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TAGGING OF SARDINE *(CLUPEA PILCHARDUS* WALB.) IN THE ADRIATIC IN 1950 AND 1951

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TAGGING OF SARDINE *(CLUPEA PILCHARDUS* WALB.) IN THE ADRIATIC IN 1950 AND 1951

by

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INTRODUCTION

Further intensive tagging of sardine *(Clupea pilchardus* Walb.) was undertaken in 1950 for the purpose of investigation into its movements. The tagging was carried out within the region of the Mid-Dalmatian islands, viz. in the Split Channel (along the coast of Brač Island), in the Hvar Channel (along the coast of Brač and Hvar Islands), and along the following islands: Pakleni, Vis, Biševo and Svetac. Some taggings were also carried out in the vicinity of Palagruž Island. The tagging operations were accomplished during the darks of the moon of the sardine fishing season, and lasted from May 7th to September 14th. During that period 29 taggings were carried out involving a total of 16,613 individuals.

The tagging of sardine in 1951 was accomplished along the coast of the north-west part of Hvar Island, and along the coasts of Pakleni, Vis, and Biševo islands. All these taggings were carried out during the third dark and lasted from July 3rd to 11th, with one exception only, vhen the tagging fell on September 7th, that is during the fifth dark of the moon. Nine taggings, involving 3,845 individuals were carried out.

The 1950 and 1951 taggings extended more or less over the same area as in 1949, during the intensive tagging of sardine.

TAGGING METHODS

The tagging methods applied in 1950 was the same as earlier, a description of which was given in previous reports.[1]) The tag used was of the opercular type, being identical with the one applied to a limited number of specimens towards the close of the 1949 sardine fishing season.

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[1]) Mužinić, R. 1948/1949. First Tagging Experiments on the Sardine *(Clupea pilchardus* Walb.) in the Adriatic. Acta Adriatica. Vol. III. No. 10. Split.

Mužinić R. 1950. Tagging of Sardine *(Clupea pilchardus* Walb.) in the Adriatic in 1949. Acta Adriatica. Vol. IV. No. 7. Split.

(Fig. 1a). That tag was 17 mm long and 1 mm wide except at one end where there was a hole for the tag point; that part of the tag terminated with a square the sides of which were 2 mm long. The tag was 0,25 mm thick and weighted 0,04 gr. In comparison with the 1949 one this tag was slightly longer and also more narrow and lighter as well. The red celluloid disc measuring 5 mm in diameter, attached together with the silver tag, rendered the latter conspicuous. The same type of tag was used also for

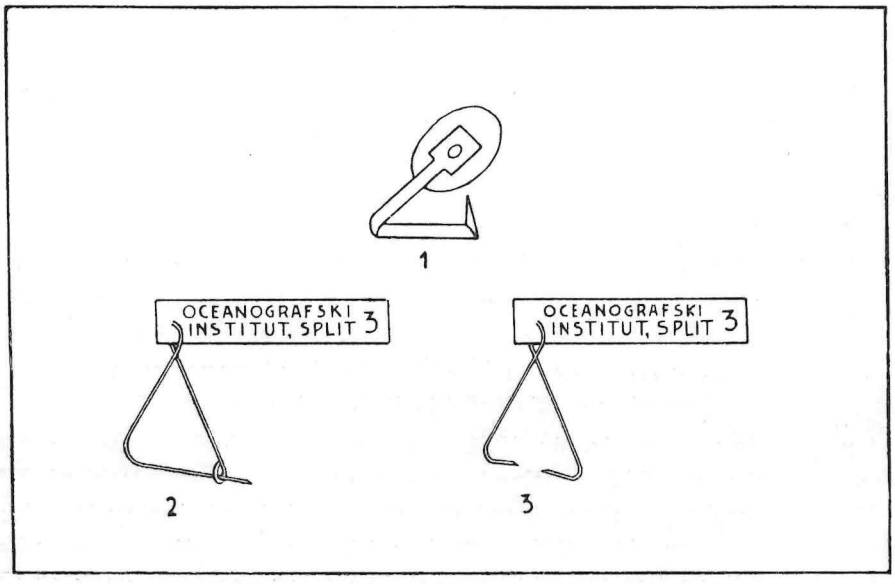

Fig. 1. — *Three kinds of tags used for tagging of sardine. While only the type No. 1 was applied in 1950, all the three kinds were used in 1951.*

tagging during the 1951 fishing season. But besides this kind of tag the application of another type had been started during the 1951 fishing season, consisting of a flaglet made of semisoft orange-coloured polyvinyl chlorid, which was attached by means of a silver wire to the back of fish, exactly before the dorsal fin.[1]) The flaglet was 26 mm long, 5 mm wide, and 0,2 mm thick. The silver wire was 0,4 mm thick. The complete tag weighted 0,14 to 0,16 gr. This tag is shown in Figure 1. (b). A certain number of these tags — about one eighth — did not close outside the body

[1]) The polyvinyl chlorid folia out of which ribbons for flaglets were cut at the Institute, have been supplied by the Chemical Works »Jugovinil« of Kaštel Sućurac near Split.

It is significant also that no recoveries at all were yielded by the tagging operations carried out during the fourth and fifth darks of the moon. It is not to be excluded that the latter fact was due to a higher mortality of sardine caused by tagging. Looking for an explanation of the increasing mortality before and after tagging, the opinion has been adopted that the cause might lie in the relatively high temperature of sea water prevailing during a part of the 1950 sardine fishing season. It has been noticed that the temperature of the sea surface was higher at the time of taggings carried out during the third dark of the moon (July), the forth (August) and the fifth (September) ones than in 1949. The mean temperature of the sea surface not far from the tagging locality amounted to 24.8°C during the interval of time in the course of which the taggings of the fourth dark of the moon were carried out. That happened to be, at the same time, the maximal mean temperature of the sea surface during the taggings within one dark of the moon in the 1950. The maximal mean temperature at the time of taggings within one dark of the moon in 1949 was 22.0°C, viz. by 2.8°C lower than that of 1950.

During the fifth dark of the moon of the 1950 sardine fishing season the mean temperature of the sea surface amounted to 23.9°C in the course of tagging operations. A temperature as high as 23.6°C was recorded pending the taggings belonging to the third dark of the moon.

It follows, then, that the mean temperature of the sea surface was higher in the course of the taggings during the third, fourth and fifth darks of the 1950 fishing season than the maximal mean temperature in 1949 (the fourth dark, July).

A considerable perishing of fish could be noticed in the meantime between the taking over of individuals and the beginning of tagging operations, as well as during the tagging itself, also on those days when a relatively high temperature of the sea surface was found. This fact was clearly evident in the course of taggings carried out on July 11th at a temperature of 23.9°C, on August 13th at a temperature of 24.5°C, on August 20th at a temperature of 25.1°C, and on September 14th at a temperature of 24.1°C. This statement is in favour of the hypothesis according to which a relatively high temperature of the sea surface might be the cause of a considerable amount of perished fish before the tagging was begun and of a higher mortality following it. It is significant, however, that such a high temperature of the surface was not found during any of the taggings accomplished in 1949.

of fish, but the bent ends of the wire simply penetrated into their body. This type of tag is also shown in Figure 1(c). Resistance wire was used for this tag, being more elastic than a silver one. The wire was in this case 0,3 mm thick. The tag weighted 0,09 to 0,11 gr. The inscription »Oceanografski Institut, Split« and the serial number were written in China ink on the flaglets which were then coated with a special seawater-resistent varnish.[1]) The flaglet-shaped tags which were attached to the back of fish, were made after samples of those used by R. Letaconnoux (1951)[2]) during the first tagging of Atlantic Sardine, carried out along the French coasts in 1950.[3]) These tags differ from ours insomuch that they are made of yellow-coloured celluloid and are attached by means of a stainless steel wire. The letters R. F. and a number for each tag were produced in the pyrografic way. The above mentioned author released 718 tagged individuals in 1950, three of which were recovered.

Although the same method of tagging and taking of fish was applied during our work in 1950 as the year before, still there were new difficulties to cope with. It has been observed, namely, that a great number of fish died in the meantime between their entering the live box and the beginning of tagging operations. This perishing of fish was a regular appearance during the fourth dark (August) and the fifth one (September), but it was felt also during the third dark (July). That was one of the principal reasons for the fact that the average number of fish marked at one tagging amounted to only 314 specimens during the fourth and fifth darks of the moon. That number was as high as 797 during the first dark of the moon (May) of the 1950 fishing season. In spite of the utmost carefulness in the handling of fish, that appearance could not be eliminated. That accounts for the total number of tagged individuals in 1950 being by far lower than in the preceding year. The perishing of fish was, besides, more frequent pending tagging operations themselves not only during the third dark of the moon, but particularly during the fourth and fifth ones than it was the case during the first dark of the moon, or in the course of the 1949 taggings of this clupeoid species.

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[1]) This varnish has also been supplied by the »Jugovinil« Chemical Works. We wish to express our appreciations to Ing. Ivan Tahi, technical manager of those Works, who met our requirements in a very kind way.

[2]) Letaconnoux, R. 1951. Une expérience de marquage sur la sardine du Golfe de Gascogne. Journ. d. Conseil. Vol. XVII, No 3. Copenhagen.

[3]) The samples have been handed over by Dr. Jean Le Gall, director of the Office Scientifique et Technique des Pêches Maritimes of Paris, to Dr. Tonko Šoljan, director of the Institute of Oceanography and Fisheries of Split, when the later asked for information about the French tagging method. We are very grateful to both Dr. Jean Le Gall and Dr. Tonko Šoljan for their cooperation.

The year 1950 was a relatively warm one. The July mean temperature of the air in the Hvar region amounted to 26.5°C in 1950, whilst it reached only 24.4°C in 1949, the difference amounting thus to 2.1°C. A far greater difference was found in the Lastovo region, where it reached even 3.3°C. The mean temperatures for some other summer months in 1950 were also higher than those in 1949. For the Hvar region, for example, the June 1950 mean temperature exceeded by 3.5°C the June 1949 one. The August mean temperature of the air in that region proved to be for 2.8°C higher in 1950 than in 1949.

A little higher mortality of fish was noticed in the course of the taggings during the fifth than during the third dark of the moon of the 1950 fishing season, although no considerable difference resulted from the comparison of the mean temperatures of the sea surface relative to intervals of time to which the taggings of the mentioned darks belonged. It is not to be excluded that the higher mortality of sardine during the fifth dark of the moon might have been caused by the begin of the evolution of gonads, which was noticed in September. It seemed also that during the fifth dark of the moon there was a higher mortality of bigger fish than of smaller one. That fact might have been a consequence of the difference in condition of gonads between bigger and smaller fish. In seams namely, that bigger sardines showed a more advanced stage of maturity of gonads at that time than smaller fish did.

In the course of work in 1950 it has been confirmed that abundant catches usually offer bad tagging material.

An alteration of the tagging method has been introduced in 1951. Whilst the live box used during the 1948 and 1949 tagging operations (being 4 m long, 1 m wide and 1.05 m high) served for keeping of both untagged and already tagged fish, untagged individuals only were kept in it in the course of 1950 taggings. Tagged specimens were kept in a smaller live box until their release, the two live boxes adjoining to each other for that purpose.

Perishing of fish to a certain extent both before and after tagging was noticeable in 1951 also. The mean temperature of the sea surface was relatively high on the days of tagging and amounted to 23,5°C. But it is necessary to point out, however, that the measurements of temperature were made in 1951 at the tagging locality itself, i. e. usually closer to the coast line of the islands than in preceding years, so that the resulting values are likely to be somewhat higher if compared with those for 1949 and 1950.

WORK DONE DURING THE 1950 FISHING SEASON

a) *The Taggings of the First Dark*

In the course of the first dark of the moon the tagging of sardine was carried out along the coast of the west section of Brač Island (Stipanska

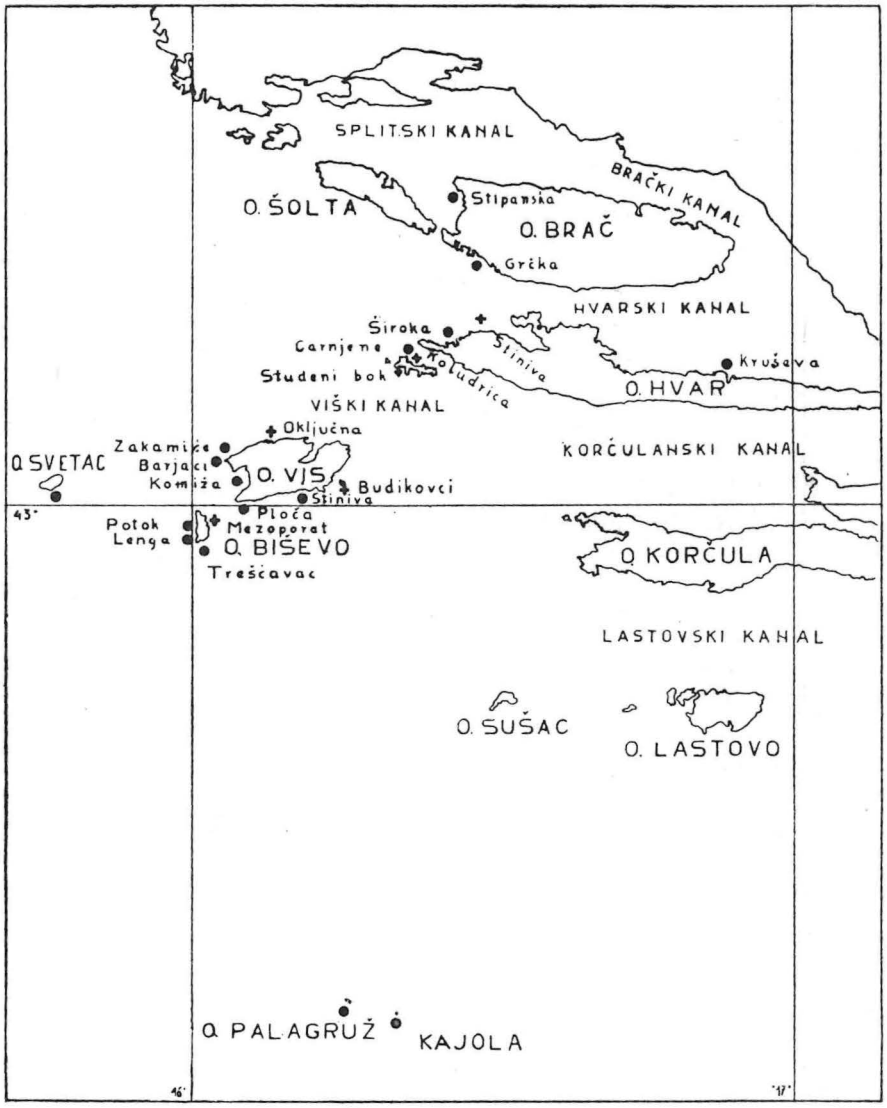

Fig. 2. — *The localities where the tagings were performed. The 1950 taggings are shown by black discs, and the 1951 ones by crosses.*

Cove), along the coast of the north and north-west sections of Hvar Island (Kruševa, and Široka Coves), along the coasts of Pakleni Islands (Carnjenje Cove), along the north-west and south-west sections of Vis Island (Zakamiće, and Ploča Coves), along the south coast of Biševo Island (Trešćavac Cove), and in the vicinity of Svetac and Palagruž Islands. Both the 1950 and the 1951 tagging localities are shown in Figure 2.

Table I. — Summary of the 1950 Tagging Data with Regard to the Number of Recoveries

Tagging No.	Locality of Tagging	Date of Tagging	Tagged Fish	Recoveries
1	Svetac Island	7. V. 1950.	901	—
2	Palagruž Island	10. V. 1950.	806	—
3	Palagruž Island	11. V. 1950.	309	—
4	Palagruž Island	12. V. 1950.	840	—
5	Trešćavac Cove,Biševo Island	13. V. 1950.	1203	—
6	Ploča Cove, Vis Island	14. V. 1950.	739	—
7	Zakamiće Cove, Vis Island	15. V. 1950.	970	2
8	Carnjene Cove, Pakleni Islands	16. V. 1950.	835	—
9	Široka Cove, Hvar Island	17. V. 1950.	990	1
10	Kruševa Cove, Hvar Island	18. V. 1950.	647	—
11	Stipanska Cove, Brač Island	19. V. 1950.	526	9
12	Trešćavac Cove,Biševo Island	6. VI. 1950.	1007	2
13	Trešćavac Cove,Biševo Island	7. VI. 1950.	896	8
14	Kajola Rock near Palagruž Island	12. VI. 1950.	58	—
15	Palagruž Island	13. VI. 1950.	285	—
16	Zakamiće Cove, Vis Island	15. VI. 1950.	134	—
17	Svetac Island	16. VI. 1950.	677	—
18	Lenga Cove, Biševo Island	11. VII. 1950.	281	1
19	Trešćavac Cove,Biševo Island	12. VII. 1950.	364	3
20	Komiža Bay, Vis Island	13. VII. 1950.	709	1
21	Stiniva Cove, Vis Island	16. VII. 1950.	922	—
22	Komiža Bay, Vis Island	12. VIII. 1950.	367	—
23	Komiža Bay, Vis Island	13. VIII. 1950.	307	—
24	Potok Cove, Biševo Island	14. VIII. 1950.	353	—
25	Trešćavac Cove,Biševo Island	20. VIII. 1950.	246	—
26	Široka Cove, Hvar Island	9. IX. 1950.	273	—
27	Zakamiće Cove, Vis Island	12. IX. 1950.	266	—
28	Barjaci Point, Vis Island	13. IX. 1950.	196	—
29	Grčka Cove, Brač Island	14. IX. 1950.	506	—
		Total	16,613	27

The taggings were carried out during the interval of time extending between May 7th and 19th. They are given in Table I, bearing numbers 1—11.

The taggings of the first dark involved a total of 8,766 specimens yielding only 12 recoveries, i.e. 0.14% of the released fish. Those recoveries are shown in Table II, which contains all the details on the tagged specimens which were recaptured. Movements of tagged fish which occured during the 1950 fishing season, are shown in Figure 3.

Table II. — Data on Recoveries of Specimens Tagged in 1950

Tagging No.	Number of Recoveries	Locality of Recovery	Date of Recovery	Period of Liberty (Days)
7	1	Komiža Bay, Vis Island	17. V. 1950.	2
7	1	Blaca Cove, Brač Island	11. IX. 1950.	119
9	1	Duga Cove, Hvar Island	20. V. 1950.	3
11	1	Mrtinica, Brač Island	20. V. 1950.	1
11	1	St. Martin, Poljica	22. V. 1950.	3
11	1	Movarštica Cove, Čiovo Island	24. V. 1950.	5
11	3	Kambelovac, Kaštela Bay	24. V. 1950.	5
11	1	St. Martin, Poljica	1. VI. 1950.	13
11	1	Vranjic, Kaštela Bay	6. VI. 1950.	18
11	1	Kaštela Bay	9. VI. 1950.	21
12	1	Lenga Cove, Biševo Island	8. VI. 1950.	2
12	1	Borova Cove, Brač Island	9. IX. 1950.	95
13	8	Lenga Cove, Biševo Island	8. VI. 1950.	1
18	1	Potok Cove, Biševo Island	13. VII. 1950.	2
19	2	Potok Cove, Biševo Island	13. VII. 1950.	1
19	1	Srebrena Cove, Vis Island	15. VII. 1950.	3
20	1	Komiža Bay, Vis Island	20. VII. 1950.	7

The tagging carried out along the coast of the west section of Brač Island, resulted in recoveries off the south coast of Čiovo Island (Movarštica Cove), in Kaštela Bay and the Poljica region (St. Martin).

Only one tag recovery, not far from the tagging locality, was yielded by the release of marked fish along the north-west section of Hvar Island.

The tagging carried out along the coast of the north-west section of Vis Island yielded two recoveries, one in Komiža Bay (Vis Island) and the other off the south-west coast of Brač Island (Blaca Cove).

The remaining releases yielded no recovery.

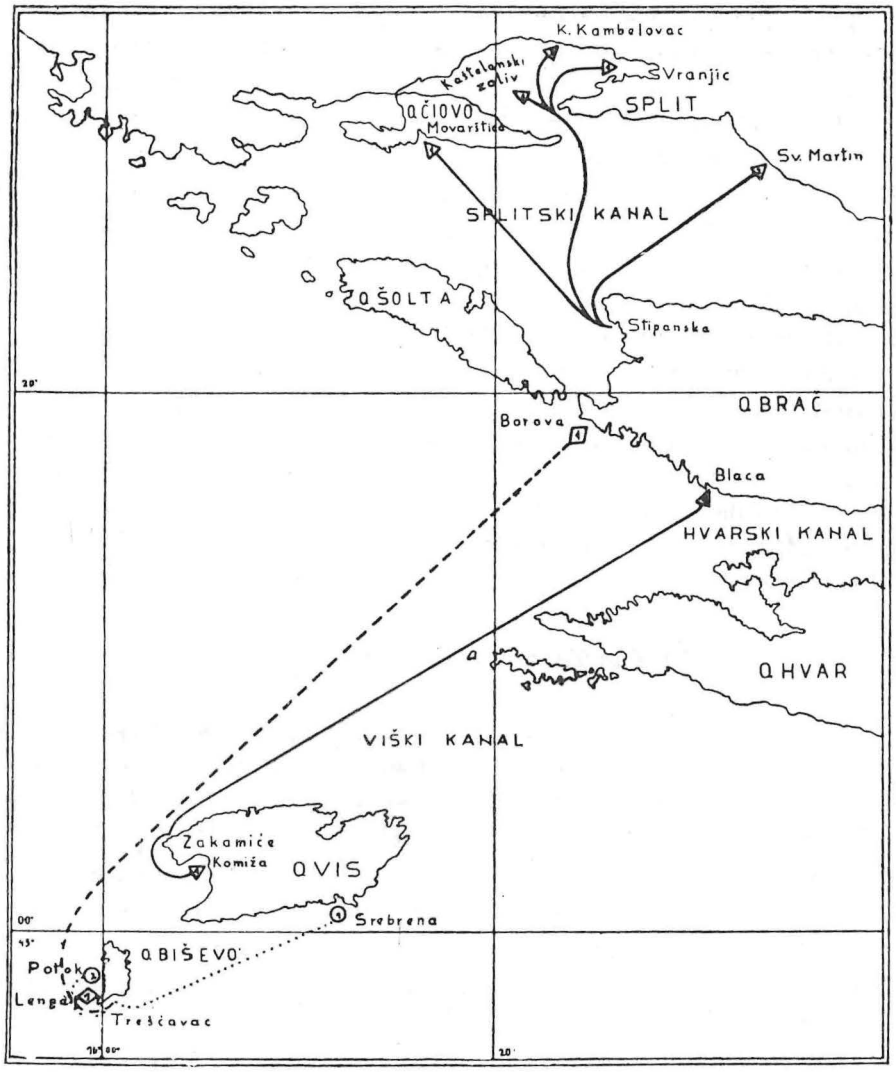

Fig. 3. — *Movements of sardine as resulting from recoveries yielded by the taggings carried out during the 1950 fishing season.*

_____ Movements shown by the results of taggings performed during the first dark of the moon.

- - - - - - - Movements shown by the results of taggings performed during the second dark of the moon.

..... Movements shown by the results of taggings performed during the third dark of the moon.

The recapture of fish tagged in the course of the first dark of the moon took place during the interval of time extending between May 17th and September 11th. Most of the recoveries occured shortly after release of tagged individuals. One of marked specimens was recaptured 119 days after the date of its release.

The occurence of a movement of sardine from the coast of the west section of Brač Island towards the coast of the mainland has been deduced from recaptured individuals which were tagged during the first dark of the moon of the 1950 fishing season. The occurence of another movement from the north-west section of Vis Island towards Hvar Channel, namely in the direction of Brač Island has been deduced on the same basis. Whilst the first movement occurred at the end of May, partially perhaps at the beginning of June, there are no data available for the second one to show its exact time, this being due to the recapture of the tagged specimen occuring 119 days after the date of its release. A movement of fish from Vis Island in the direction of Hvar Channel was recorded, however, in in 1949 also.

b) *The Taggings of the Second Dark*

The taggings of sardine carried out during the second dark of the moon of the 1950 fishing season involved the regions along the coast of the north-west section of Vis Island (Zakamiće Cove), along the coast of south section of Biševo Island (Trešćavac Cove), along the coasts of Svetac and Palagruž Islands, and around Kajola rock reef (near Palagruž).

These taggings took place from June 6th to 16th. They are shown in Table I, under numbers 12—17.

In the course of the taggings of the second dark 3,057 tagged individuals were released, of which only 10, i.e. 0,33% were recaptured.

The release of tagged specimens, which took place on June 6th along the south coast of Biševo Island, yielded two recoveries, one on a nearby fishing ground (Lenga Cove), and the other off the coast of the south-west section of Brač Island (Borova Cove). The tagging, carried out at the same locality on the following day, yielded eight recoveries on a nearby fishing ground (Lenga Cove).

The remaining releases of tagged specimens yielded no recoveries.

The recapture of tagged specimens, which were released during the second dark of the moon, took place on June 8th, i.e. immediately after

tagging. Only one recovery was recorded on September 9th, viz. 95 days after release.

There was impossible to determine the exact time of the movement of sardine from the south coast of Biševo Island towards the south-west section of Brač Island, the occurence of which was evident from tagging results, as the space of time intervening between the release and the recovery was a considerable one. This sardine movement, however, was in accordance not only with that one resulting from recoveries yielded by the tagging of the first dark but with those in 1949 as well.

c) *The Taggings of the Third Dark*

The taggings of sardine carried out during the third dark of the moon took place along the coast of the south and west sections of Vis Island (Stiniva Cove, and Komiža Bay), and along the south and south-west coasts of Biševo Island (Trešćavac, and Lenga Coves).

The taggings were carried out during the interval of time extending between July 11th and 16th. They are shown in Table I, under numbers 18—21.

The taggings of the third dark involved a total of 2,276 individuals of which only 5, i.e. 0.22% were recaptured.

The tagging carried out in Komiža Bay yielded a recovery at the locality of release. Such was also the case with the release of tagged specimens along the coast of the south-west section of Biševo Island.

The releases of tagged specimens which took place along the south coast of Biševo Island yielded three recoveries, two of them not far from the tagging locality (Potok Cove), and the third one off the coast of the south-east section of Vis Island (Srebrena Cove).

The recoveries of tagged specimens were recorded during the interval of time extending between July 13th and 20th, i.e. 1—7 days after the date of release.

The results of tagging carried out during this dark of the moon do not offer any indication on important movements of sardine.

WORK DONE DURING THE 1951 FISHING SEASON

In the course of the third dark of the moon, taggings of sardine were carried out from July 3th to July 11th both inside and outside Pakleni Islands (Koludrica Cove, Studeni bok Cove), along the coast of the north

and south-east sections of Vis Island (Oključna Cove, Budikovci Islets), and along the east coast of Biševo Island (Mezoporat Cove). The tagging of September 7th (the fifth dark) took place along the coast of the north-west section of Hvar Island (Stiniva Cove). The tagging localities are shown in Figure 2. The data relative to these taggings are given in Table III.

Table III. — Summary of the 1951 Tagging Data with Regard to the Number of Recoveries

Tagging No.	Locality of Tagging	Date of Tagging	Fish Tagged with		Recoveries of	
			Opercular Tags	Flaglets	Opercular Tags	Flaglets
1	Koludrica Cove, Pakleni Islands	3. VII. 1951.	442	378	4	4
2	Budikovci Islets near Vis Island	4. VII. 1951.	—	333	—	—
3	Mezoporat Cove, Biševo Island	5. VII. 1951.	248	431	1	1
4	Mezoporat Cove, Biševo Island	6. VII. 1951.	—	119	—	—
5	Mezoporat Cove, Biševo Island	7. VII. 1951.	239	407	—	1
6	Oključna Cove, Vis Island	9. VII. 1951.	—	229	—	—
7	Oključna Cove, Vis Island	10. VII. 1951.	—	160	—	—
8	Studeni bok Cove, Pakleni Islands	11. VII. 1951.	301	375	—	3
9	Stiniva Cove, Hvar Island	7. IX. 1951.	—	183	—	1
		Total . . .	1,230	2,615	5	10

Table IV. — Data on Recoveries of Specimens Tagged in 1951

Tagging No.	Number of Recoveries	Locality of Recovery	Date of Recovery	Period of Liberty (Days)
1	1	Parja Cove, Hvar Island	5. VII. 1951.	2
1	1	Sviračna Cove, Hvar Island	6. VII. 1951.	3
1	1	Jagodna Cove, Hvar Island	6. VII. 1951.	3
1	1	Vira Cove, Hvar Island	7. VII. 1951.	4
1	1	Stiniva Cove, Hvar Island	7. VII. 1951.	4
1	1	Sviračna Cove, Hvar Island	9. VII. 1951.	6
1	1	Zagradac Cove, Brač Island	9. VII. 1951.	6
1	1	Lučišće Cove, Hvar Island	10. VII. 1951.	7
3	1	Mezoporat Cove, Biševo Island	6. VII. 1951.	2
3	1	Taršće Cove, Pakleni Islands	8. VII. 1951.	3
5	1	Oključna Cove, Vis Island	9. VII. 1951.	2
8	1	Carnjene Cove, Pakleni Islands	15. VII. 1951.	4
8	2	— — — — — — — —	14. VII. 1951.	3
9	1	Stiniva Cove, Hvar Island	10. IX. 1951.	3

The first numbers in the last two columns of that Table contain data on cpercular tags whilst the second ones refer to flaglets which were fixed on the back of fish.

These taggings involved a total of 3,845 specimens, out of which 15 tagged individuals were recaptured, viz 0,39%. The release of 1,230 spe-

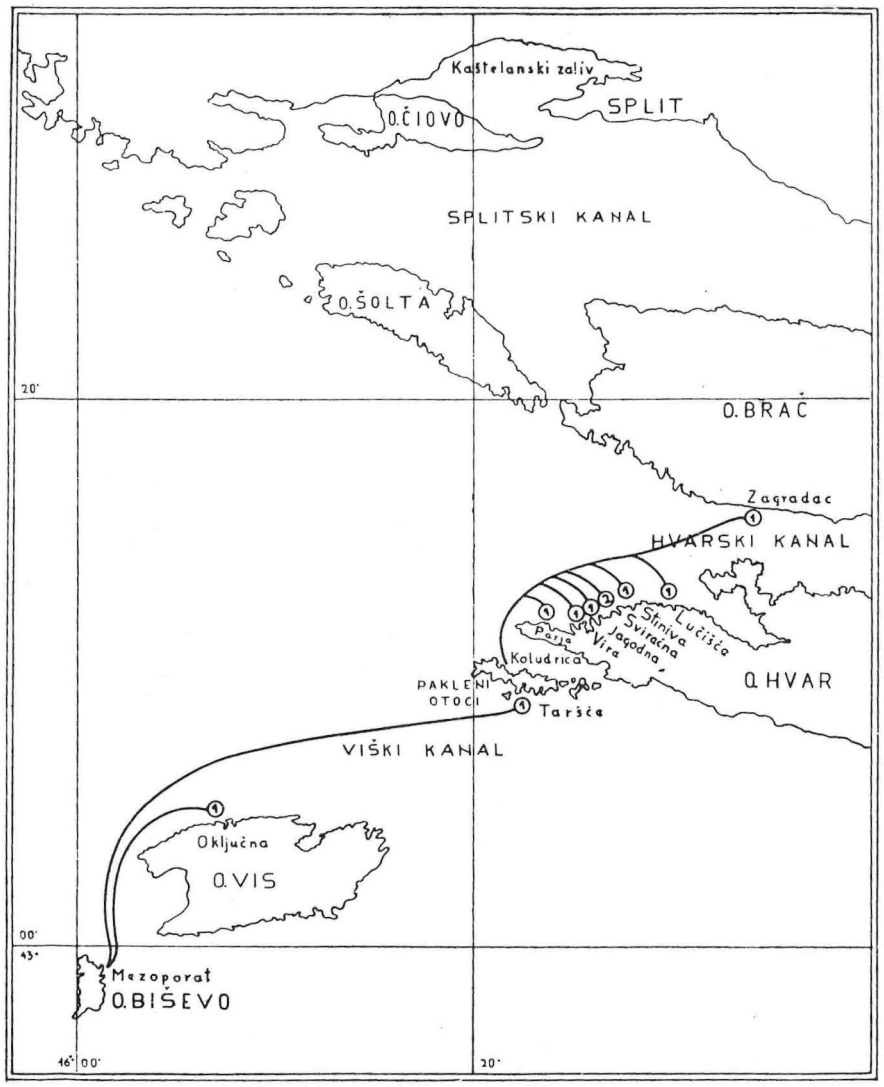

Fig. 4. — *Movements of sardine as resulting from recoveries yielded by the taggings carried out during the 1951 fishing season.*

cimens marked by means of opercular tags yielded 5 recoveries, i.e.0.41%, whilst the tagging of 2,615 individuals by means of flaglets resulted in 10 recoveries, i.e. 0.38%. The percentage of recovered flaglets was slightly lower than the one relative to opercular tags.

The data relative to recoveries of tagged fish are shown in Table IV. For two recoveries no data on the locality of recapture are available. The noticed movements of fish are shown in Figure 4.

The release of tagged individuals along the inside coast of Pakleni Islands yielded eight recoveries, seven of them having been recaptured off the coast of the north-west section of Hvar Island, and the eighth one off the south coast of Brač Island (Zagradac Cove.).

The tagging carried out on July 5th along the east coast of Biševo Island, yielded two recoveries, one at the tagging locality itself and the other off the south coast of Pakleni Islands (Taršće Cove). The release of tagged specimens, which took place at the same locality on July 7th, resulted in one recovery off the coast of the north section of Vis Island (Okljućna Cove).

Three recoveries were yielded by the tagging carried out along the outside coasts of Pakleni Islands. Whilst one of those tagged specimens was recaptured in the inside waters of Pakleni Islands (Carnjene Cove), no data are available as to locality of recovery of other two.

Only one recovery was yielded by the release of tagged individuals on September 7th, along the coast of north-west section of Hvar Island. That individual was recaptured at the tagging locality itself.

The recapture of tagged specimens took place 2—7 days after their release.

DISCUSSION OF RESULTS

The tagging of sardine, which was carried out in one section of the Mid-Dalmatian region and in the vicinity of Palagruž Island during the interval of time extending between May 7th and September 14th, 1950, involving a total of 16,613 individuals, disclosed limited movements of fish.

A movement was noticed starting from the coast of the west section of Brač Island towards the south coast of Čiovo Island, in the direction of Kaštela Bay and the Poljica region respectively, viz. towards the mainland. That movement took place towards the end of May, partially perhaps

at the beginning of June. The movement of sardine, occuring in July and partially perhaps in August, from the west coast of Brač Island in the direction of Kaštela Bay, was evident from the 1948 tagging. It is not known, however, whether such a movement occured also before July 1948.

There was a movement of sardine between May 15th and September 11th from the coast of the north-west section of Vis Island in the direction of Hvar Channel, towards the coast of Brač Island. A movement of sardine in the same direction was noticed in 1949 also, by the end of May, in the course of July, and by the end of August.

During the interval of time extending between June 6th and September 9th a movement of sardine occured from the south coast of Biševo Island in the direction of the coast of south-west section of Brač Island.

By the middle of July a movement of sardine was noticed from the south coast of Biševo Island towards the coast of the south-east section of Vis Island.

The movements, noticed in 1950, agreed, then, with those recorded in 1949, and partially also with the 1948 ones.

No recovery was yielded by the release of tagged specimens which took place between August 12th and September 14th, 1950, along the coast of the south-west section of Brač Island, along the coast of the north-west section of Hvar Island, along the coast of the west and north-west sections of Vis Island, and in the vicinity of Biševo Island.

The most of the tagged specimens were recaptured shortly after their release. The latest recovery occured 119 days after the date of tagging.

The recapture of the most part of tagged fish took place not very far from the tagging locality. The greatest distance between the tagging locality and the locality of recapture amounted to thirty nautical miles.

Only 27 specimens, i.e. 0.16%, were recaptured out of a total of 16,613 tagged ones in 1950. This percentage is six times lower than that one achieved by the 1949 taggings. It is also almost as much lower than the percentage recorded in 1948, when metallic tags with red celluloid discs were applied. We have no explanation to offer as to this fact, at least for the time being. There was no alteration of the tagging methods. Only the tag was altered. A little longer and more narrow tag was used, which was at the same time also lighter than the 1949 one. Both kinds of tags were equally conspicuous, owing to the red celluloid disc of the same diameter. The tag applied in 1950 could not, then, have been less efficacious than the 1949 one. The following comparison may confirm that. Out of

265 tag recoveries in 1949 with known dates of recapture, as many as 261 occured within the first month after the date of release. The remaining four recoveries were recorded 35, 36, 59 and 89 days after tagging. Out of 27 recoveries in 1950, as many as 25 occured within the first three weeks after the date of release. One of the remaining recoveries was recorded after 95, and the other after 119 days following the tagging. This comparison might point out to the fact that the tag, used in 1950, remained a little longer on the opercle of the tagged individuals.

The low percentage of recovered sardine tags in 1950 could have been, to some extent, a consequence of the higher mortality of fish after tagging, which was noticed in July, and particularly during August and September. A relatively high temperature of the sea surface in 1950 might have caused a higher post-tagging mortality during those months, as well as a considerable perishing of fish from the moment of its taking over till the beginning of tagging. It was noticed that the maximal mean temperature of the sea surface in the course of taggings during a dark of the moon in 1950 was by 2.8°C higher than that in 1949. The low percentage of recovered specimens, tagged during the first dark of the fishing season, in the course of which no significant perishing of fish after tagging was noticed, proves that the higher mortality of sardine after release cannot be considered as the only cause of the low percentage of recovered tags in 1950. This being so, we leave still open the question of the low percentage of recoveries of specimens tagged in 1950.

It cannot be excluded, however, that the export of fresh sardine to Italy, grown higher in 1950, might have unfavourably influenced the recovery of tagged specimens. It was not possible to have the publicity with regard to tagging of sardine as successful in Italy as it was in Yugoslavia. It seemed, however, that the publicity in 1950 was somewhat less intensive in Yugoslavia too than it happened to be in 1949. This factor might have also played a part in the decrease of the percentage of recovered tags.

A movement of sardine of a small extent was shown also by the results of tagging carried out during first half of July of the 1951 sardine fishing season. That movement started from Pakleni Islands in the direction of the north-west section of Hvar Island and towards the south coast of Brač Island.

A movement was also noticed starting from the east coast of Biševo Island in the direction of the north section of Vis Island and towards the south coast of Pakleni Islands. The noticed movements of this clupeoid species were, then, in accordance with those recorded during the previous

fishing seasons. It is significant that all these movements were directed towards the inside channels and the mainland coast.

We should mention here that the data on movements of sardine, resulting from tagging of this clupeoid species, are also confirmed by the (as yet unpublished) results which we have obtained in the course of some other researches into Adriatic sardine, relative to analysis of the composition of samples of catches as to the total length and to the number of vertebrae.

The recoveries of specimens tagged in 1951 followed 2—7 days after tagging. The recorded movements occured during the first half of July.

The percentage of recoveries of tagged individuals amounted to 0.39%, being thus two and a half times higher than the 1950 one, and two and a half times lower than the 1949 one. The opercular tags and flaglets, which were fixed on the back of fish, yielded an almost equal percentage of recoveries.

A certain perishing of fish both preceding the tagging and after it was noticed also in the course of 1951. The mean temperature of the sea surface on the July days, during which the tagging took place, was relatively high. A thorough comparison between the new and the earlier data on temperature is, however, not possible, as the measurements were carried out closer to the coasts of the islands than it was the case in previous years.

MARKIRANJE SRDELE (*CLUPEA PILCHARDUS* WALB.) U JADRANU U 1950. I 1951. G.

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Kratak sadržaj

U sezoni lova 1950. g. nastavilo se intenzivno markiranje srdele radi ispitivanja njezinih kretanja. To se vršilo u jednom dijelu srednjodalmatinskog područja, t.j. u Splitskom i Hvarskom kanalu, na Paklenim otocima, te na otocima Visu, Biševu i Svecu. Nekoliko markiranja provelo se u blizini otoka Palagruža. Markiranja su se izvršila u vremenskom razmaku od 7. svibnja do 14. rujna.

U sezoni lova 1951. g. izvršilo se markiranje srdele na sjeverozapadnom dijelu otoka Hvara, na Paklenim otocima, te na otocima Visu i Biševu. Sva su ta markiranja bila provedena od 3. do 11. srpnja osim jednog, koje se izvršilo 7. rujna.

Kod markiranja u 1950. g. primijenila se ista tehnika rada kao i u 1949. g. Upotrebljena operkularna markica bila je nešto duža, a osim toga uža i, prema tomu, laganija od one, koja se primjenjivala u 1949. g. Ovakva je markica izgledala nešto efikasnija od prije upotrebljene. Ova se markica upotrebila i kod markiranja u 1951. g. Međutim, pored te pokušala se u 1951. g. i markica u obliku zastavice od narančastog polivinil-klorida, koja se pričvršćivala na hrbat ribe, ispred dorsalne peraje.

U 1950. g. izvršilo se 29 markiranja na ukupnom broju od 16.613 primjeraka. Od toga se pronašlo svega 27 riba. t.j. 0,16%. Taj je procenat šest puta manji od onog, što je bio postignut u 1949. g. Uzroci tako krupnog opadanja procenta nalaza označenih individua nisu potpuno objašnjeni. Zapaženi porast mortaliteta poslije markiranja u mjesecu srpnju, a osobito kolovozu i rujnu mogao je donekle izazvati opadanje procenta nalaza označenih primjeraka. Porast mortaliteta zbog markiranja, kao i znatno pogibanje ribe prije samog markiranja mogli su biti posljedica relativno visoke temperature površine mora, koja je vladala u srpnju, kolovozu i rujnu. Maksimalna srednja temperatura površine u vremenskom intervalu, u kojemu su se izvršila markiranja jednog mraka u 1950., bila je, naime, za 2,8°C viša od one u 1949. g.

U 1951. g. izvršeno je 9 markiranja na ukupnom broju od 3.845 primjeraka. Od toga ih je povraćeno 15, t.j. 0,39%. Taj je procenat, prema tomu, dva i po puta veći od onoga, koji se ustanovio u 1950., a dva i po puta manji od onog iz 1949. g. Operkularne markice i zastavice, koje su se pričvršćivale na hrbat ribe, pokazale su gotovo jednak procenat nalaza.

U 1951. g. bilo je također zapaženo neko pogibanje ribe prije i poslije markiranja.

Najveći broj nalaza od eksperimenata u 1950. g. bio je kroz prve tri sedmice poslije markiranja. Svi nalazi od markiranja u 1951. g. bili su zabilježeni u prvoj sedmici nakon markiranja.

Zapažena kretanja bila su malene amplitude. U 1950. g. na kraju svibnja, a možda dijelom i na početku lipnja, izvršilo se kretanje srdele sa zapadne obale otoka Brača prema južnoj obali otoka Čiova, prema Kaštelanskom zaljevu i području Poljica, t.j. u pravcu obale kopna. Takvo se kretanje moglo ustanoviti i u 1948. g., a izvršilo se u srpnju, a možda dijelom i u kolovozu.

Između polovine svibnja i rujna 1950. g. bilo je kretanja ribe sa sjeverozapadnog dijela otoka Visa prema Hvarskom kanalu, i to k obali otoka Brača. Između prve polovine lipnja i rujna izvršilo se kretanje ribe s južne obale otoka Biševa prema jugozapadnom dijelu otoka Brača. Kretanje prema Hvarskom kanalu registriralo se i u 1949. g., i to na kraju svibnja, u srpnju i na kraju kolovoza.

U prvoj polovini srpnja 1951. g. nastupilo je kretanje srdele s Paklenih otoka prema sjeverozapadnom dijelu otoka Hvara i južnoj obali otoka Brača, kao i s istočne obale Biševa prema sjevernoj strani otoka Visa i južnoj obali Paklenih otoka.

Kretanja srdele, zapažena u sezonama lova u 1950. i 1951. g., podudarala su se, prema tomu, s kretanjima, koja su bila zabilježena u 1949. g., a dijelom i u 1948. g. Značajno je, da su ona gotovo sva bila upravljena unutrašnjim kanalima i obali kopna. Rezultati ostalih istraživanja srdele (još neobjavljeni) potvrđuju podatke o kretanju, dobijene putem markiranja ovog klupeida.

Tisak: Novinsko izdavačko poduzeće „Slobodna Dalmacija“ - Split