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by

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INTRODUCTION

In a previous report¹⁾ the first tagging experiments on the sardine (*Clupea pilchardus* Walb.) in the Adriatic have been described. The report contained a description of the opercular tag used for that purpose and the details on the tagging techniques. The results, obtained by the first experiments, have shown that the tagging of this clupeid species was possible. This encouraged a more extensive application of the tagging method during the 1949 fishing season, designed to provide data on the sardine movements.

The tagging program included an intensive sardine tagging in a section of the Mid-Dalmatian region, and an extensive one along the larger part of the Yugoslav coast of the Adriatic. The devised program has been accomplished in the frame of a sardine research scheme instituted by the Institute of Oceanography and Fisheries, Split.

TAGGINGS

The majority of taggings took place in Hvar Channel (along the coasts of Brač and Hvar Islands), particularly along the coast of the north-west section of Hvar Island, and around Vis and Biševo Islands. A total of 20,827 tagged individuals were released in these areas. Here are included also the taggings made along Pakleni Islands.

The special attention given to this region is due to the fact

¹⁾ Mužinić, R. 1948/1949. First tagging experiments on the sardine (*Clupea pilchardus* Walb.) in the Adriatic. Acta Adriatica. Vol. III. No. 10. Split.

that earlier already this part of central Dalmatia has been chosen for investigations concerning biology of this clupeid species. This region includes, moreover, best sardine fishing grounds.

No tagging was possible in Split Channel which also belongs to the investigated region, owing to the catch being a very poor one during the major part of the fishing season.

Along the coast-line of the Dalmatian mainland sardines were marked not very far from Split and in the vicinity of Rogoznica.

A small-scale tagging, involving a limited number of individuals, was carried out around Svetac Island.

Three consecutive taggings were accomplished in a short time interval along the coast of the west section of Korčula Island, totalling 1,403 sardines.

A relatively small number of fish was marked along the coast of the north-west section of Mljet Island.

The southernmost tagging, involving a very small number of individuals, was carried out around Palagruž Island.

Fish releases took also place along the outer south-east and west coasts of Dugi Island, in the vicinity of Premuda Island, and around Susak Island. A total of 2,379 tagged fish were released along the outer south-east coast and the west coast of Dugi Island, whilst 972 individuals were marked around Susak Island.

The tagging localities are shown on the map placed at the end of this report. On some of these localities more than one taggings took place.

The experiments started at the beginning of May and were closed at the beginning of October. It is necessary to point out that the sardine fishing season in the Adriatic is commonly regarded as commencing in April and closing in October. The sardine fishing is not a continuous one during that time interval but is limited to darks of the moon only. In some cases the fishing may be prolonged for few nights. The data concerning the duration of darks of the moon during the 1949 sardine fishing season are given in Table I. In this way, our experiments were dependent upon the periods of fishing. The data concerning all the taggings are given in Table II.

In handling the data, taggings carried out during one dark of the moon, including the relative recoveries, have been separately considered. Figures 2, 3, 4, and 5 show the recorded movements of sardine. The taggings that yielded insignificant or no returns at all, are not shown in the figures.

In Table III data are given on all the tag recoveries made

Table I.
Review of Darks of the Moon in the 1949
Sardine Fishing Season

Dark No.	D a r k	
	Beginning in the evening of	Closing in the morning of
I.	April 16	May 6
II.	May 16	June 5
III.	June 14	July 4
IV.	July 13	August 2
V.	August 12	September 1
VI.	September 10	September 30

during the 1949 sardine fishing season. The cases, where data on recovery were missing, have not been included, but recoveries with at least one of the two data have been taken into account.

T A G S

For the sardine marking in the Adriatic during the year 1949 the same type of tag was used as in the previous experiments on this clupeid species. A red coloured celluloid disc measuring 5 mm in diameter was attached to each tag.

In accordance with the observation made during the previous experiments, the recoveries in 1949 have shown the appearance of some wearing off of the tissue on the part of the opercle where the tag was affixed.

In order to reduce this wearing off the application of a tag

having a very small metallic part was tested, but this type had to be rejected as complicated, requiring more time to be affixed to the opercle. This experience led to a modification of our previously used tag, directed at obtaining a more narrow and, therefore, a lighter one (Fig. 1). Having maintained the thickness

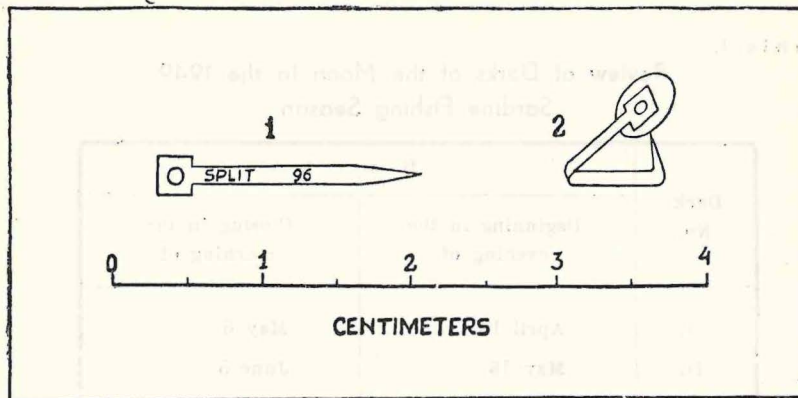


Fig. 1. — The new (modified) opercular tag applied at the end of the 1949 tagging experiments. No. 1. Straight tag. — No. 2 Curved tag (with celluloid disc).

of the previous type, the new tag was 17 mm long and 1 mm wide, ending with a square the sides of which were 2 mm long. Inside of the square there was a hole for the tag point measuring 1 mm in width. The weight of this tag was 0.04 gr.

Owing to technical difficulties which prevented the full-scale application of the new tag type in the year 1949, only 105 individuals were marked by it, and, consequently, its effectiveness can be only guessed for the time being.

This tag was also used with the red coloured celluloid disc and bore a serial number and the inscription like the previously applied one.

TAGGING METHODS

Neither with regard to the way of application of the tag nor as to the tagging techniques in general any essential changes are to be reported.

The tagging operations were performed by using the same live box which served this purpose during the previous experiments. The transfer of fish for tagging, during the experiments in 1949, was not performed directly from the net into the live box, but by means of a dip-net. This way of transferring fish proved to be by far simpler, without any unfavourable consequence for the sardine, provided that the work was most carefully done. The dip-net used for this purpose was the same one that was employed for taking the fish from the live box during the tagging operations. The lower part of the dip-net, made of stramin, provided against fish growing dry.

But there were some other moments causing the bad condition of sardines in the live box. The observation has been made that the fish, deriving from abundant catches did not stand with the requirements for tagging. The weather conditions, the currents, and the fishermen's skill in encircling the schools also influenced the quality of fish taken for tagging purposes. Swift and unhindered work during the encircling the schools gave usually a good quality of individuals as a result. A longer towing of live box with sardines, particularly if the sea was agitated, unfavourably influenced the quality of the fish. It seemed that the condition of sardine was relatively bad in cases when the catch included different kinds of fish. This fact was especially evident when a larger number of horse mackerel (*Trachurus spec.*) was present among sardines. No proper selection of fish for tagging operations was possible unless the fish in the live box were in a relatively good condition.

The speed of tagging varied considerably, being dependent on several factors. The quality of fish was the most important factor at calm sea. Under most favourable circumstances a sardine may be tagged and returned to the water within 4 seconds.

The tagged fish were released on the same spot where the tagging took place. Each release of marked individuals during one experiment regularly included one or two hundred specimens. The tagged fish left the live box in one school themselves in all cases when the individuals were in the best possible condition. Otherwise it was necessary to drive them out, the fish leaving then in several groups.

TAGGINGS CARRIED OUT DURING THE FIRST DARK

During the first dark of the 1949 fishing season only two taggings were made, towards the very end of the dark. Both of them were carried out along the west section of Biševo Island (Porat Cove). A total of 1,059 marked individuals were released. None of these was recovered, in spite of a relatively intensive sardine fishing during this dark of the moon.

TAGGINGS CARRIED OUT DURING THE SECOND DARK

During the second dark of the 1949 fishing season the taggings were carried out in Hvar Channel, along the north-west coast of Hvar Island (Stiniva Cove), along Pakleni Islands (Carnjene Cove), along the north coast of Vis Island (Oključna Cove), along the east coast of Biševo Island (Mezoporat Cove), and along the west coast of that island (Porat Cove). During this dark of the moon tagging operations were also accomplished along the west coast of Korčula Island (Potplat Cove), and Proizd Islet. The southernmost tagging was made along the north-west coast of Mljet Island (Goli Point, near Poma Cove). The taggings were carried out during the time interval from May 18th to June 2nd. These experiments are designated by numbers 3-14 in Table II.

A total of 8,564 individuals were marked during this dark, of whom 34, that is 0.40 % were recovered. For two of the recaptured specimens there were no data on the locality of catch and for one of these two neither the date of catch was established. A further specimen, with both data missing, has been also recaptured. The localities of recovery of tagged fish, released during the second dark of the moon, are shown on Figure 2.

As evident from Figure 2, the tagged fish released along the coast of the north-west section of Hvar Island were recovered along the north coast of that island (Crkvica Cove), along the coasts of the south and south-east sections of Brač Island (Zlatni Point, Žirje Cove), and along the coast-line of Makarska Littoral (Ramova). Judging from these recoveries, the sardine movement took place in the west-east direction, that is from

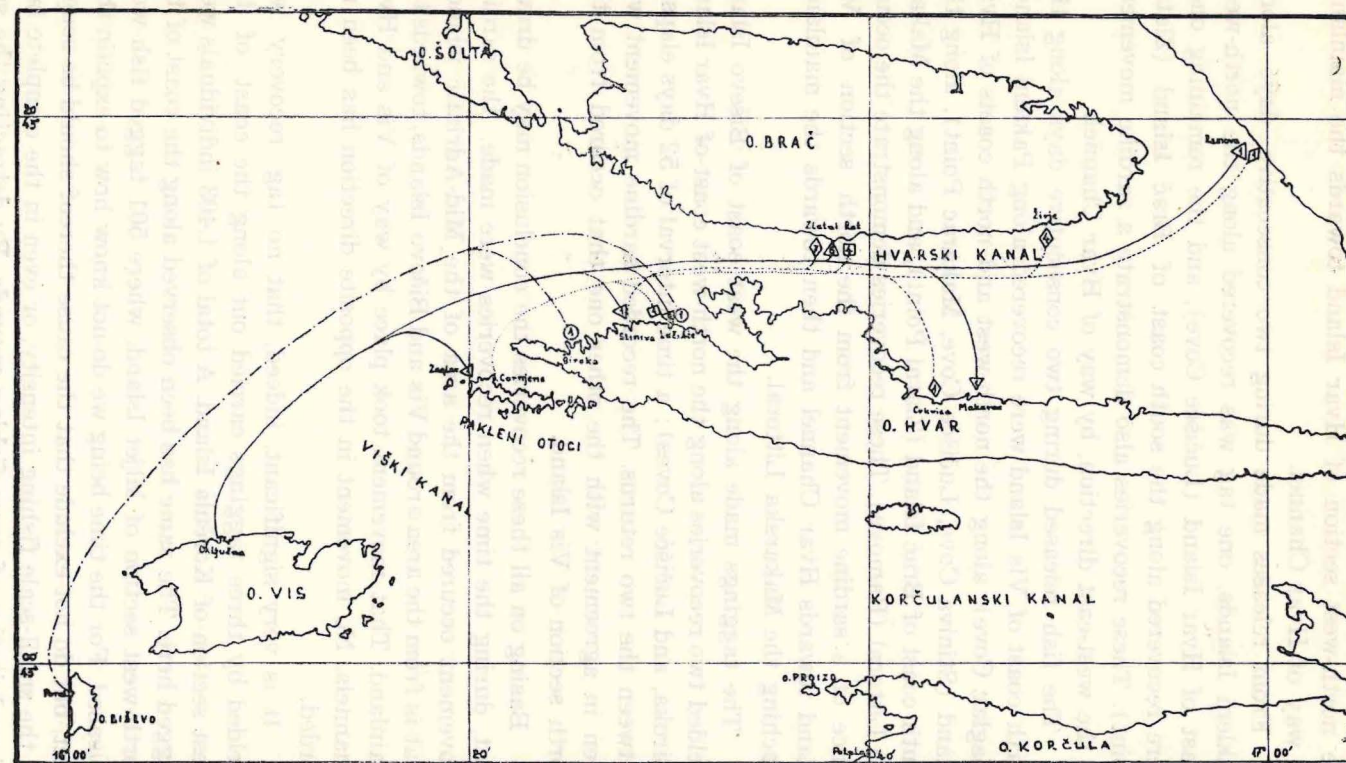


Fig. 2. — Movements of sardine shown by recoveries from the taggings carried out in the second dark of the moon in the 1949 fishing season.

the north-west section of Hvar Island towards the mainland, by way of Hvar Channel.

From releases made during two consecutive days along Pakleni Islands, one tag was recovered along the north-west coast of Hvar Island (Lučišće Cove), and the remaining ones were recovered along the south coast of Brač Island (Zlatni Point). These recoveries also demonstrate a sardine movement in the west-east direction, by way of Hvar Channel.

The fish released during two consecutive days along the north coast of Vis Island were recovered along Pakleni Islands (Zaglav Cove), along the north-west and north coasts of Hvar Island (Stiniva Cove, Lučišće Cove, Makarac Point), along the south coast of Brač Island (Zlatni Point), and along the Makarska Littoral (Ramova). These recoveries demonstrate the occurrence of a sardine movement from the north section of Vis Island towards Hvar Channel and then towards the mainland, reaching the Makarska Littoral.

The taggings made along the west coast of Biševo Island yielded two recoveries along the north-west coast of Hvar Island (Široka, and Lučišće Coves); a time interval of 52 days elapsed between the two returns. The recorded sardine movement was then in agreement with the other one that occurred from the north section of Vis Island.

Basing on all these recoveries the conclusion may be drawn that, during the time when recoveries were made, the sardine movement occurred from the area of the Mid-Adriatic islands, that is from the area around Vis and Biševo Islands, towards the mainland. That movement took place by way of Vis and Hvar Channels. No movement in the opposite direction has been recorded.

It is very significant, indeed, that no tag recovery was yielded by three taggings carried out along the coast of the west section of Korčula Island. A total of 1,403 individuals were tagged here. The same has been observed along the coast of the north-west section of Mljet Island, where 501 tagged fish were released. For the time being we do not know how to explain that fact, but do not exclude that the cause thereof should be sought in the small-scale fishing intensity, or even in the complete lack of exploitation of some fishing grounds. By detracting the spe-

cimens tagged in these areas from the total number of marked fish pertaining to this dark, we will find that the recovery percentage amounted to 0.51.

The recoveries of fish tagged during the second dark of the fishing season took place from May 26th to July 23rd. Of the 32 recovered fish with the date of catch known, 30 of them were caught until June 6th. One of the remaining two was caught on June 15th and the other on July 23rd.

The sardine movement from the area of the Mid-Adriatic islands towards the coast of the mainland took place, according to tag recoveries, by the end of May and during the first half of June. We cannot tell whether there was a movement in the same direction also before that period, because no recovery was yielded by the taggings carried out during the first dark of the fishing season. From an analysis of the condition of gonads, made during the examination of samples of sardines captured in May and June, the fact has been stated that the above sardine movement from the Mid-Adriatic islands towards the mainland took place after the termination of the spawning season.

The tags were recovered in time intervals of 3 to 14 days from the date of release. Only one specimen was recaptured after 59 days. The recorded sardine movement from the Mid-Adriatic islands towards the mainland was performed, then, at a considerable speed. This fact becomes quite clear by analyzing some of the recoveries.

One tagged specimen, released along the north-west coast of Hvar Island, was recovered after four days along Makarska Littoral (Ramova).

Of the tagged fish, released along the north coast of Vis Island, one was recovered after five days along the north coast of Hvar Island (Makarac Point), two of them were recaptured after six days along the south coast of Brač Island (Zlatni Point), and one of them was recovered after thirteen days along the Makarska Littoral (Ramova). One specimen, tagged along Biševo Island, was recovered after seven days along the north-west coast of Hvar Island (Lučišće Cove).

None of the 31 recovered specimens with available data on the locality of recapture was caught on the same spot where

their release took place. The shortest distance between the locality of tagging and that of recapture was cca 9 nautical miles, and the greatest one amounted to cca 42 nautical miles.

TAGGINGS CARRIED OUT DURING THE THIRD DARK

During the third dark of the 1949 fishing season sardine taggings were accomplished in Hvar Channel, along the south-east coast of Brač Island (Konjska Cove), along the south coast of Vis Island (Stiniva Cove), and along the west and south coasts of Biševo Island (Porat, Potok, and Treščavac Coves). One tagging was made in the vicinity of mainland, not far from Rogoznica (Konj Point). During two consecutive days sardine tagging was carried out along the south-east section of Dugi Island (Lučica Cove).

The sardine taggings during the third dark were carried out from the 21st to the 30th of June. In Table II, they are designated by numbers 15-22.

A total of 5,912 tagged specimens were released during this dark, yielding 38 recoveries, that is 0.64 %. The localities of recapture are shown on Figure 3. It is evident from the figure that the releases of tagged fish which took place along the south coast of Brač Island, yielded recoveries along the north coast of Hvar Island (Žukova Cove), and along the west section of Pakleni Islands (Palilo Cove). These recoveries indicate the occurrence of a sardine movement in the east-west direction, by way of Hvar Channel.

Of the fish released along the coast of the south section of Vis Island, one was recovered along the south-west coast of Hvar Island (Milna Cove) and the other in the Komiža Bay (Vis Island).

Three taggings carried out along Biševo Island, in the course of which 2,509 fish were released, yielded 31 recoveries, seven of these in the vicinity of that island and nineteen along the north-west, west, and south coasts of Vis Island (Ploča Bank, Komiža Bay, and Stiniva Cove). One individual was recaptured along Pakleni Islands (Palilo Cove), one along the north-west coast of Hvar Island (in one of the coves : Vira, Široka, Duga),

and two along the south-west coast of that island (Milna Cove). Only one specimen was recovered along Svetac Island.

The recapture of individuals tagged along Biševo Island demonstrates the occurrence of a sardine movement towards Vis Island and towards the west section of Hvar Island, this being in agreement with the observations made during the second dark of the 1949 fishing season. It is impossible, however, to follow this movement beyond the west coast of Hvar Island and Pakleni Islands, where it joins the already mentioned sardine movement by way of Hvar Channel. The movement towards Svetac Island lies beyond the frame of these movements.

The results of taggings made during this dark in the mentioned areas demonstrate the occurrence of a sardine movement from the area of the Mid-Adriatic islands towards the west section of Hvar Island as well as of another one by way of Hvar Channel in the east-west direction. The direction of the latter movement was, thus, opposite to that one determined by tag recoveries deriving from releases during the second dark of the fishing season.

Of the fish marked in the vicinity of Rogoznica, only one was recaptured, along the south-east section of Šolta Island (Stračinska Cove). This recapture indicates the occurrence of a withdrawal of the fish from the coast-line of the mainland by Rogoznica.

Two taggings, carried out during two consecutive days along the outer south-east section of Dugi Island, yielded only one recovery, not far from the tagging locality, although 1,705 specimens were marked in this area.

The recoveries of fish tagged during the third dark took place from June 22nd to July 24th. Of the 38 recaptured fish, 36 ones were caught until July 7th. From the remaining two specimens, one was recaptured on July 18th and the other on July 24th. The tags were recovered in time intervals of 1 to 27 days from the date of release.

By analyzing the results of these taggings, we find that some specimens kept some time in the vicinity of the point of release. The individuals, for example, which were marked along Biševo Island, were recaptured along the north-west section of Vis Island (Ploča Bank), in time intervals of 1, 4, 9, 11, 12, 14, and

24 days from the date of release. On the other hand, the quick withdrawal of the fish from the coast-line of the mainland of Rogoznica is shown by the fact that one of the individuals, marked in the vicinity of Rogoznica, was recaptured along south-east coast of Šolta Island two days after the release had taken place. The minimum speed of the fish movement in this case amounted to about 12.5 nautical miles a day.

The recovery of the majority of fish released during the third dark of the 1949 fishing season took place not far from the tagging localities. The greatest distance between the tagging and the recovery localities amounted to cca 33 nautical miles.

TAGGINGS CARRIED OUT DURING THE FOURTH DARK

During the fourth dark of the 1949 fishing season fish were marked along the coast-line of the mainland, in the Poljica region (Kućine), along the north-west section of Hvar Island (Jagodna Cove), along the north section of that island (Prapratna Cove), along the east section of Pakleni Islands (Ražnjić Point), along the north-west coast of Vis Island (Zakamiće), and along the west coast of that island (Komiža Bay). Further taggings were made along Svetac and Palagruž Islands.

During the fourth dark sardine taggings took place from the 15th to 30th of July. These taggings are designated by numbers 23-31 in Table II.

A total of 6,193 marked sardines were released during this dark, yielding 150 recoveries, that is 2,42 %. For two of the recaptured individuals the locality of catch was missing. The date of recapture could not be found out in one case. A further specimen, with both data missing, has been also recaptured. Points of recovery are shown on Figure 4.

The majority of fish, released along the coast-line of the mainland in the Poljica region, were recovered close to the point of release (Sv. Martin, Javor, Dugirat). Two marked individuals were recaptured in Kaštela Bay, one at the west point of Čiovo Island, and the other along the north-west coast of Šolta Island

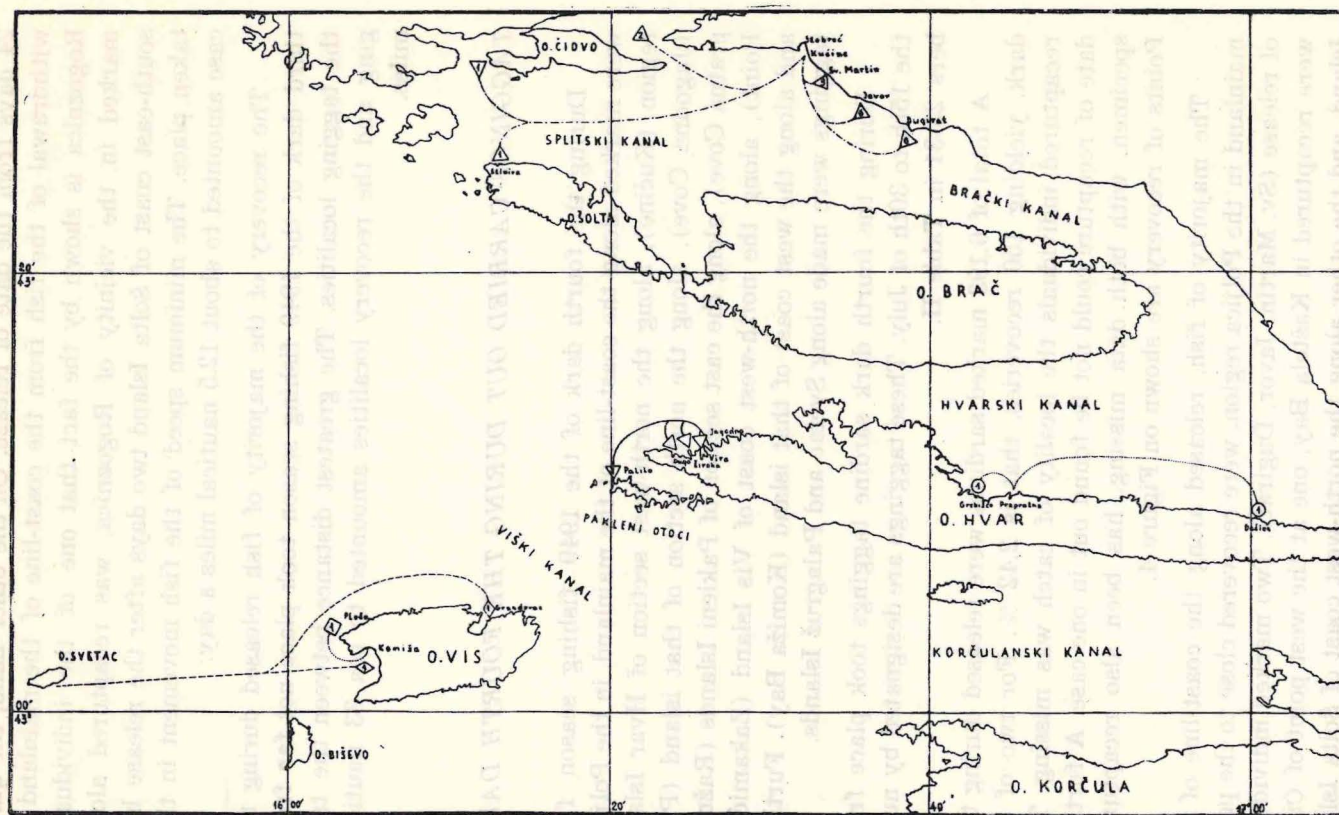


Fig. 4. — Movements of sardine shown by recoveries from the taggings carried out in the fourth dark of the moon in the 1949 fishing season.

(Stiniva Cove). It follows from these returns that the sardine movements in this area were rather limited.

The taggings, carried out along the north-west coast of Hvar Island, yielded recoveries close to the point of release (Vira, Široka, and Duga Coves)¹⁾. Only one marked specimen was recaptured along the west section of Pakleni Islands (Palilo Cove). The recovery percentage from this tagging amounted to 9.01. The high percentage of recaptures indicates the occurrence of a concentration of marked specimens close to the point of release.

The tagging, carried out along the north coast of Hvar Island, yielded recoveries along the same section of that island, not far from the point of release (Grebišće, and Gaćice Coves).

Of the marked individuals, released along the east section of Pakleni Islands, one was recaptured in the vicinity of the tagging locality (Uljeni bok Cove).

The specimens marked in Komiža Bay (Vis Island) were recaptured in the vicinity of the tagging locality. One of them was recaptured along the north-west section of Vis Island (Ploča Bank).

The tagging which took place along Svetac Island yielded two recoveries, one of them in Komiža Bay, and the other along the north-east coast of Vis Island (Grandovac Cove). It is necessary to point out that this latter recapture was made 36 days after the release of tagged specimens.

It is a striking fact that no tag was returned from the release of the tagged fish carried out along the north-west section of Vis Island, although 909 individuals were marked here. An analogous fact has been observed with regard to the release made off Palagruž Island. In this locality it was possible to mark only 312 individuals.

The returns, obtained from the taggings carried out during the fourth dark of the fishing season, indicate the occurrence of a concentration of tagged specimens close to the point of release. The recorded sardine movements were rather limited.

The recoveries of fish tagged during the fourth dark of the

¹⁾ The number of these recoveries is not given on Figure 4 owing to the fact that the recaptured fish were forwarded together, without any indication as to how they should be apportioned among these three coves.

fishing season were made from July 16th to October 27 th. Of the 148 recaptured individuals, with the date of catch established, 141 tags were recovered until August 6th. Of the remaining seven, five tags were recovered from the 21st to the 27th August, one on September 3rd, and one on October 27th.

The time interval between the date of tagging and that of recovery varied from 1 to 89 days. The marked fish kept for some time, partially at least, close to the point of release, this being proved by the fact that some of them were recaptured after several days not far from that point. This was the case with the specimens marked along the coast of the north-west section of Hvar Island. The tagged fish were recovered in the closest vicinity of the locality of release in time intervals of 1, 2, 4, 8, 9, 13, and 15 days from the date of release. In the same way, the marked individuals, released along the coast-line of the mainland (Kućine), were recaptured in the vicinity of the tagging locality in time intervals of 1, 3, 7, 23, 24, 28, 35, and 89 days from the date of release. During that time interval a movement of tagged specimens occurred in the direction of Kaštela Bay, the west point of Čiovo Island, and of the north-west coast of Šolta Island.

TAGGINGS CARRIED OUT DURING THE FIFTH DARK

During the fifth dark of the 1949 fishing season the sardine taggings took place along the coast of the north-west section of Hvar Island (Jagodna Cove), along the east section of Pakleni Islands (Ražnjić Point), and along the north-east coast of Vis Island (Viš and Stenjalo Coves). One tagging was also made along the west coast of Dugi Island (Lopata Point), along the west coast of Premuda Island, and along the south section of Susak Island (Tijesna Cove). The taggings, carried out during this dark, took place from 22nd to the 31st of August. These experiments are designated by numbers 32—38 in Table II.

The releases involved 5,032 marked individuals. Of these 28 that is 0.56 %, were recaptured. For two of the recovered tags data of catch were not available. The points of recovery are shown on Figure 5.

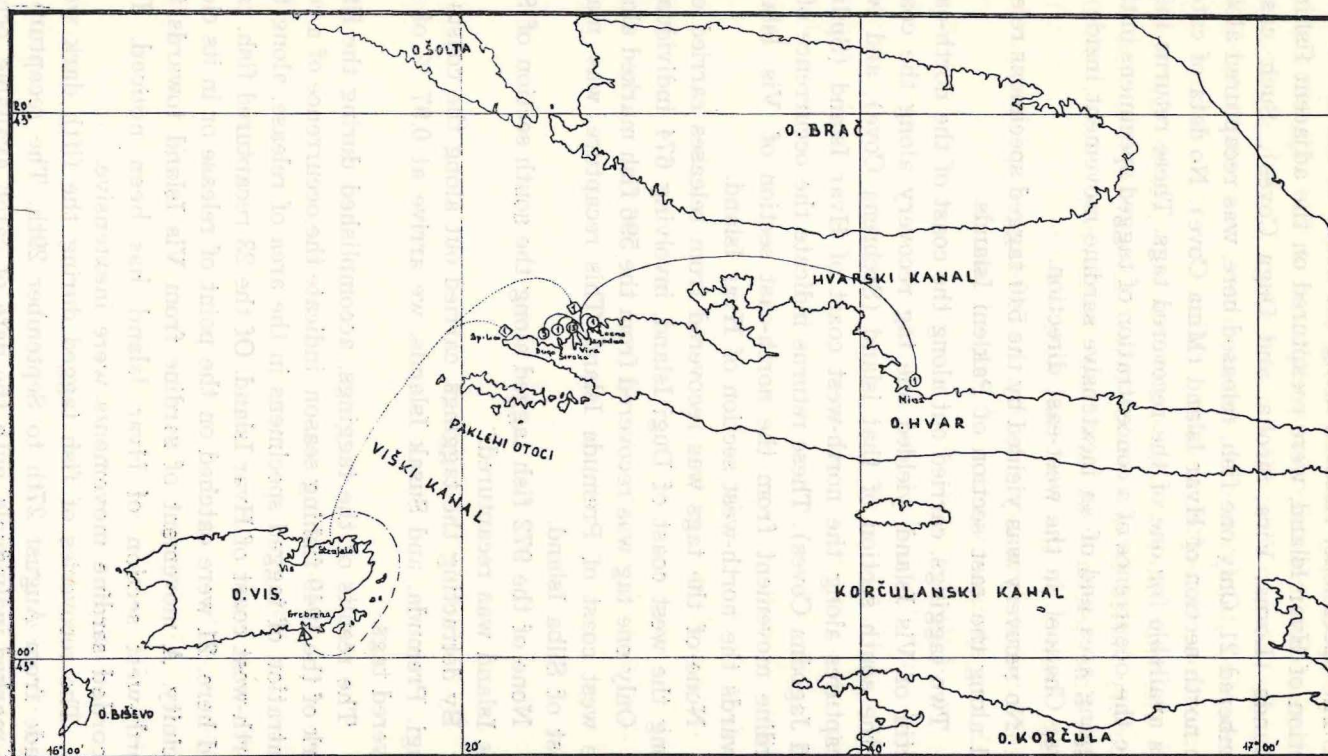


Fig. 5. — Movements of sardine shown by recoveries from the taggings carried out in the fifth dark of the moon in the 1949 fishing season.

The specimens, released along the coast of the north-west section of Hvar Island, were recaptured on the adjacent fishing grounds (Lozna, Vira, Široka, and Duga Coves). Such cases numbered 21. Only one fish, released here, was recaptured along the north section of Hvar Island (Mina Cove). No data of catch was available for one of the recovered tags. These returns indicate the occurrence of a concentration of tagged specimens in the tagging area and of an inextensive sardine movement inside of Hvar Channel, in the west-east direction.

No recovery was yielded by the 540 tagged specimens released along the east section of Pakleni Islands.

Two taggings, carried out along the coast of the north-east section of Vis Island, yielded one tag recovery along the coast of the south section of that island (Srebrena Cove), and two recaptures along the north-west coast of Hvar Island (Spilice and Jagodna Coves). These returns indicate the occurrence of a sardine movement from the north-east section of Vis Island towards the north-west section of Hvar Island.

None of the tags was recovered from releases carried out along the west coast of Dugi Island, involving 674 individuals.

Only one tag was recovered from the 596 fish marked along the west coast of Premuda Island. This recapture was made west of Silba Island.

None of the 972 fish tagged along the south section of Susak Island was recaptured.

By detracting the taggings, carried out along the coasts of Dugi, Premuda, and Susak Islands, we arrive at 0.97 % of recovered tags.

The results of the taggings, accomplished during the fifth dark of the 1949 fishing season, indicate the occurrence of a concentration of tagged specimens in the area of release, along the north-west coast of Hvar Island. Of the 23 recaptured fish, tagged here, 21 were caught on the point of release or in its close vicinity. A movement of sardine from Vis Island towards the north-west section of Hvar Island has been noticed. The recorded sardine movements were inextensive.

The recoveries of fish tagged during the fifth dark were made from August 27th to September 29th. The recapture of 23 marked individuals, with the date of catch available, occur-

ed in 22 cases until September 3rd, and in the remaining four from the 14th to the 29th of September. The recoveries took place in time intervals of 1 to 29 days from the date of release. Some of the tagged specimens were recaptured a certain time after release in the vicinity of the tagging locality. The specimens released, for example, along the coast of the north-west section of Hvar Island, were recaptured on adjoining fishing grounds in time intervals of 1, 2, 3, 14, and 29 days from the date of release. One of the marked individuals was recaptured during that period along the north coast of Hvar Island (Mina Cove), this indicating the occurrence of a sardine movement inside of Hvar Channel.

TAGGINGS CARRIED OUT DURING THE SIXTH DARK

During the sixth dark of the 1949 fishing season the sardine taggings took place along the coast of the north-west section of Hvar Island (Široka Cove), along the coast of the north section of Vis Island (Slatina Cove), and along the south coast of Brač Island (Zlatni Point). These taggings were carried out from September 28th to October 1st. They are designated by numbers 39-41 in Table II.

The sardine taggings, accomplished during this dark, involved 1,782 individuals. The recovery included 21 tags, that is 1.18 %.

The tagging made along the coast of the north-west section of Hvar Island yielded 13 recoveries, all of them either close to the point of release or on the adjacent fishing grounds (Jagodna, and Vira Coves, probably also Stiniva, and Široka Coves). The releases made along the coast of the north section of Vis Island gave 8 recoveries, all of them on the adjoining fishing grounds (Oključna, and Stenjalo Coves). None of the tags was recovered from the release carried out along the south coast of Brač Island. Here, however, only 139 individuals were marked.

During the sixth dark, then, no movements of tagged fish were recorded. It should be noted here that by some technical reasons these taggings had to be delayed towards the very end

of the dark. All the recoveries were made either the first or the second day after the date of release.

It is necessary to point out that during the next supplementary dark there was a negligible sardine fishing which, moreover, was limited to some inextensive areas.

During the sixth dark 105 tags of the new — narrow — type were used and three of them were recovered.

DISCUSSION OF RESULTS

The results of tagging experiments on the sardine made in 1949 along a section of the east shore of the Adriatic, during the period from May 6th to October 1st, involving a total of 28,542 specimens, demonstrated the occurrence of sardine movements of a relatively small extent. The movements were recorded only in one section of the Mid-Dalmatian region.

The releases made from the coasts of Susak, Premuda, Dugi, Korčula and Mljet Islands, totalling 5,851 marked individuals, yielded only two tag recoveries, not far from the point of release.

The most pronounced sardine movement occurred towards the end of May and during the first half of June. As no tag recovery was made prior to the end of May, no data are available concerning the sardine movements that might have occurred before that time. The sardine movements were directed from the area of the Mid-Adriatic islands, that is from the region of Vis and Biševo Islands, towards the coast of the mainland along Makarska Littoral, this occurring by way of Vis and Hvar Channels. Judging from single tag recoveries, this movement was carried out at a speed not to be disregarded. The movement from the area of the Mid-Adriatic islands took place on the termination of the spawning period.

Another sardine movement from the region of Biševo and Vis Islands towards the west section of Hvar Island was manifest by the end of June and at the beginning of July, according to tag recoveries made from June 22nd to July 7th. It remains still to be proved whether this movement may be taken as a continuation of that one recorded towards the end of May and at the beginning of June.

During the same period a movement of sardine by way of Hvar Channel in the east-west direction was recorded. This movement occurred, thus, in the direction opposite to that one indicated by recoveries made during the period running from the end of May to the first half of June.

One recovery, made at the end of June, significantly indicates the occurrence of a sardine withdrawal, at a considerable speed, from the mainland along the Rogoznica region towards the south-east section of Šolta Island.

During the second half of July a sardine movement was recorded occurring from Svetac Island towards Vis Island. At the same time a concentration of marked individuals was found along the coast of the north-west section of Hvar Island, where their release took place.

The tagging made towards the very end of July along the coast of the mainland (Poljica region) showed also a concentration of marked specimens in the tagging locality. A sardine movement has, however, been recorded towards Kaštela Bay, in the direction of the north-west section of Šolta Island, and towards the west point of Čiovo Island.

By the end of August a sardine movement was recorded from the north-east section of Vis Island towards the north-west section of Hvar Island.

During the month of September the occurrence of a concentration of marked specimens was recorded along the coast of the north-west section of Hvar Island, where the release took place. At the same time one recovery indicates the occurrence of a movement in the west-east direction inside of Hvar Channel.

There was, unfortunately, no opportunity to follow further sardine movements, owing to the fact that the last taggings, involving a relatively small number of individuals, were technically possible towards the very end of the sixth dark, at the close of the fishing season.

We should like to mention, for the purpose of comparison, that some minor movements have been noticed during our first tagging experiments, carried out in the 1948 sardine fishing season, designed to examine the possibility of marking this clupeid species. The occurrence of a sardine movement directed towards Kaštela Bay, that is approaching the mainland, has been

stated from the releases of tagged fish carried out in Split Channel, along the west section of Brač Island, during the first half of July. Certain movements have been noticed to occur also inside of Hvar Channel, one of them in the first half of September. Other sardine movements by way of this Channel lack exact information on the period involved, owing to recoveries having been made in some longer time intervals.

The majority of the 1949 tag recoveries took place shortly after the release of marked specimens. From the 265 specimens with the date of recovery available, 261 were returned within the first month following the date of release. The most extended time interval between the date of release and that of recovery amounted to 89 days.

The majority of recaptures took place not far from the tagging locality. The greatest distance recorded between the point of release and that of recovery amounted to cca 42 nautical miles.

The percentage of recoveries varied from dark to dark. It amounted from 0.40 to 2.42 %. From a total of 28,542 tagged fish 271 ones were recovered, that is 0.95 %. The percentage of recoveries, yielded by the taggings carried out during the 1949 sardine fishing season, slightly exceeded the resulting recovery percentage relative to our first tagging experiments on the sardine.

MARKIRANJE SRDELE (*CLUPEA PILCHARDUS* WALB.)
U JADRANU U 1949. G.

Radosna Mužinić
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K r a t a k s a d r Ź a j

U 1949. g. pristupilo se ekstenzivnijoj primjeni metode markiranja na ispitivanje kretanja srdele (*Clupea pilchardus* Walb.). Kod toga se upotrebila markica, jednaka onoj, koja je bila upotrebljena u prvim eksperimentima markiranja ovog klupeida u Jadranu. Metalne markice kombinirale su se sa crvenim celuloidnim krugovima.

Trošenje tkiva škržnog zaklopca ribe, na mjestu pričvršćivanja markice, manifestiralo se slično, kao što je to bio slučaj i kod naših prvih eksperimenata markiranja srdele. U cilju reduciranja ovog trošenja izrađena je nova, uža markica. Međutim, ona je, iz tehničkih razloga, mogla biti upotrebljena samo na vrlo malom broju primjeraka.

Eksperimenti markiranja srdele u 1949. g. bili su izvršeni duž istočne obale Jadrana, od otoka Suska do otoka Mljeta. Vrlo je intenzivno bila markirana srdela u jednom dijelu srednjedalmatinskog područja, i to u Hvarskom kanalu i na području otoka Visa i Biševa.

Markiranja su bila izvršena u toku sezone lova srdele, od 6. svibnja do 1. listopada. U tom vremenskom razmaku izvršeno je 41 markiranje srdele, na ukupnom broju od 28.542 primjeraka. Od toga je bila pronađena 271 riba, t. j. 0,95 %.

Najveći broj označenih primjeraka bio je ulovljen nedaleko mjesta markiranja, i to u toku prvog mjeseca iza datuma markiranja.

Zapažena kretanja srdele bila su malene amplitude, a mogla su biti ustanovljena samo u srednjedalmatinskom području. Najznatnije kretanje srdele primijećeno je koncem svibnja i u prvoj polovini lipnja, a izvršilo se s područja otoka Visa i Biševa prema obali kopna u Makarskom Primorju. Dolazak sr-

dele k obali kopna uslijedio je kroz Hvarski kanal. Bilo je ustanovljeno, da se ovo kretanje izvršilo poslije svršetka mrijestjenja.

Koncem lipnja i u početku srpnja zapaženo je kretanje srdele s područja otoka Biševa i Visa prema zapadnom dijelu otoka Hvara, gdje se ono sukobilo sa kretanjem kroz Hvarski kanal od istoka prema zapadu. Koncem lipnja zapaženo je i brzo kretanje srdele od područja Rogoznice prema jugoistočnom dijelu otoka Šolte.

U drugoj polovini srpnja konstatirano je kretanje ribe od otoka Sveca prema otoku Visu, i koncentracija markiranih individua na mjestu markiranja, na sjeverozapadnom dijelu otoka Hvara.

Markiranje, koje je bilo izvršeno na području Poljica krajem srpnja, ukazalo je također na koncentraciju označenih primjeraka srdele na mjestu markiranja. Međutim, bilo je primijećeno kretanje ribe s ovog lokaliteta prema Kaštelanskom zaljevu, sjeverozapadnom dijelu otoka Šolte i zapadnom rtu otoka Čiova.

Krajem kolovoza bilo je zapaženo kretanje srdele sa sjeveroistočne strane otoka Visa prema sjeverozapadnom dijelu otoka Hvara.

Izvišna koncentracija markiranih primjeraka na mjestu markiranja, na sjeverozapadnom dijelu otoka Hvara, bila je primijećena i u toku ruina.

Markiranja, koja su bila izvršena na otoku Susku, Premudi, Dugom otoku, Korčuli i Mljetu, dala su samo dva nalaza označenih riba, i to nedaleko mjesta markiranja.

МЕЧЕНИЕ САРДИНКИ (*CLUPEA PILCHARDUS* Walb.)
В АДРИАТИЧЕСКОМ МОРЕ В 1949 Г.

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Краткое содержание

В 1949 году началось более широкое применение методы мечения, с целью исследования передвижений сардинки (*Clupea pilchardus* Walb.). При этом была употреблена такая же метка, какая употреблялась при первых опытах мечения этого вида сельдевых в Адриатике. Металлические метки были снабжены красными целлюлоидовыми кружочками.

Разрушение ткани жаберной крышки рыбы на месте прикрепления метки оказалось таким же, как при наших первых опытах мечения сардинки. С целью уменьшения этого разрушения была выработана новая, более узкая метка. Между тем, по причинам технического характера, она могла быть употреблена только к очень малому количеству экземпляров.

Опыты мечения сардинки в 1949 г. были произведены вдоль восточного берега Адриатики, от острова Суска до острова Млета. Особенно интенсивно сардинка была мечена в одной части среднедалматинской области, а именно в Хварском канале и в районе островов Виса и Бишева.

Мечение было произведено в течение сезона ловли сардинки, от 6 мая до 1 октября. За этот промежуток времени произведено 41 мечение сардинок и помечено общим числом 28.542 экземпляря. Из них была найдена 271 рыба, т. е. 0,95%.

Самое большое число помеченных экземпляров было выловлено недалеко от места мечения, в течение первого месяца после мечения.

Замеченные передвижения сардинки были небольшой амплитуды, и обнаружить их удалось только в среднедалматинской области. Самое значительное передвижение сардинки наблюдалось в конце мая и в первой половине июня, и происходило от района островов Виса и Бишева в направлении Макарского Приморья. Приближение сардинки к побережью последовало через Хварский канал.

Было установлено, что это движение совершалось после окончания нереста.

В конце июня и в начале июля, было замечено передвижение сардинки из области островов Бишева и Виса к западной части острова Хвара, где оно столкнулось с передвижением сардинки через Хварский канал с востока на запад. В конце июня замечено также быстрое передвижение сардинки из области Рогозницы к юго-восточной части острова Шольты.

Во второй половине июля было установлено передвижение рыбы от острова Свеца к острову Вису и концентрация меченых особей на месте мечения у северозападной части острова Хвара.

Мечение произведенное в районе Полицы в конце июля также показало концентрацию меченых экземпляров сардинки на месте мечения. Между тем было замечено передвижение рыбы из этого района к Каштеланскому заливу, к северозападной части острова Шольты и к западному мысу острова Чиова.

В конце августа наблюдалось передвижение сардинки от северо-восточной стороны острова Виса к северозападной стороне острова Хвара.

Некоторая концентрация меченых экземпляров на месте мечения около северозападной части острова Хвара наблюдалась и в сентябре.

В результате мечения произведенного на островах Суску, Премуди, на Дугом острове, на островах Корчуле и Млету было найдено всего две рыбы, обе недалеко от места мечения.

Table II.

Summary of the Tagging Data with Regard
to the Number of Recoveries

Tagging No.	Locality of Tagging	Date of Tagging		Tagged Fish	Recoveries
1	Porat Cove, Biševo Island	6. V.	1949.	935	—
2	Porat Cove, Biševo Island	7. V.	1949.	124	—
3	Carnjene Cove, Pakleni Islands	18. V.	1949.	661	3
4	Carnjene Cove, Pakleni Islands	19. V.	1949.	1155	3
5	Porat Cove, Biševo Island	20. V.	1949.	436	—
6	Mezoporat Cove, Biševo Island	21. V.	1949.	315	—
7	Oključna Cove, Vis Island	23. V.	1949.	757	10
8	Oključna Cove, Vis Island	24. V.	1949.	914	3
9	Porat Cove, Biševo Island	25. V.	1949.	647	2
10	Potplat Cove, Korčula Island	26. V.	1949.	766	—
11	Proizd Islet, near Korčula Island	28. V.	1949.	181	—
12	Goli Point, Mljet Island	30. V.	1949.	501	—
13	Proizd Islet, near Korčula Island	1. VI.	1949.	456	—
14	Stiniva Cove, Hvar Island	2. VI.	1949.	1775	13
15	Konjska Cove, Brač Island	21. VI.	1949.	623	2
16	Stiniva Cove, Vis Island	22. VI.	1949.	621	3
17	Potok Cove, Biševo Island	24. VI.	1949.	907	11
18	Porat Cove, Biševo Island	25. VI.	1949.	310	5
19	Treščavac Cove, Biševo Island	27. VI.	1949.	1292	15
20	Konj Point, near Rogoznica	28. VI.	1949.	454	1
21	Lučica Cove, Dugi Island	29. VI.	1949.	955	1
22	Lučica Cove, Dugi Island	30. VI.	1949.	750	—
23	Jagodna Cove, Hvar Island	15. VII.	1949.	1176	106
24	Zakamiće, Vis Island	16. VII.	1949.	909	—
25	Palagruž Island	18. VII.	1949.	312	—
26	Svetac Island	19. VII.	1949.	332	2
27	Komiža Bay, Vis Island	22. VII.	1949.	583	—
28	Komiža Bay, Vis Island	23. VII.	1949.	1008	10
29	Ražnjić Point, Pakleni Islands	24. VII.	1949.	727	1
30	Prapratna Cove, Hvar Island	25. VII.	1949.	380	2
31	Kučine near Stobreč, Poljica	30. VII.	1949.	766	29
32	Ražnjić Point, Pakleni Islands	22. VIII.	1949.	540	—
33	Vis Cove, Vis Island	24. VIII.	1949.	793	1
34	Stenjalo Cove, Vis Island	25. VIII.	1949.	538	3
35	Premuda Island	27. VIII.	1949.	596	1
36	Susak Island	28. VIII.	1949.	972	—
37	Lopata Point, Dugi Island	29. VIII.	1949.	674	—
38	Jagodna Cove, Hvar Island	31. VIII.	1949.	919	23
39	Široka Cove, Hvar Island	28. IX.	1949.	620	13
40	Slatina Cove, Vis Island	30. IX.	1949.	1023	8
41	Zlatni Point, Brač Island	1. X.	1949.	139	—
Total . . .				28542	271

Table III. —

Detailed list of Recoveries

Tagging No.	Number of Recoveries	Locality of Recovery	Date of Recovery		Period of Liberty (days)
3	1	_____	26. V.	1949.	8
3	1	Zlatni Point, Brač Island	31. V.	1949.	13
3	1	Lučišće Cove, Hvar Island	1. VI.	1949.	14
4	3	Zlatni Point, Brač Island	31. V.	1949.	12
7	1	Zaglav Cove, Pakleni Islands	26. V.	1949.	3
7	1	Makarac Point, Hvar Island	28. V.	1949.	5
7	1	Stiniva Cove, Hvar Island	29. V.	1949.	6
7	2	Lučišće Cove, Hvar Island	29. V.	1949.	6
7	1	Zlatni Point, Brač Island	30. V.	1949.	7
7	1	Zlatni Point, Brač Island	31. V.	1949.	8
7	1	Ramova, Makarska Littoral	5. VI.	1949.	13
8	2	Zlatni Point, Brač Island	30. V.	1949.	6
8	1	Zlatni Point, Brač Island	31. V.	1949.	7
9	1	Lučišće Cove, Hvar Island	1. VI.	1949.	7
9	1	Široka Cove, Hvar Island	23. VII.	1949.	59
14	7	Zlatni Point, Brač Island	5. VI.	1949.	3
14	4	Žirje Cove, Brač Island	6. VI.	1949.	4
14	1	Ramova, Makarska Littoral	6. VI.	1949.	4
14	1	Crkvica Cove, Hvar Island	15. VI.	1949.	13
15	1	Žukova Cove, Hvar Island	22. VI.	1949.	1
15	1	Palilo Cove, Pakleni Islands	7. VII.	1949.	16
16	1	Stiniva Cove, Vis Island	23. VI.	1949.	1
16	1	Komiža Bay, Vis Island	28. VI.	1949.	6
16	1	Milna Cove, Hvar Island	6. VII.	1949.	14
17	1	Potok Cove, Biševo Island	27. VI.	1949.	3
17	1	Ploča Bank, Vis Island	28. VI.	1949.	4
17	3	Stiniva Cove, Vis Island	28. VI.	1949.	4
17	1	Svetac Island	30. VI.	1949.	6
17	3	Ploča Bank, Vis Island	6. VII.	1949.	12
17	1	Palilo Cove, Pakleni Islands	7. VII.	1949.	13
17	1	Ploča Bank, Vis Island	18. VII.	1949.	24
18	1	Komiža Bay, Vis Island	28. VI.	1949.	3
18	2	Stiniva Cove, Vis Island	28. VI.	1949.	3
18	1	Komiža Bay, Vis Island	30. VI.	1949.	5
18	1	Ploča Bank, Vis Island	6. VII.	1949.	11
19	2	Potok Cove, Biševo Island	28. VI.	1949.	1
19	2	Porat Cove, Biševo Island	28. VI.	1949.	1
19	1	Komiža Bay, Vis Island	28. VI.	1949.	1
19	1	Ploča Bank, Vis Island	28. VI.	1949.	1
19	1	Mezoporat Cove, Biševo Island	29. VI.	1949.	2
19	1	Komiža Bay, Vis Island	30. VI.	1949.	3
19	1	Potok Cove, Biševo Island	1. VII.	1949.	4
19	3	Ploča Bank, Vis Island	6. VII.	1949.	9
19	2	Milna Cove, Hvar Island	6. VII.	1949.	9
19*	1	Vira, Široka, and Duga Coves, Hvar Island	24. VII.	1949.	27
20	1	Stračinska Cove, Šolta Island	30. VI.	1949.	2
21	1	Lučica Cove, Dugi Island	30. VI.	1949.	1
23	1	_____	16. VII.	1949.	1
23	1	Duga Cove, Hvar Island	17. VII.	1949.	2
23	1	Palilo Cove, Pakleni Islands	17. VII.	1949.	2
23	1	Vira Cove, Hvar Island	19. VII.	1949.	4
23	20	Široka Cove, Hvar Island	23. VII.	1949.	8
23*	72	Vira, Široka, and Duga Coves, Hvar Island	24. VII.	1940.	9

23	4	Široka Cove, Hvar Island	20. VII.	1949.	15
26	1	Duga Cove, Hvar Island	22. VII.	1949.	3
26	1	Komiža Bay, Vis Island	24. VIII.	1949.	36
28	8	Grandovac Cove, Vis Island	25. VII.	1949.	2
28	1	Komiža Bay, Vis Island	29. VII.	1949.	6
29	1	Ploča Bank, Vis Island	25. VII.	1949.	1
30	1	Uljeni bok Cove, Pakleni Islands	28. VII.	1949.	3
30	1	Grebišće Cove, Hvar Island	29. VII.	1949.	4
31	1	Gačice Cove, Hvar Island	—	—	—
31	3	Stobreč, Poljica	31. VII.	1949.	1
31	2	Stobreč, Poljica	1. VIII.	1949.	2
31	1	Kaštela Bay	1. VIII.	1949.	2
31	1	Stobreč, Poljica	2. VIII.	1949.	3
31	1	Stobreč, Poljica	27. VIII.	1949.	28
31	1	Stobreč, Poljica	3. IX.	1949.	35
31	4	Sv. Martin, Poljica	31. VII.	1949.	1
31	1	Sv. Martin, Poljica	22. VIII.	1949.	23
31	5	Javor Cove, Poljica	2. VIII.	1949.	3
31	1	Javor Cove, Poljica	27. X.	1949.	89
31	3	Dugirat Point, Poljica	2. VIII.	1949.	3
31	2	Dugirat Point, Poljica	6. VIII.	1949.	7
31	1	Dugirat Point, Poljica	23. VIII.	1949.	24
31	1	Stiniva Cove, Šolta Island	3. VIII.	1949.	4
31	1	West point of Čiovo Island	21. VIII.	1949.	22
33	1	Srebrena Cove, Vis Island	27. VIII.	1949.	3
34	1	Spilice Cove, Hvar Island	30. VIII.	1949.	5
34	1	Jagodna Cove, Hvar Island	1. IX.	1949.	7
35	1	Silba Island	1. IX.	1949.	5
38	1	Jagodna Cove, Hvar Island	1. IX.	1949.	1
38	3	Duga Cove, Hvar Island	1. IX.	1949.	1
38	11	Vira Cove, Hvar Island	2. IX.	1949.	2
38	1	Široka Cove, Hvar Island	2. IX.	1949.	2
38	1	Jagodna Cove, Hvar Island	3. IX.	1949.	3
38	1	Lozna Cove, Hvar Island	3. IX.	1949.	3
38	1	Jagodna Cove, Hvar Island	14. IX.	1949.	14
38	1	Mina Cove, Hvar Island	23. IX.	1949.	23
38	2	Vira Cove, Hvar Island	29. IX.	1949.	29
39	5	Vira Cove, Hvar Island	29. IX.	1949.	1
39	2	Jagodna Cove, Hvar Island	29. IX.	1949.	1
39*	6	Siroka, Vira, and Stiniva Coves, Hvar Island	30. IX.	1949.	2
40	7	Oključna Cove, Vis Island	1. X.	1949.	2
40	1	Stenjalo Cove, Vis Island	1. X.	1949.	2

*) Three localities of recapture — mutually adjoining coves — have been given for recoveries marked with the asterisk, as it was impossible to determine on which of them the recoveries were made or how they should be apportioned among them.

