CORROSION RESISTANCE OF FISH TAGGING PINS

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CORROSION RESISTANCE OF FISH TAGGING PINS

by

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ABSTRACT

Aquarium-held haddock were tagged with nickel and Type 304 stainless steel pins to compare the corrosion resistance of the two metals. The stainless steel pins proved to be superior.

CONTENT

CORROSION RESISTANCE OF FISH TAGGING PINS

Wire or pins made of various metals, including silver, platinum, copper, and nickel, have been used extensively to fasten tags to fish. For some years nickel pins were used with Petersen discs to mark haddock (Melanogrammus aeglefinus L.) in the Gulf of Maine (Rounsefell 1941) and on Georges Bank. When recovered many of them were corroded, suggesting that many tags may have been lost from the fish. To avoid this loss, stainless steel pins were considered as a possible substitute.

An experiment with tagged haddock was conducted in the Fish and Wildlife Service aquarium at Woods Hole to compare the corrosion resistance of Type 304 stainless steel pins with that of the nickel pins used in the past. The metallic composition and dimensions of the two types of pins are shown in table 1.

CONDITIONS OF THE EXPERIMENT

Tanks

Six indoor aquaria each holding about 300 gallons were used in the experiment. Flowing sea water at the rate of four changes per day was supplied to the tanks from Great Harbor, on which the laboratory is located. The water temperature in the tanks was recorded with a Bristol recording thermometer. The average salinity of the water in Great Harbor is 32 parts per thousand, and because of the frequency of change the salinity of the aquarium water was presumably the same.

Fish

The haddock used in the experiment were captured by an otter trawl on Georges Bank during Albatross III cruise 59, April 6-12, 1955. A total of 168 fish were transported to Woods Hole on board the vessel in wooden tanks supplied with running sea water.

Haddock are delicate and difficult to maintain in aquaria. Four weeks were therefore allowed for initial mortality and to acclimate the fish before the experiment began. Forty-three fish survived and 36 of the strongest, ranging in size from 30 centimeters to 60 centimeters, were selected for use.

Table 1.--Composition and dimensions of tagging pins [1/]

Stainless Steel		Nickel	
Chromium	18.7%	Nickel	98.5%
Nickel	10.7	Cobalt	0.5
Molybdenum	0.22	Silicon	0.3
Carbon	0.08	Manganese	0.2
Titanium*	0.1	Copper	0.2
Niobium*	0.1	Iron	0.1
Iron	70.1		
	100.0		99.8
Length (in.)	1.53	Length (in.)	1.81
Diameter (in.)	.035	Diameter (in.)	.032

*Spectrographic analysis

1/ Analyzed by National Bureau of Standards

Method of Tagging

The fish were tagged with Petersen discs on May 9 using the technique described by Rounsefell (1941) in which the pin is threaded through the center of one disc and then pushed through the operculum from the inside. The second disc is then threaded on the projecting point of the pin. The surplus part of the pin is cut off and the remainder twisted into a loop and bent over with long-nosed pliers. To calm the fish while being tagged, they were placed in a tank containing 12 gallons of sea water to which one-half pound of ethyl carbamate (Urethane) had been added. After about one minute in the anesthetizing bath the fish began to float belly up, made only feeble swimming movements and were generally relaxed enough to permit tagging. On 18 fish the tags were fastened with stainless steel pins and on the other 18 fish the tags were fastened with nickel pins. Three fish tagged with stainless steel pins and three fish tagged with nickel pins were placed in each tank.

Control Pins

In addition to pins attached to the fish, two groups of control pins were set up to distinguish the effects of the raw harbor water, the aquarium water and the body fluids of the fish. A group of 10 stainless steel pins and 10 nickel pins were put in the aquarium water with the fish and a similar group was placed in the harbor. Half of these pins were bent as in tagging and half were left straight to see if bending affected the resistance to corrosion.

Fish Survival

There was some mortality throughout the experiment, but 20 fish survived for eight weeks. All these died during the ninth week, probably from lethal water temperatures. Previous studies at Woods Hole have shown that haddock do not survive well at water temperatures higher than 65° F. The temperature in the tanks was 53° F. on May 9 and reached 65° F. on June 19, six weeks later. The temperature continued rising until it reached 70° F. on July 1. The last fish succumbed on July 12. These data are shown in table 2.

Table 2.--Abstract of the experimental log

Date	Water Temperature (degrees Fahrenheit)	Number of fish alive
May 9	53	36
16	54	32
23	57	27
30	59	26
June 6	60	25
13	62	25
20	67	22
27	69	22
July 4	70	20
12	70	All dead

Although 36 fish had been tagged, only 34 tags were recovered from fish during the course of the experiment. The tags which had fallen off two fish were later recovered from the bottom of the tank. When a fish died its tags and pin were removed intact and washed in fresh water. The tag number, the date and the condition of the tagging wound were noted. At the end of the experiment the control pins were removed from the tanks and the harbor and washed in fresh water. All pins were examined under a binocular microscope for evidence of corrosion.

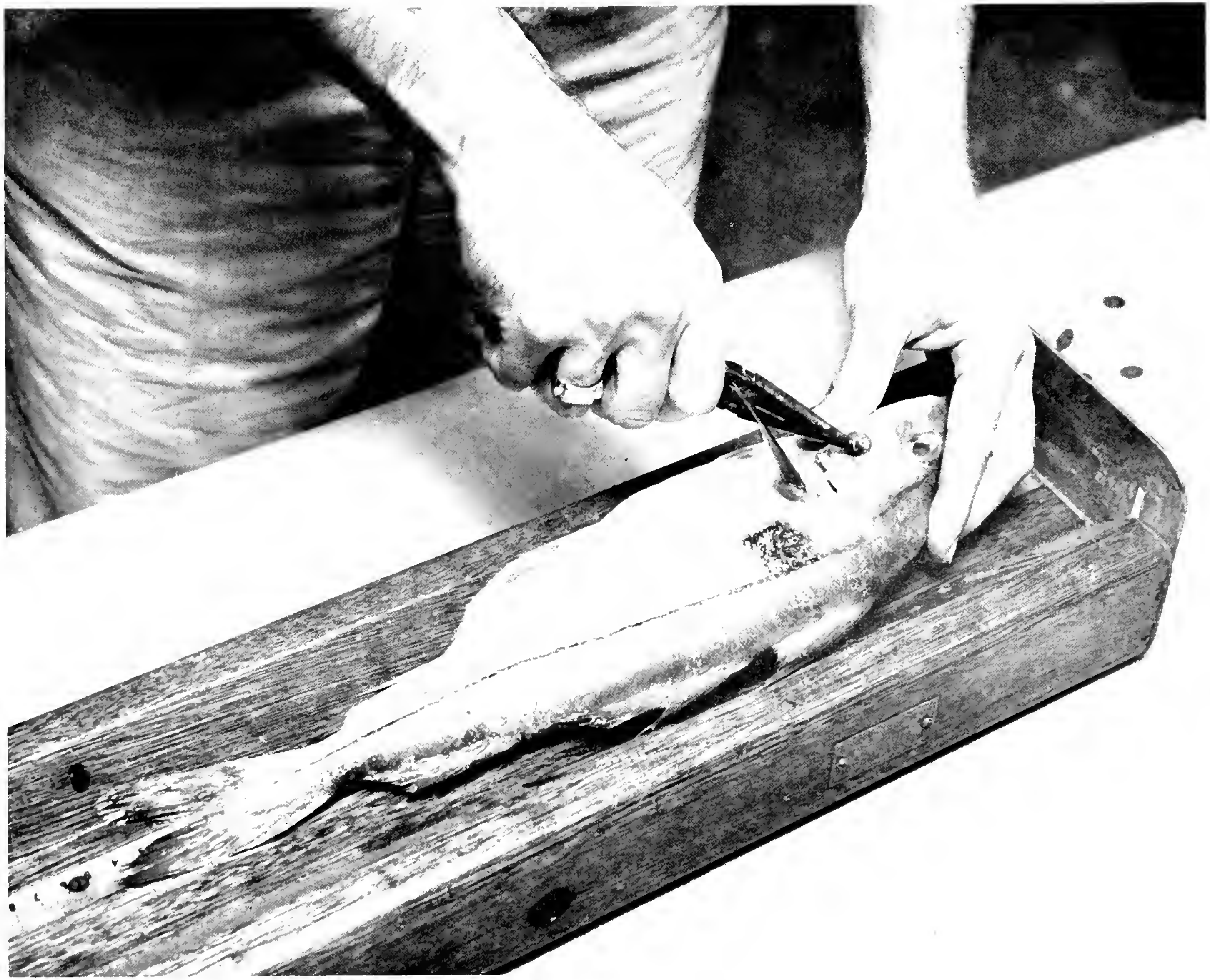
RESULTS

Nickel Pins

On Tagged Fish

All the nickel pins were corroded except one pin that was on a fish which died the day after tagging. Most of the nickel pins were corroded where they passed through the operculum and were in contact with tissue. The degree of corrosion varied from minor (staining and shallow etching on the surface metal) to extensive (deep etching and weakening of the metal). Two pins were partially worn through from abrasion by the tag discs, one was abraded by the inner disc, the other by the outer disc.

Three pins appeared sound on the surface but broke when bent, revealing a hollow corroded interior covered by a thin skin of apparently unaffected metal. This phenomenon has also been noted by Calhoun, Fry, and Hughes (1951) and Forrester and Ketchen (1955). In one case the nickel pin weakened and broke, allowing the pin head and inner disc to fall off the fish. The rest of the pin and the outer disc remained attached to the fish. This probably explains the loss of both tags by two fish on which nickel pins had been used. Table 3 summarizes the condition of nickel pins on tagged fish.



Attaching a Petersen disc tag to the operculum of a haddock.

Controls

All of the nickel pins in the aquarium control lot were corroded. In the bent pins the degree of failure ranged from pitting and surface corrosion to hollowing. All of the straight pins were hollowed, and broke when tested with pliers.

The control pins in the harbor showed varied resistance to corrosion. Two bent pins bore minor surface corrosion at the bend, the other three were unaffected. Two of the straight pins showed minor surface corrosion and one was unaffected. The remaining two were lost during the experiment.

Stainless Steel Pins

On Tagged Fish

The stainless steel pins were almost completely free from corrosion. Three pins showed rust spots and one pin was partially worn through by abrasion from the outer disc. These results agree well with those of Forrester and Ketchen (1955) who used pins of Type 316 stainless steel in a field tagging study. Type 316 differs from the Type 304 used in this experiment mainly in having 15 times as much molybdenum (Anon. 1947).

Controls

None of the control stainless steel pins were affected by immersion in the aquarium or in the harbor.

Table 3.--Summary of the average condition of the nickel pins used to tag fish

Time on Fish Days	Condition
1 - 21	Minor corrosion
22 - 42	Moderate surface corrosion
43 - 61	Moderate to extensive corrosion
62 - 64	Extensive corrosion; hollowed pins

37/8

Discussion and Conclusions

Most of the structural damage to the pins occurred where the pin contacted fish tissue. Body fluids of the fish may have been primarily responsible for the corrosion of the nickel pins on fish. Additional factors (Calhoun, Fry and Hughes 1951) which may have entered into the process which caused the pin damage are the galvanic effect produced by dissimilar metals (i.e., stainless steel, nickel and the iron pipes and drain screens) immersed in the aquarium tanks and/or the concentration-cell effect produced by a metal immersed in a mixture of electrolytes (i.e., fish excretory products and sea water). Electrolysis from either cause, coupled with actual chemical corrosion, would accelerate destruction of the pins. This could explain why the nickel control pins in the tanks were more corroded than the nickel control pins in the harbor which corroded slightly or not at all.

The artificiality of the aquarium tanks as a fish habitat should be considered before any strict conclusions are drawn concerning the usefulness of the pins which were tested in this study. However, since the nickel pins did corrode in the aquarium and to some extent in the harbor, it is reasonable to assume they would corrode in the open sea over a period of months instead of weeks. This conclusion is supported by the number of nickel pins which have corroded in the field tagging of haddock. Similarly, since the stainless steel pins did not corrode in the aquarium or in the harbor they probably would not corrode in field use. Based on the results of these studies we have decided to stop using nickel pins for tagging haddock.

Since the Type 304 stainless steel pins we tested are resistant to corrosion by the metabolic products of the haddock and also resistant to corrosion by raw sea water, we are using them exclusively in field tagging of several marine species. The pins were used in an extensive haddock tagging program conducted in 1956 and 1957. When sufficient returns are available, the relative corrosion resistance of the stainless steel and the nickel pins in actual field use will be compared.

EFFECTS OF TAGS ON THE FISH

Although the study was conducted to compare the corrosion resistance of the two types of tagging pins, observations also were made on the effects of the tags and the tagging technique upon the opercula on which the tags were fastened.

Damage to the operculum occurred in almost all the haddock which survived more than two weeks after tagging, varying from a mild inflammation to severe ulceration. In an extreme case, extensive necrosis occurred which resulted in loss of the tag. This tag was recovered intact from the bottom of the tank. When examined, the fish was found to have a raw hole about 3/4 inches in diameter where the tag had been applied.

On seven fish the inner disc was partially or completely grown over with tissue, but no fish had only the outer disc grown over. On one fish both inner and outer discs were grown over. The concealment of Petersen discs by overgrowth of tissue may be a factor contributing to rapidly diminishing returns from field tagging (Rounsefall 1941).

Black granular tissue which surrounded the pin for a radius of about 1/4 inch was seen on seven fish, five of which had been tagged with nickel pins.

Opercular ulcerations occurred on eight fish which were tagged with nickel pins and on twelve which were tagged with stainless steel pins. The small increase in ulceration associated with the stainless steel pins may have been a result of the stiffness of these pins. They are slightly more resistant to bending than are the nickel pins. The tagger's unfamiliarity with the new pin material caused him to exert more pressure when twisting the pins and this resulted in tight tags. Pressure from the tag discs probably caused a sore to develop beneath the discs which ultimately led to a deep ulceration. This hypothesis about the causes of the tagging wounds is supported by the effects of three tags which had been loosely fastened. One fish had been tagged with a stainless steel pin and developed only a slight sore under the discs. The other two fish had been tagged with nickel pins; one developed no sore under the discs, the second developed only minor sores.

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APPENDIX

Table A. --Condition of pins and opercula following tagging

Nickel Pins

Tag No.	Days on Fish [1]	Pin Condition	Operculum Condition	Remarks
60	1	No corrosion	Good	
41	8	Minor surface corrosion at operculum.	Good	
21	10	Minor surface corrosion at operculum.	Good	
51	21	Minor surface corrosion at operculum.	Good	
15	42	Moderate surface corrosion at operculum.	Ulcerated, both sides.	
33	42	Moderate surface corrosion at operculum.	Good	
37	53	Hollowed at operculum.	Minor sore, both sides.	Black granular tissue around pin.
98	57	Lost in tank.		
22	57	Extensive surface corrosion at operculum. Abraded by inner disc.	Minor ulceration externally. Inner disc grown over.	Black granular tissue around pin.
82	57	Moderate surface corrosion at operculum. Abraded by outer disc.	Moderate ulceration externally. Inner disc grown over.	Black granular tissue around pin.
43	57	Extensive surface corrosion at operculum.	Severe ulceration externally. Inner disc grown over.	Black granular tissue around pin.
59	58	Moderate surface corrosion at operculum.	Severe ulceration externally. Moderate ulceration internally.	Tight tag, dropped off operculum.
31	58	Moderate surface corrosion at operculum. Pin pitted near head on shank.	Moderate ulceration both sides.	Black granular tissue around pin.
76	59	Minor surface corrosion at operculum.	Good	Loose tag.
27	61	Moderate surface corrosion at operculum. Pitted under head.	Minor ulceration, both sides.	Loose tag.
29	63	Hollowed at operculum.	Decomposed	Dead in tank several days.
80	63	Hollowed and broken. Head and inner disc missing in tank.	Good	Part of tag broken off.
32	63	Lost in tank.		

[1] Days on fish refers to elapsed time between the day the fish was tagged and the day it died.

APPENDIX

Table B. --Condition of pins and opercula following tagging

Stainless Steel Pins

Tag No.	Days on Fish 1/	Pin Condition	Operculum Condition	Remarks
19	4	No corrosion	Good	
71	7	No corrosion	Good	
94	7	No corrosion	Good	
57	8	No corrosion	Good	
77	8	No corrosion	Good	
70	14	No corrosion	Moderate ulceration both sides of operculum.	
24	22	No corrosion	Ulcerated, both sides.	
56	42	Rust spot at twist.	Ulcerated, both sides.	Tight tag.
45	53	No corrosion.	Ulcerated, both sides. Inner and outer discs grown over.	
89	57	No corrosion	Minor ulceration externally. Inner disc grown over.	
84	58	No corrosion	Moderate ulceration externally. Inner disc partially grown over.	
65	58	Abraded by outer disc. Rust spot at twist.	Severe ulceration externally. Inner disc grown over.	Black granular tissue around pin.
42	58	No corrosion	Good	
91	58	No corrosion	Severe ulceration externally. Inner disc grown over.	Tight tag.
64	61	No corrosion	Severe ulceration, both sides.	Tight tag.
39	61	No corrosion except black spot near pin head.	Severe ulceration, both sides.	
03	63	Abraded by outer disc. Rust spot at twist.	Severe ulceration, both sides.	Black granular tissue around pin.
46	64	No corrosion	Minor ulceration externally.	Loose tag.

1/ Days on fish refers to elapsed time between the day the fish was tagged and the day it died.

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