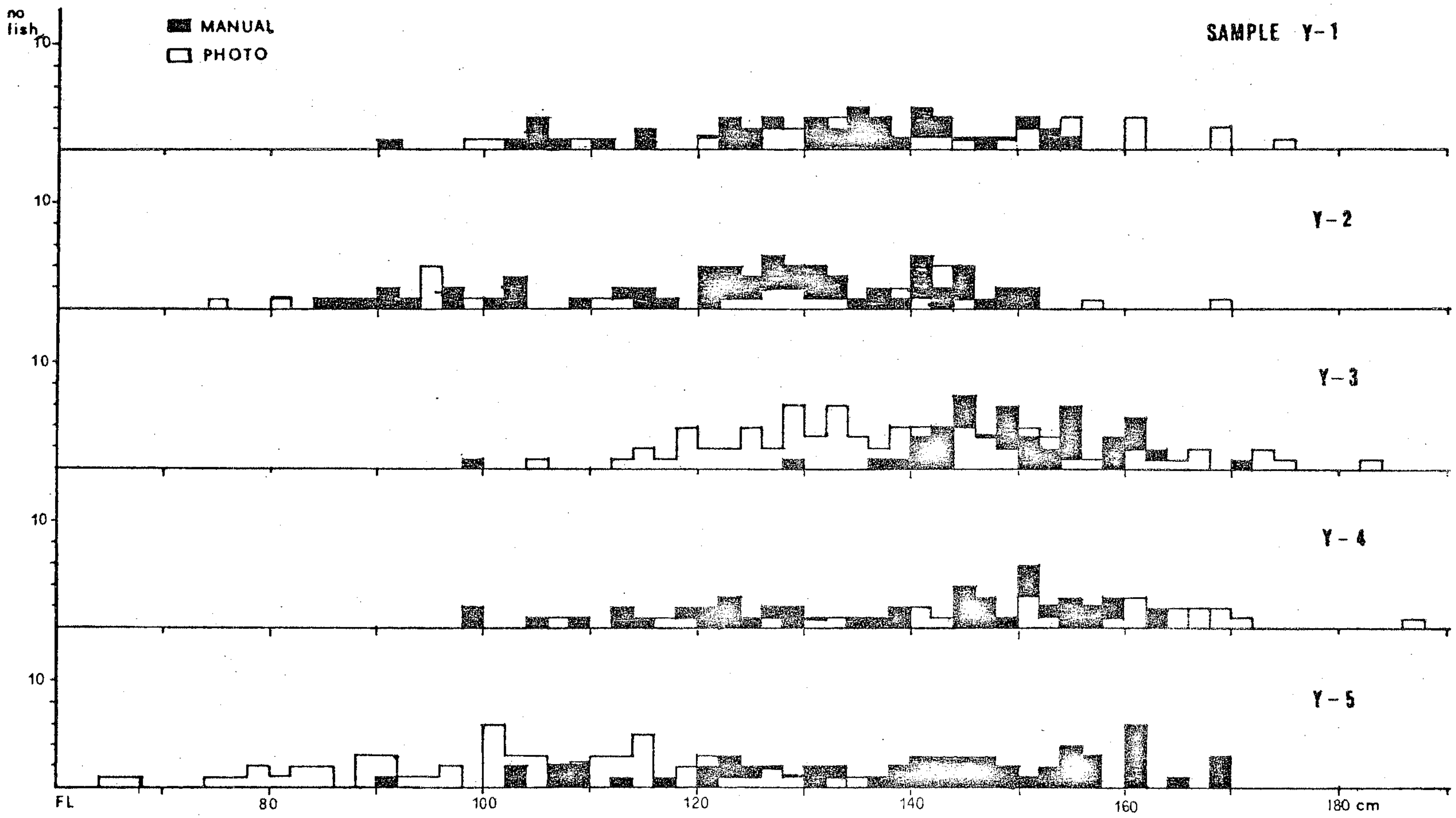


Fig. 3. Comparison of size frequency between photo and manual samplings of yellowfin.

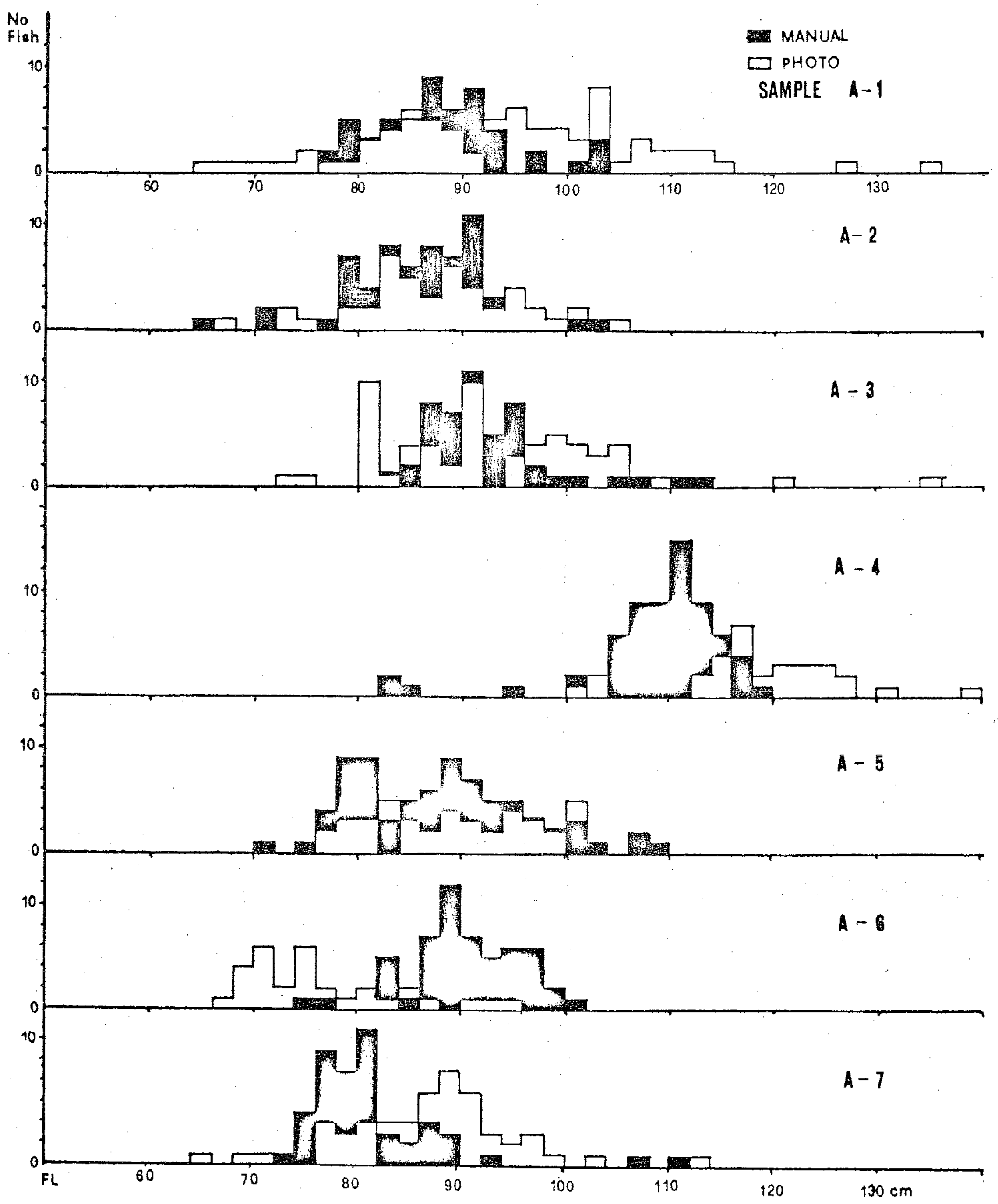


Fig. 4. Comparison of size frequency between photo and manual samplings of albacore.

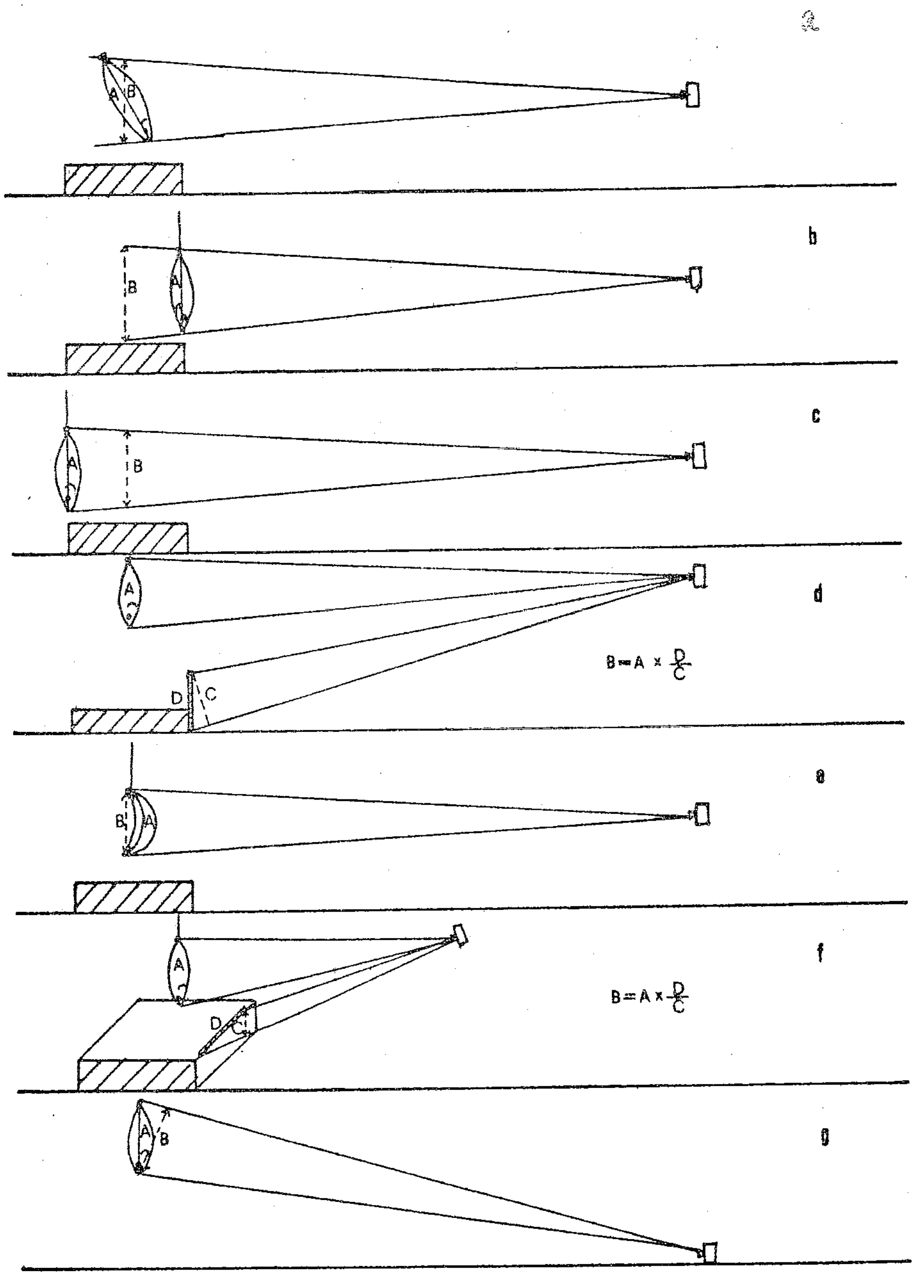


Fig. 5. Optical sources of errors.

A = true value   B = calibrated value on photo

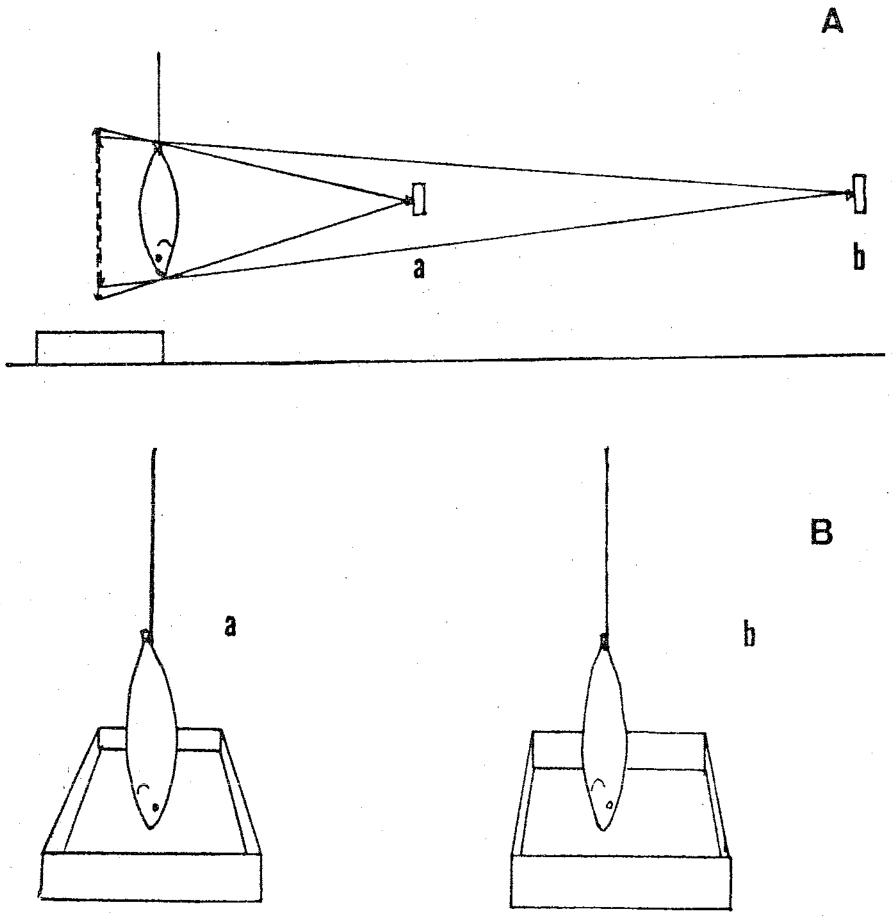


Fig. 6. Errors due to the perspective view of the photo.

A) Two camera positions

B) Fish and fish well opening as would appear in the pictures taken at these two camera positions

a) Camera with standard lens

b) Camera with long focal lens

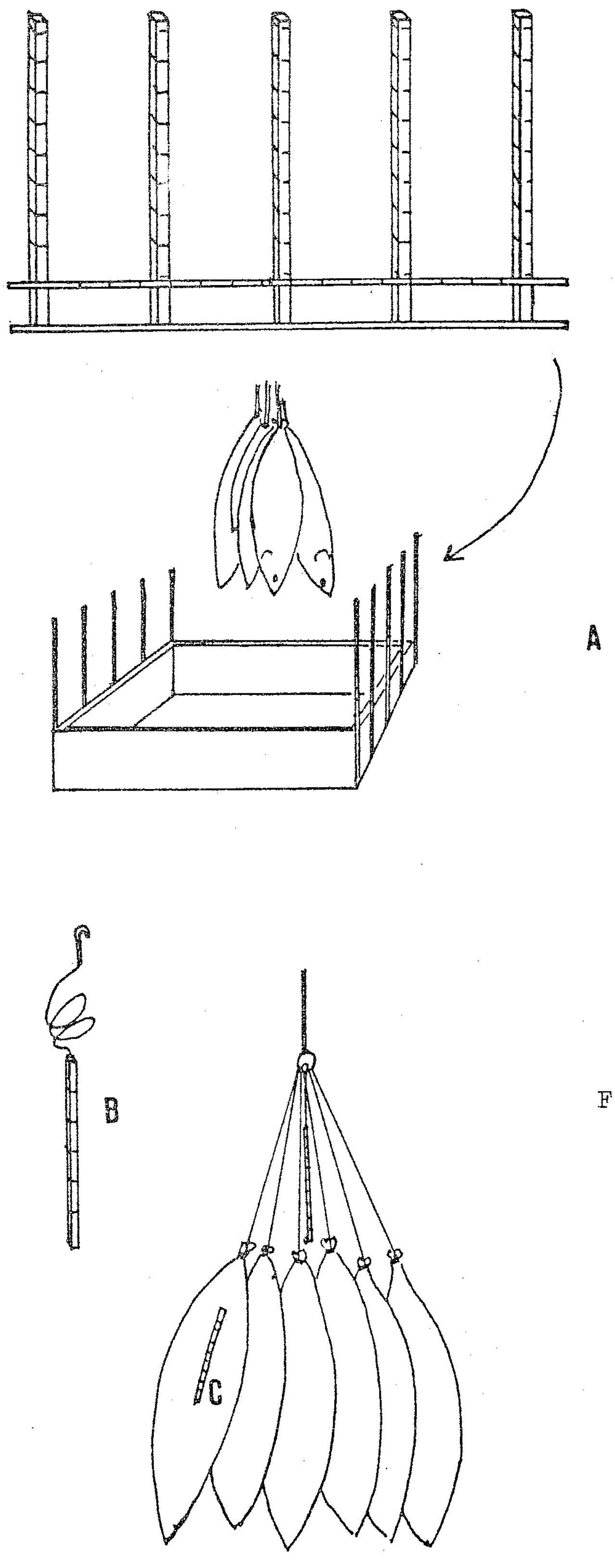


Fig. 7. Improvements proposed.

A) Three-dimentional scales

B) Special scale attachable to the lines hauling up fish

C) Paper scales attachable on the surface of fish