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Observations on the Depth Range of tagged Bluefin Tuna (*Thunnus thynnus* L.) based on Pressure Marks on the Lea Tag

by
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Introduction

Our knowledge of the vertical distribution of bluefin tuna is mainly based on catch data from various regions. The main part of the North Atlantic bluefin tuna catch is made from typical surface fisheries, but some catch data from the hook and line fisheries indicate that the tuna also may occur at greater depths. According to Tiews (1963) the deepest catch records of tuna on the eastern side of the Atlantic are from the Turkish waters where bluefin tuna occur at depths between 14 and 25 fathoms, whereas on the western side this species has been hooked down to a depth of 100 fathoms.

In the present paper the question of the depth range of the bluefin tuna has been considered on the basis of pressure marks on recovered Lea tags used in the Norwegian tuna tagging experiments. Although the present material is inadequate for any definite conclusion, it is probable that this technique could be developed into a useful research tool.

The Material

The material consist of 24 recovered Lea tags which have been attached to adult bluefin tunas in Norwegian coastal waters. The Lea hydrostatic fish tag is described in Journal du Conceil, Vol.19(2), page 270. The total length of the tag used for tuna is 50 mm, the length of the waterproof plastic tube is 40 mm with an outer diameter of 5 mm.

If a fish carrying a Lea tag goes down below the depth corresponding to the maximum pressure the waterproof tube can resist, the tube collapses. Owing to the stiffness of the plastic material, the tube does not regain its original form when the pressure is removed so that all collapsed tags can easily be recognized if the tubes are available. In most cases, however, the only available part of the tag is the letter inside, but it has been observed that typical pressure marks also occur on the slip of paper. The marks consist of stripes on the unrolled paper as illustrated in Figure 1.

In Table 1 is given the release and recovery data of the 24 tuna tags, grouped in two categories: collapsed tags and uncollapsed tags.. From the table it appears that the within season recaptures have uncollapsed tags whereas all the fish which have been out for one winter season or more have been down to greater depths than the tag can resist. These data indicate that the tuna have a deeper vertical distribution during the winter than in the summer when they are feeding in Norwegian coastal waters, provided that the resistance of the waterproof tube to pressure does not get poorer when submerged in sea water for longer periods.

Test of the Plastic Material

In order to determine the maximum depth thetube can resist under varying conditions, two samples of 10 tags each from the same series as used for the taggings were selected, one kept in sea water for 8 months (A) and one dry stocked sample (B). These were tested in a pressure aquarium, and the following results were obtained:

Pressure corresponding to							Tags collapsed	A	B
100 metres depth for					24 hours			0	0
150	"	"	"	further	24	"		0	1
200	"	"	"	"	24	"		0	1
250	"	"	"	"	24	"		0	6
300	"	"	"	"	24	"		4	2
350	"	"	"	"	6	"		6	

A chi-square test shows a significant difference in pressure resistance of the two samples: those soaked in sea water have become stronger. The manufacturer of the tag has been consulted about this unexpected finding. He indicates as a possible explanation that in the soaked sample the most volatile components of the plastic material may have been removed. This makes the tube less elastic and in cases where the pressure is increased over several days a stiff tube may stand for a higher pressure than an elastic one.

Discussion and Results

The basic technique for the present investigation is to locate the depth at which the waterproof tubes of the Lea tags get the pressure marks illustrated in Figure 1. This has been done by testing 20 tags as described previously, but it would have been desirable to improve the confidence of the test by using larger samples. However, this investigation was not in mind when the tagging was executed. Consequently there were no tags spared for this particular purpose, and the tags used in the test were the only ones left of this series.

The method gives a lower limit for the depth range of fish carrying uncollapsed tags, which in the present case are the 9 within season recaptures. From Table 1 it appears that except one recovery at Anholt in Kattegat, these tunas have been released an recovered off the Norwegian coast between N 59°30' and N 60°55'. This includes the most important fishing grounds for the Norwegian purse seiners who catch the tunas when they appear at the surface. The maximum depth in the area concerned is 386 metres. The tagged fish have been out in different time intervals during August-September in the years 1959-1961.

The recaptured fish on the Norwegian coast have been found in catches varying in size from 120 to 300 fish. The tuna is a typical school fish and it is reasonable to assume that when the tagged fish is is liberated it will soon join a new school. If the school only once migrate to the greatest depth the tuna enter, the tagged fish becomes representative for the population with regard to the actual problem. The weight of each recovery as a reliable indicator of the depth range will therefore increase proportionally to the time in liberty. Judging from the fishermen's experience the tuna seem to have a uniform vertical migration pattern. The fish have certain periods in the day when they feed in the surface so that when a fisherman hears on his radio that a boat has observed tuna, he will be on guard because then he expects to spot fish. There is no reason to expect that this behaviour pattern is changed when the tuna enter the deeper water layers so that a tagged fish which has been out for only a few days may be expected to have been down to the greatest depth the tuna stock usually enters in the time under study. The 9 uncollapsed tags may therefore be regarded as one sample of the population. If the test of the dry stocked sample is used and a 90 percent confidence limit is accepted, one can draw the lower limit of the depth range of the population in the area at 250 metres depth.

The sample of collapsed tags indicates that the tuna stocks go down to deeper water layers than 250 metres during the winter season, but as no tags have been tested with regard to the pressure resistance over long periods the data are inconclusive.

There exists no exact observation that can indicate to which depth the tuna may go during their stay on the Norwegian fishing grounds. It is obvious that if the actual depth limit was close to 250 metres, there would have been a fair chance to get collapsed tags also from the within season recaptures. Generally it can be stated that in cases where the true limit of the depth range lies within the depth range where the pressure marks occur, one must expect to obtain both categories of recoveries randomly distributed with regard to number of days in liberty within the period under study. In such cases the proportion of collapsed tags to uncollapsed ones may locate precisely where the true limit of depth range is situated if a sufficient number of recoveries is available and the strength of the tags sufficiently known. This means that if a pressure tag which covers the area above 250 metres depth were available, a new tagging experiment might have solved the problem in question.

Knowledge of the depth range of tuna stocks may be of both practical and scientific interest. It is felt that the present method of investigating such problems is so promising that a special pressure tag should be developed for the purpose. The tag should consist of several pressure cells each covering a certain part of a broader depth range. The technique and economic side of making such a tag has been considered in consultation with the manufacturers of the Lea tag. It is believed that a pressure tag applicable to tunas and other fish above a ceratin size can be developed and produced at a reasonable price, and at the Norwegian Institute of Marine Research further work will be done in order to construct the tag in question.

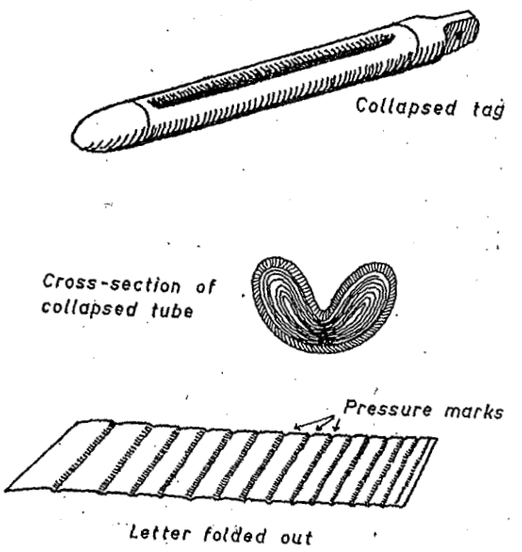

Figure 1. Illustrations of the pressure marks of the Lea tag.