ACTA ADRIATICA
INSTITUT ZA OCEANOGRAFIJU I RIBARSTVO U SPLITU
FNRJ JUGOSLAVIJA

Vol. III. No. 10.

FIRST TAGGING EXPERIMENTS ON THE SARDINE (CLUPEA PILCHARDUS WALB.) IN THE ADRIATIC

R. Mužinić

SPLIT 1948/1949

FIRST TAGGING EXPERIMENTS ON THE SARDINE *(CLUPEA PILCHARDUS* WALB.) IN THE ADRIATIC

by

Radosna Mužinić

(Institute of Oceanography and Fisheries, Split)

INTRODUCTION

The immediate purpose of these tagging experiments on the sardine *(Clupea pilchardus* Walb.) in the Adriatic Sea, carried out during the sardine fishing season of 1948, was to examine the possibility of tagging that clupeid species. By reason of its delicateness, the European sardine was for a long time regarded as not being suitable for that kind of investigation. However, it seemed to us possible to tag the sardine on the basis of an orientation experiment. This was made on a very small number of fish, in a wooden hexagonal live box, with two longer sides, in which was built up a central chamber to be used for the tagging work itself and in which a small mesh brass cloth, disposed at the bottom, allowed ample circulation of water. Unfortunately, by reason of technical difficulties, we could not carry out on a bigger scale this preliminary tagging and we had to liberate the tagged fish. The results obtained through these experiments indicate the feasibility of tagging sardine by the method described in this paper. Such feasibility having been proved, it will render possible the tracing of migrations and, eventually, the estimates of fishing intensity of that economically most important Adriatic fish species, this being the ultimate object of our tagging experiments on the sardine. Furthermore, the acquisition of knowledge of sardine movements will establish definitively whether the sardines caught along the Eastern coast of the Adriatic constitute a homogeneous population or whether there occurs an intermingling of distinct populations.

The taggings were carried out during the spring and summer of 1948 (between the middle of April and the first days of September) in a part of Central Dalmatia.

Thanks are due to Dr. Tonko Šoljan, Director of the Institute, who accepted, without any hesitation, my suggestion to attempt the tagging of sardine, who gave me full support during the carrying out of these experiments and, furthermore, offered me much useful advice on the preparation of them, particularly as regards the kind and dimensions of the tag and the form of pliers used in the tagging, and who later followed with the greatest interest the whole course of the work. I am grateful to Prof. Franjo Margetić, Chief in charge of Hydrometeorological Service of Zagreb, who supervised in the workshop of the same institution the manufacture of the pliers and the first tags. I am indebted also to Dr. Aristide Vatova of Talassographic Commitee of Venice for keeping the Italian public informed of our experiments by means of the daily press, so that the Italian fishermen as well as the consumers of fresh sardines could cooperate in the recovery of tagged specimens. The investigations have been assisted by the extensive co-operation of our fishermen, cannery workers and consumers of fresh sardines. Several people employed at this Institute have aided the carrying out of tagging experiments, in every way possible.

DESCRIPTION OF THE TAGS USED IN TAGGING EXPERIMENTS

The tag adopted for sardine marking on the Adriatic coast was of the opercular type, resembling that employed by Rounsefell and Dahlgren in the experimental tagging of Pacific herring (1933)[1]. This type of tag has been widely used in the tagging of cod, salmon and halibut. Such a tag is a small metal flat strip pointed at one end and having a slot at the other, through which the point goes during the attachment of the tag

[1] Rounsefell, George A., and Edwin H. Dahlgren. 1933. Tagging experiments on the Pacific herring. Journ. du Cons. Perm. Intern. Explor. Mer., Vol. VIII, No. 3. Copenhague.

to the opercle of the fish. Our tags were 12.5 mm. long (stretched, without point), 2 mm. wide, 0.25 mm. thick and weighed 0.07 gr. The length of the tag point was 3.5 mm. The tags were made of silver, since it offers the advantage of being resistant to corrosion. Each clinched tag, i. e. when definitively fixed to the opercle of the fish, bore on the upper side the inscription »SPLIT« and, on the lower one, the serial number. The Figure 1 shows the stretched, bent and clinched tag.

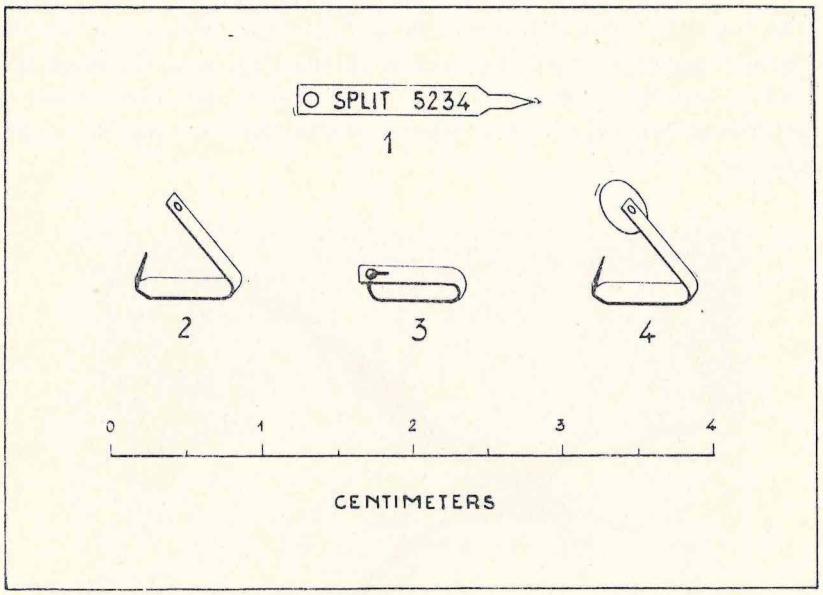

Fig. 1. — *Tags used in the tagging work. No. 1. — Stretched tag. No. 2— Curved tag. 3. — Clinched tag. No. 4 — Tag combined with celluloid disc.*

As in practice it was proved that the strap tags employed were not sufficiently conspicuous, we tried to remedy that defect by applying discs of coloured celluloid in connection with them. Each curved strap tag was supplied with such a disc on its upper part (Fig. 1). The use of metal strap tags combined with showy coloured discs has proved very efficacious. At the beginning, the celluloid discs had a diameter of 5 or 7 mm. and later we retained the 5 mm. diameter discs. In the course of

these experiments celluloid discs of different colours were used. It is comprehensible that in the recovery of tagged specimens, the colour of celluloid has played a very important part. The greatest number of recovered specimens bore red celluloid discs.

METHOD OF ATTACHING THE TAGS

The tags were affixed to the right opercle of the fish. While the tag was being attached, the point of the lower part of the curved tag perforated the opercle of the fish, went through the slot of the upper part and bent itself over it. The pliers used in attaching the tags to the opercle of the fish are shown in Figure 2.

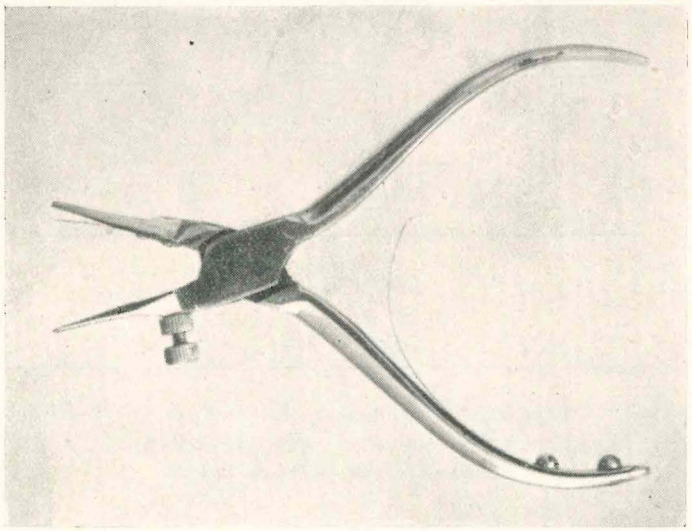

Fig. 2 — *Pliers used in attaching the tag to the fish.*

It is not known what the influence of the opercular tag on the fish is since its opercula are in constant movement on account of respiration and feeding. In spite of that, the opercular type of tag has been used successfully for tagging many fish species and it has proved also very efficacious in the experimen-

tal tagging of Pacific herring (1933)[1]), made by R o u n s e f e l l and D a h l g r e n in order to determine the relative efficacy of various methods of marking. The opercular type of tag involves the danger of loss of the tag through wearing off of tissue round it.

This fact must be taken into consideration, particularly when the recovery is expected during several years, which is not the case in the object of our investigation. In our tagging experiments on the sardine, there were many cases of wearing away of tissue under and round the tag, especially in specimens recovered after a long period of liberty. Figure 3 shows a tagged sar-

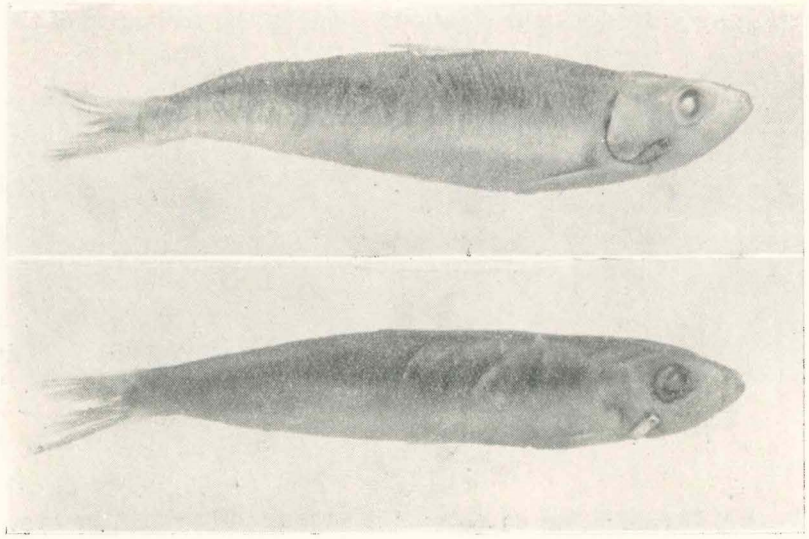

Fig. 3. — *The upper of these sardines was recaptured 129 days after tagging and the lower one 31. Note the great enlargement of the opercular wound in the first case.*

dine recaptured 129 days after it had been released. As can be seen, the wearing off of the tissue has manifested itself here to such an extent that the tag would soon have fallen off. We must

---

[1]) Rounsefell, George A., and Edwin H. Dahlgren. 1933 Tagging experiments on the Pacific herring. Journ. du Cons. Perm. Intern. Explor. Mer.; Vol. VIII, No. 3. Copenhague.

mention that this sardine was among the first tagged ones. In Figure 3 is shown also a tagged sardine found 31 days after it had been set free. These specimens were photographed after having been kept a long time in a 4% solution of formalin. We do not show a greater number of recovered sardines because many of them were remitted to us in unsatisfactory condition, or badly preserved; besides, cases of damaged opercles were not scarce, since the recovered fish went through the hands of many inquisitive fishermen and cannery workers.

In order to reduce to a minimum the possibility of tag loss due to the wearing off of the tissue of gill-cover, it is absolutely necessary to attach the tag to the preoperculum as shown in Figure 4. Besides, the clearance between the two parts of the

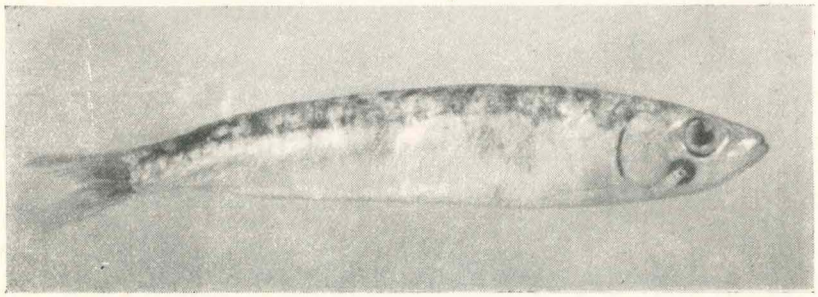

Fig. 4. — *A freshly marked sardine (133 mm. totallength)*

clinched tag must not be bigger than required to clasp the opercle and the celluloid disc, so that the tag does not swing in its place of attachment, since such swinging would enlarge the hole through which the tag point goes. The possibility of motion of the tag at its place of attachment is reduced by the celluloid disc as, on account of the friction, this produces a resistance to such motion. In that manner, the celluloid disc protects, to a certain extent, the opercle against damage caused by the tag point acting in a single point of opercle perforation. Apart from that, the use of the celluloid disc enables us to lessen the dimensions of the metallic part of the combined strap tag. Since this part completely loses its role of attraction — such role being transferred to the coloured celluloid disc — it remains therefore

bearer of the distinguishing mark and serial number only and, consequently, can be reduced to the smallest possible dimensions. In this way, we diminish the weight of the tag also and at the same time the possibility of enlarging the hole on the opercle. Moreover, if the celluloid disc itself could carry the inscription and number, it would result in the possibility of a further reduction in the metallic part of the tag. At all events it appears necessary to employ tags of two sizes: the larger ones could be used for sardines over 150 mm. total length, and the smaller ones for those below that limit.

The question arises as to whether the celluloid disc causes a certain resistance in the swimming of the fish. The possibility of producing such resistance is reduced to a minimum if the disc snugly fits the opercle of the fish. While observing, in the live box, the tagged sardines on which this snug fitting had not always taken place, we could not note that the celluloid disc handicapped the fish in their movements. We can mention here that a sardine of 130 mm. total length was recaptured 36—40 hours after having been tagged by means of a strap tag combined with the celluloid disc, 7 mm. in diameter, 10.7 nautical miles far from the releasing-place. Although the sardine, moving in a straight line, might have travelled that distance in a much shorter time, it is however a proof, in a rough way, that the fish tagged with strap tag bearing such a big celluloid disc, particularly in relation to its total length, has accomplished a movement of a relative great amplitude within a short time interval.

These large celluloid discs, especially in smaller specimens, were later avoided so that, as mentioned previously, we retained only the smaller ones, i. e. 5 mm. in diameter.

LIVE BOX

During tagging operations the fish were held in a rectangular live box made of a small mesh coton web, 4 m. long, 1 m. wide and 1.05 m. deep. Its frame was made partly of wood and partly of metal. Such a live box really consisted of two equal parts, one of which had a door at the joint while the other was open on that side. In that way, during tagging operations, two

compartments might be made inside the live box: one for the tagged specimens and the other for the non-tagged ones. Besides, the live box compartment with door could be used independently in the release of tagged fish.

HANDLING OF FISH AND TAGGING PROCEDURE

For marking purposes, the fish were taken from fishermen's catches made by purse seines under a light at night. We did not carry out any fishing ourselves for that purpose. Two people in a motor-boat 6 m. long, with the live box at the prow, cruised to the fishing grounds and looked for the boat having the greatest chance of capture, and in the neighbourhood of which was suitable ground for tagging—some sheltered cove for instance. When they had found this, they stood by and took the fish just before brailing them. In order to transfer the fish as quickly as possible and with a minimum of injury, the cork line of the net, placed along one edge of the live box, was sunk below the water level, thus enabling the fish to swim themselves into the inclined live box. The door going across the middle of the live box was meanwhile kept open, so that the fish had enough space to move about. The fish were then transported to the nearest shelter.

The tagging work began early in the morning. Immediately prior to tagging operations, the fish were driven into one of the live box compartments (the one without a door) and the door was closed. The tagged specimens were put in the empty compartment of the live box.

Tagging operations were carried on from a small boat 3.5 m. long, lying alongside one of the Institute's vessels: »Predvodnik« or »Srdela«. The disposition of the three boats and the position of the live box in relation to them are shown in Figure 5. The seat of the tagger corresponded to the middle of the live box. Two men were employed at the tagging besides the tagger himself. The one in the motor-boat dipped the fish from the live box in a dip-net, the lower part of it being made of stramin, so that the water did not flow out too quickly; he took a few specimens only at a time. The other man put the tag into the pliers, raised up the opercle of the fish with a small bone lever, 160 mm.

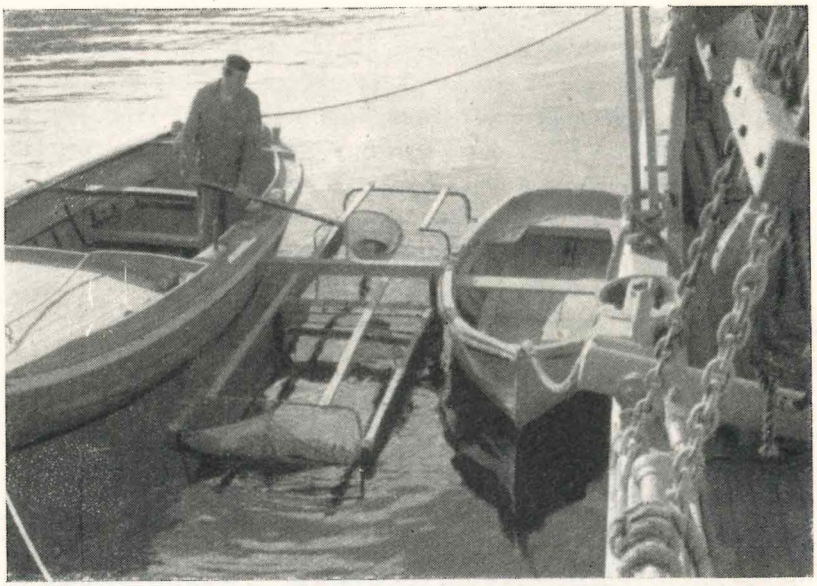

Fig. 5. — *Disposition of the live box and boats during tagging operations.*

long and 10 mm. wide; the end used to raise the opercle of the fish being very flat.

During tagging operations, the greatest care was taken in choosing the fish: any specimen looking in bad condition was eliminated. The author has personally carried out all the taggings. The experience has shown that the fish must be handled with the utmost care throughout the tagging operation. The fish was grasped from dip-net out of the water with the left hand wearing a thin cotton glove. According to J a n s s e n[1]) such a glove facilitates the holding of the fish since the fish slime collecting on the smooth hand compels to exert undue pressure. Although, in our experiments, the tagger himself took the fish from the partly immerged dip-net and let it out through the water after the tagging procedure, having thus the occasion to free his hand from collected fish slime, however the use of a cot-

[1]) Janssen, John F., Jr. 1939. Two years of Sardine tagging in California. Journ. du Cons. Perm. Intern. Explor. Mer., Vol. XIV, No. 1. Copenhague.

ton glove seemed useful to us. The holding of the fish in the hand wearing such a glove involves a minor risk of its wriggling or even sliding off out of the hand. Therefore, the use of a cotton glove reduces the losing of scales, this being most probably the main cause of death of a certain number of sardines after the tagging procedure. In any case it is absolutely necessary to get hold of the fish firmly in order to keep it from wriggling and in such way that it needs no futher adjustment in the hand. Meanwhile, the right side of the anterior body end must be free. So that, during the inserting of the tag, the fish could not move its

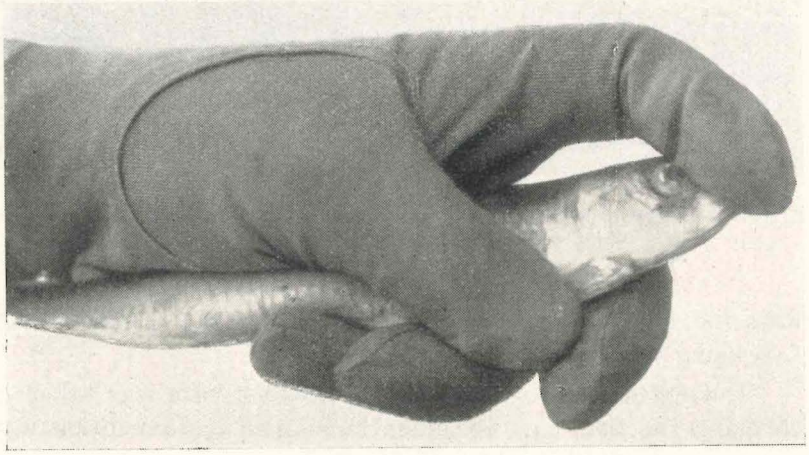

Fig. 6. — *Position of the sardine in the hand before inserting the tag.*

head, the index finger of the hand holding the fish had to be thrown over the front part of the head. The position of the fish in the hand after overthrowing the index finger is shown in Figure 6.

Immediately after the tag has been affixed, the fish must be very carefully released in the othher compartment of the live box enabling it to slide off into the water as easily as possible. It is even desirable to lead the fish through the water so that it can swim away without wriggling. We must bear in mind that each movement of the fish in the hand means loss of scales which is fatal for it.

The complete procedure for tagging a single fish and its return to the water took an average of twenty seconds. The tagging could be carried on only when the sea was quite calm. During tagging operations the fish were never exposed to direct sunlight.

That it is absolutely necessary, during the tagging work, to give full attention to the above mentioned details is proved by the fact that, immediately after the first experimental tagging, nearly 12% of tagged individuals died or were in such bad condition that they could not survive. In the second tagging, the number of similar specimens was reduced to one-half, and, in the third, to one-fourth. On the whole, the mortality immediately after the tagging procedure varied from 0 to 3%. It seems that this mortality could be eliminated by severe selection of material and good technique in handling and tagging the fish. Unfortunately, we were seldom able to realize all of these ideal conditions, having been hindered, on the one hand, by bad sardine fishing in some localities and, on the other, by uncertain weather and roughness of the sea. We cannot say, for the time being, whether such a mortality was partly due to certain environmental factors, particularly temperature. It is hardly possible that in this respect the physiological condition of specimens submitted to tagging might account for it. We must point out that the tagging of sardines was carried on out of the spawning season. Only the samples examined before the first half of May 1948 contained a certain percentage of individuals in which the development of the gonads was such that their volume exceeded half the body cavity. Besides, in the course of our experiments a considerable number of immature specimens were tagged.

The measurement of the total length of particular specimens submitted to tagging was made during one of the first experiments only. Later, this was given up in order not to keep the fish too long out of the water, even more so that these experiments did not aim to examine the growth. As from the same catch which yielded material for tagging purposes, a sample was always taken for biometric analysis, we had therefore at our disposal all the data obtained through it, i. e. total length, sex ratio, stage of development of gonads, quantity of

mesenteric fat and number of vertebrae. For age determinations, scales and otoliths were removed from individual fish.

The latest phase of tagging work was the release of tagged specimens. This took place at the very spot of tagging or, if the tagging was carried on in coves running far into the land, the live box compartment with tagged fish (the one with door) was towed slowly towards the open sea and emptied there. When tagging had to last longer, the tagged specimens were liberated several times. In those cases, the last release only could be carried on, if it seemed indispensable, at some distance from the tagging place. However, the towing of the live box with fish is not convenient and has to be avoided whenever possible. The tagged fish were set free in groups of several specimens so that they could rejoin shoals more easily. Moreover, it might be necessary to release the tagged fish in shoals.

RECOVERY OF TAGGED FISH

A very important point in the tagging work is the recovery of tagged specimens. This was also shown in our tagging experiments on the sardine. Sardines are caught in large quantities and, as they spoil very quickly, they must be transported immediately after the catch and brought into markets or canneries and factories for fish salting. It was therefore rarely possible to fishermen themselves to search for tagged specimens, except in cases of poor catches. For that reason, the recovery of tagged fish had to be expected mainly from the consumers of the fresh sardine and those concerned in the handling of it in canneries and salting factories[1]). That is why the widest publicity had to be made on our tagging experiments, even more so that it was the first attempt of marking an object of sea fishery on the Yugoslav coast of the Adriatic. The publicity was arranged through the daily press, radio and placards placed in all sardine consumers towns and which, in addition,

[1]) In canneries the sardines are handled individually. In cutting off the heads of the fish and taking out their entrails before the canning process itself, the right side of individual fish faces the worker, this being the reason why the sardine ought to be tagged upon the right side.

were sent directly to canneries and fishing cooperatives. At the same time the Albanian Fishery Authorities were informed about these experiments. The Italian public in fishery centers of the Western Adriatic coast were also kept aware of our tagging experiments.

A reward was offered for the recovery of tagged sardines, which at first was 250 dinars for each specimen and, later, 500 dinars. The marked sardine had to be sent undamaged to our Institute, as early as possible, either fresh or preserved. In case a part of the sardine was remitted (the head, for instance) bearing a tag or even a tag alone, the reward amounted at the beginning to 150 dinars and, later, to 300 dinars. Besides the tagged sardine or the tag alone, the finder had to present exact data as to locality and date of catch, as well as the source of such information in case he had not made the catch himself. Data concerning recapture of tagged sardines have been verified whenever possible.

In order to examine the efficiency of recovery of tagged specimens in canneries, in one of them eight tags were inserted on dead sardines which were later distributed at random among the remaining fish intended for canning. In the course of salting a single tagged sardine was found by the cannery staff. For that test ordinary strap tags (without coloured celluloid discs) were used. Therefore, it is clear that a significant number of tagged specimens and particularly those with ordinary strap tags have been overlooked. As immediately after the above mentioned test, strap tags bearing coloured celluloid discs were employed, and as, furthermore, the interest in searching for marked fish was stimulated through the increase in the reward, the number of overlooked tagged individuals must have considerably decreased. It is, therefore, possible to improve the recovery efficiency by stimulating the interest among cannery workers in searching for tagged specimens by inserting test tags on dead sardines, from time to time.

In any case, it is highly necessary to emphasize the fact that finders of tagged fish originate from the ranks of our fishermen, cannery workers and consumers of fresh sardines. This insures the success of an extensive tagging programme on the sardine.

TAGGING LOCALITIES

The tagging experiments were carried on in a part of Central Dalmatia. The localities of taggings are shown by black discs in Figure 9. The places in which more than one tagging was carried on are designated with a circle around the black disc for each ulterior tagging experiment. The tagging made in the same locality during two succeeding days has been treated as a single one.

As indicated in Figure 9, the area in which these tagging experiments were carried on is relatively narrow. It includes Kaštel Bay, Split Channel (coast of Brač Island), Hvar Channel (coasts of Brač and Hvar Islands) and Vis Island. How the number of tagged fish was distributed among these major areas, is given in Table I. In that table are included the numbers which concern ordinary strap tags as well as those relating to tags with coloured celluloid discs. As indicated by the numbers of individuals marked by ordinary strap tags, we had intended to put in relation the number of tagged sardines with the distance from the main land. According to the results of previous investigations on the biology of Adriatic sardine (S. Mužinić, 1931)[1]) and personal ones, which are in course of execution, the

TABLE I. — *Number of Tagged Sardine according to Major Area of Tagging und Type of Tag used*

Area of Tagging	Type of Tag		Total
	Strap Tags	Strap Tags bearing Celluloid Discs	
Kaštel Bay	478	567	1.045
Split Channel	—	650	650
Hvar Channel	1.783	1.517	3.300
Vis Island	3.332	1.770	5.102
Total	5.593	4.504	10.097

[1]) Mužinić Slavko. 1936. Ekološka ispitivanja na jadranskoj srdeli (Clupea pilchardus Walb.) Beograd.

size of the sardine grows with the distance from the main land. For that reason, we might presume that even the extent of the sardine movements increases in the same direction. Unfortunately, this plan was altered during the second phase of tagging i. e. when applying combined strap tags, due partly to bad weather and partly to various technical difficulties. Hence, the difference between the numbers of sardines tagged in Hvar Channel and in the Vis Island area is very small. A detailed list of localities in which taggings were carried out is given in Table II. In tagging experiments designated by serial numbers 13 to 20 strap tags combined with coloured celluloid discs were used.

DISCUSSION OF RECOVERIES

As shown in Table II, from a total of 10,097 tagged sardines, 44 were recovered (i. e. 0.44 %). In this number are included recoveries of tags on damaged sardines or on their heads alone. While out of 5,593 specimens marked by ordinary strap tags only 3 have been returned, on the other hand, the 4,504 individuals marked by strap tags combined with coloured celluloid discs have yielded 41 recoveries (i. e. 0.91 %). Percentage recovery of strap tags bearing coloured celluloid discs in the total recovery percentage clearly demonstrates the superiority of those. It must be mentioned that when beginning to use combined tags, we increased at the same time the amount of the reward for returned marked specimens of sardine, and this may eventually diminish the value of comparison as to the efficiency of two kinds of tags.

Detailed data on recoveries are included in Table III. It will be noted that the highest number of recoveries, i. e. 24 (54.5 % of all) were obtained with the fish tagged in Kaštel Bay. Of the tagged fish liberated in Split Channel there have been 9 returns (20.4 %). From sardines tagged in Hvar Channel 6 specimens (13.7 %) have been recaptured. The Vis Island area has yielded 5 recoveries (11.4 %) only. Such a distribution of recoveries among these major areas was caused by a variety of factors, which we cannot analyse for the time being.

The largest number of tags were recovered in close proxi-

TABLE II. — *Summary of the Tagging Data with regard to number of Recoveries*

Tagging No.	Locality	Date	Tagged	Recovered		
				Tagged fish	Tags	Total
1	Marjan Point, Kaštel Bay	15. IV. 1948	114	—	—	—
2	Lučišće Cove, Hvar Island	5. V. 1948	111	—	—	—
3	Žukova Cove, Hvar Island	6. V. 1948	538	1	—	1
4	Zečevo Island, Hvar Channel	16. V. 1948	182	—	—	—
5	Slatine, Kaštel Bay	28. V. 1948	364	—	—	—
6	Lučišće Cove, Hvar Island	29. V. 1948	630	—	—	—
7	Porat Cove, Biševo Island	30. V. 1948	459	—	—	—
7	Porat Cove, Biševo Island	31. V. 1948	221	—	—	—
8	Komiža_port, Vis Island	1. VI. 1948	725	—	—	—
9	Srebrena Cove, Vis Island	3. VI. 1948	8.5	1	—	1
10	Žukova Cove, Hvar Island	5. VI. 1948	512	1	—	1
11	Rukavac Cove, Vis Island	10. VI. 1948	477	—	—	—
12	Srebrena Cove, Vis Island	11. VI. 1948	625	—	—	—
13	Slatine, Kaštel Bay	5. VII. 1948	567	22	2	24
14	Okrubiokova Cove, Brač Island	9. VII. 1948	650	7	2	9
15	Srebrena Cove, Vis Island	10. VII. 1948	412	—	1	1
16	Taleška Cove, Vis Island	13. VII. 1948	609	2	—	2
17	Komiža_port, Vis Island	15. VII. 1948	659	1	—	1
18	Lučica Cove, Brač Island	1. IX. 1948	64	—	—	—
19	Osibova Cove, Brač Island	2. IX. 1948	630	3	—	3
20	Stiniva Vela Cove, Hvar Island	3. IX. 1948	158	—	—	—
20	Stiniva Vela Cove, Hvar Island	4. IX. 1948	665	1	—	1
		Total . . .	10,097	39	5	44

mity to the releasing-place of tagged specimens. In 34 recoveries (77.3 %) this distance varied from 0 to 5 Nm. The remaining 10 (22.7 %) tagged sardines were recaptured at a distance varying from 9 to 15 Nm. In Figure 9 the localities of recovery are designated with arrows. The tagging and recovery localities are jointed to each other by lines which of course do not necessarily indicate the directions of real fish movements.

As regards the distances between places of tagging and recovery, it can be noted that they are very small for the Vis Islang area in spite of a relatively great time interval between tagging and recovery dates. In this respect it is not possible to

TABLE III. — *Detailed Table of Recoveries*

Tagging No.	Number of Recoveries	Place of Recovery	Distance from Tagging to Recovery Place (Miles)	Date of Recovery	Period of Liberty (Days)
3	1	Travna Cove, Šolta Island	12.3	12. IX. 1948	129
9	1	Duboka Cove, Vis Island	3.2	10. IX. 1948	99
10	1	Zaraće Cove, Hvar Island	15.3	14. VII. 1948	39
13	1	Slatine, Kaštel Bay	0.5	7. VII. 1948	2
13	1	Arbanija, Kaštel Bay	1.4	11. VII. 1948	6
13	1	Slatine, Kaštel Bay	1.0	13. VII. 1948	8
13	1	Slatine, Kaštel Bay	1.0	25. VII. 1948	20
13	1	Kaštel Novi, Kaštel Bay	1.9	29. VII. 1948	24
13	2	Slatine, Kaštel Bay	1.0	31. VII. 1948	26
13	1	Slatine, Kaštel Bay	1.0	1. VIII. 1948	27
13	3	Slatine, Kaštel Bay	1,0	2. VIII. 1948	28
13	2	Supetar Point, Kaštel Bay	1.6	3. VIII. 1948	29
13	4	Supetar Point, Kaštel Bay	1.6	4. VIII. 1948	30
13	1	Supetar Point, Kaštel Bay	1.6	5. VIII. 1948	31
13	2	Slatine, Kaštel Bay	0.5	5. VIII. 1948	31
13	1	Prizinice, Čiovo Island	4 7	6. VIII. 1948	32
13	1	Supetar Point, Kaštel Bay	.6	8. VIII. 1948	34
13	1	Slatine, Kaštel Bay	0.5	12. VIII. 1948	38
13	1	Marjan Point, Kaštel Bay	2.5	26. VIII. 1948	52
14	1	Okrubiokova Cove, Brač Island	0.0	10. VII. 1948	1
14	1	Supetar Point, Kaštel Bay	10.7	11. VII. 1948	2
14	1	Milna_port, Brač Island	1.7	13. VII. 1948	4
14	2	Slatine, Kaštel Bay	12.0	30. VII. 1948	21
14	1	Slatine, Kaštel Bay	12.0	4. VIII. 1948	26
14	1	Supetar Point, Kaštel Bay	10.7	5. VIII 1948	27
14	1	Slatine, Kaštel Bay	12.0	5. VIII 1948	27
14	1	Slatine, Kaštel Bay	12.0	12. VIII. 1948	34
15	1	Srebrena Cove, Vis Island	0.5	12. VII. 1948	2
16	1	Metudoli Cove, Vis Island	3.2	14. VII. 1948	1
16	1	Srebrena Cove, Vis Island	2.4	4. VIII. 1948	22
17	1	Boke, Vis Island	2.2	25. VIII. 1948	41
19	2	Stračinska Cove, Šolta Island	3.8	11. IX. 1948	9
19	1	Travna Cove, Šolta Island	3.3	12. IX. 1948	10
20	1	Bristova Cove, Hvar Island	9.3	12. IX. 1948	8

give any explanation for the time being, more so because the number of recovered specimens from taggings made in the area of Vis Island is very low. In any case we may not exclude the possibility of a failure of tagged individuals to rejoin shoals.

The total length of tagged sardines recaptured in Kaštel Bay, in Split and Hvar Channels, i. e. amounting to 35 (89.7 % from all returned specimens) varied from 11.5 to 14.5 cm. and

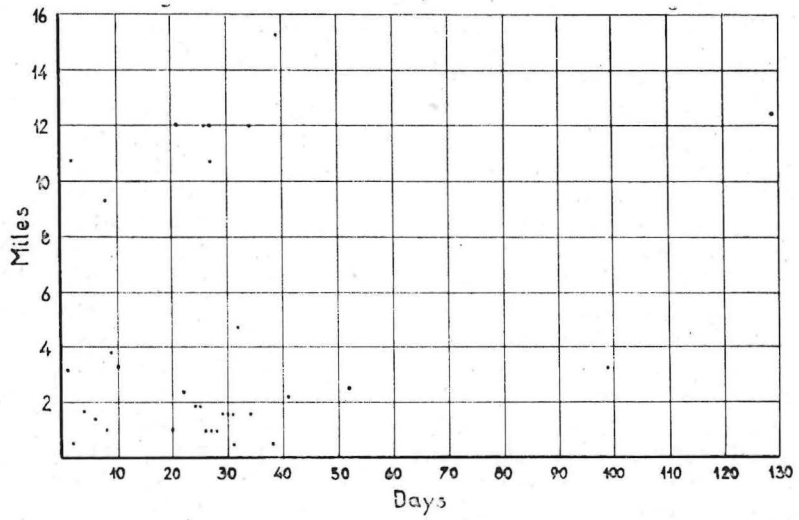

Fig. 7. — *Dispersion of tagged fish with time (all experiments). Each dot represents, on the horizontal scale, the time elapsed between tagging and recovery; on the vertical scale, the distance between the locality of release and that of recovery.*

of the 4 (10.3 %), found in the Vis Island area, from 15 to 18 cm.

In Table III we can see that the length of time elapsed between tagging and recovery varied from 1 to 129 days. Therefore, the tagged fish lived for intended purposes long enough. In Figure 7 the recoveries are shown according to the period of liberty (in days) and according to distance between the localities of tagging and recovery (in miles). The complete lack of returns corresponded to the non-fishing periods[1]). We can

[1]) In the Adriatic the sardine is caught usually at night during the darks of the moon, i. e. those 20 days of the moon's phases while it remains for the shortest time above the horizon.

conclude therefrom that the number of returns would be far greater if fishing were continuous. In addition, the number of recoveries would be more important if the taggings were carried on at the beginning of every period of sardine fishing within the fishing season. Meanwhile, we have intentionally avoided that, in order to get back specimens which have had a longer period of liberty and would have eventually been found at a greater distance from the tagging locality. This is illustrated by the diagram in Figure 8. In this, on abcissa, is shown in

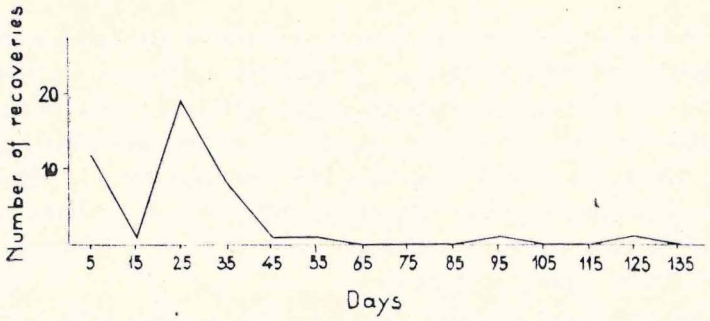

Fig. 8. — *Number of recovered sardines according to the time elapsed between tagging and recovery.*

days the time elapsed between tagging and recovery and, on ordinate, the number of returned specimens. The maxima, in front of 5 and 25 days as well as the minimum which comes in front of 15 days can be explained only by the fact that the taggings were carried on in the second half of the sardine fishing period (dark of the moon).

From all that has been mentioned it can be seen that many factors have affected the recovery of tagged fish. However, the percentage of recoveries, namely those concerning the strap tags bearing coloured celluloid discs, could be considered as not being very far from satisfactory. This fact, as well as the long period of liberty enjoyed by tagged fish, justifies the use of tagging of the sardine by the method described here in investigations upon migrations and, eventually, upon the fishing intensity of that clupeid species.

PRVI EKSPERIMENTI MARKIRANJA SRDELE (*CLUPEA PILCHARDUS* WALB.) U JADRANU

Radosna Mužinić

(Institut za oceanografiju i ribarstvo, Split

Kratak sadržaj

Pokušalo se u 1948. g. ispitati mogućnost markiranja srdele *(Clupea pilchardus Walb.)* u Jadranskom moru, i to u cilju primjene ove metode kod ekstenzivnijeg ispitivanja migracija i intenziteta lova ove riblje vrste. Kod toga su bile upotrebljene metalne markice operkularnog tipa, bez i sa bojadisanim celuloidnim krugovima. Opisane su te dvije vrste markica i njihov način pričvršćivanja na škržni zaklopac ribe. Iscrpno je izložena tehnička strana samog markiranja.

Eksperimenti markiranja izvršeni su u jednom dijelu srednjedalmatinskog područja. Pri tome su obuhvaćena slijedeća područja: Kaštelanski zaljev, Splitski i Hvarski kanal, te otok Vis. Markiranja su izvršena u vremenskom intervalu od 15. aprila do 4. septembra 1948. g.

Ukupno je markirano i pušteno na slobodu 10.097 primjeraka srdele, a od toga 4.504 markicama kombiniranim s bojadisanim celuloidnim krugovima. Ove posljednje pokazale su se daleko efikasnije od običnih metalnih markica bez takvih krugova. Dok su od svih upotrebljenih markica pronađene samo 44 (0,44 %), a od onih bez celuloidnih pločica samo 3 (0,05 %), dotle je od samih kombiniranih markica dobijena natrag 41 (0,91 %).

Najveći broj markiranih primjeraka bio je ulovljen u maloj udaljenosti od mjesta njihovog puštanja na slobodu. Udaljenost između mjesta puštanja na slobodu i nalaza markiranih riba iznosila je u 10 (22,7 %) slučajeva 9—15 Nm.

Totalna dužina kod 35 (89,7 %) pronađenih markiranih primjeraka bila je 11,5 — 14,5 cm, a kod preostalih 4 (10,3 %) kretala se od 15 — 18 cm.

Vrijeme proteklo između datuma markiranja i nalaza markiranih riba kretalo se od 1 — 129 dana.

Zapaženi su bili česti slučajevi većeg ili manjeg raspadanja tkiva škržnog zaklopca na mjestu pričvršćivanja markice, osobito kod individua, koje su duže vremena boravile na slobodi. Pretpostavljamo, da se ovo raspadanje tkiva škržnog zaklopca, i s tim u vezi mogućnost gubljenja markice, dade svesti na minimum primjenom mjera naznačenih u radu.

Budući da su srdele, markirane u toku ovih eksperimenata, ostajale na životu za postavljeni cilj dovoljno dugo vremena, te se pronalazile i pored brojnih faktora, koji su remetili njihovo pronalaženje, smatramo potpuno opravdanom primjenu markiranja srdela ovom metodom na ispitivanje migracija, a eventualno i intenziteta lova ove vrste klupeida.

ПЕРВЫЕ ОПЫТЫ МЕЧЕНИЯ САРДИНКИ *(CLUPEA PILCHARDUS* Walb) В АДРИАТИКЕ

Радосна Мужинич
(Институт океанографии и рыболовства, Сплит)

Краткое содержание

В 1948 г. были произведены опыты мечения сардинки *(Clupea pilchardus* Walb.) в Адриатическом море, с целью применения этого метода при более широком исследовании миграций и интенсивности лова этого вида рыб. При этом были употреблены металлические метки оперкулярного типа как с цветными кружочками из целлулойда так и без них. Дано описание этих двух сортов меток и способ их прикрепления к жаберной крышке рыбы. Исчерпывающе изложена техническая сторона самого мечения.

Опыты мечения были произведены в одной части среднедалматинской области. При этом были исследованы следующие области: Каштеланский залив, Сплитский и Хварский каналы и остров Вис. Мечения были произведены в промежутке времени от 15 апреля до 4 сентября 1948 г.

Из общего количества 10.097 меченных и выпущенных экземпляров, 4.504 сардинки были отмечены метками снабженными цветными целлулойдными кружочками. Последние оказались гораздо целесообразнее обыкновенных металлических меток без таких кружочков. Из числа всех употребленных меток было найдено всего 44 (0,44%), причем только 3 (0,05%) обыкновенных металлических и 41 (0,91%) меток с целлулойдными кружочками.

Самое большое количество отмеченных экземпляров было поймано в небольшом отдалении от места где они были пущены на свободу. Расстояние между местом выпуска и местом улова меченных рыб в 10 (22,7%) случаях равнялось 9—15 *Nm.*

Было поймано 35 (89,7%) меченных экземпляров всей длиною от 11,5 до 14,5 cm, а длина остальных 4 (10,3%) колебалась между 15—18 *cm.*

Время протекшее между числом мечения и числом поимки отмеченных рыб колебалось между 1 и 129 днями.

Часто были замечены случаи большего или меньшего разрушения ткани жаберной крышки в месте прикрепления метки, особенно у особей живших продолжительное время на свободе. Мы предполагаем что применением мер изложенных в этой работе можно сократить до минимума такое разрушение ткани жаберной крышки, а в связи с этим и возможность потери меток.

Ввиду того, что сардинки меченные в течение этих опытов продолжали жить для поставленной цели довольно долгое время и были пойманы несмотря на многочисленные факторы, препятствующие их розыску, мы находим вполне обоснованным применение мечения сардинок этим способом для исследования миграций а в случае надобности и интенсивности лова этого вида сельдевых.

Legend

- Locality one tagging experiment
- Locality two taggings on different dates
- Locality three taggings on different dates
- → Locality recovery

Kaštel Novi
Arbanija
Slatine
O. ČIOVO
Supetar
Prisnaca
Marjan
Split
O. Drvenik Veli
O. Drvenik Mali
ŠOLTANSKI KANAL
SPLITSKI KANAL
BRAČKI KANAL
O. ŠOLTA
Stračinska
Travna
Okrobleskova
Milna
Osibova
Lučica
O. B R A Č
HVARSKI KANAL
Žukova
Lučišće
O. Zečevo
Stiniva Vela
Zavala
H V A R
Brišlova
PAKLENI OTOCI
VIŠKI KANAL
SĆEDARSKI KANAL
O. Šćedro
KORČULANSKI KANAL
Komiža
O. VIS
Dubaka Talaška
Srebrena
Matvadi
O. Biševo
Porat
N
W
E
S

Fig. 9. — *Part of Central Dalmatia showing the tagging localities with black discs and those of recovery with arrows.*

Legend

- Locality one tagging experiment
- Locality two taggings on different dates
- Locality three taggings on different dates
- → Locality recovery

Kaštel Novi
Arbanija
Slatine
O. ČIOVO
Supetar
Prisnaca
Marjan
Split
O. Drvenik Veli
O. Drvenik Mali
ŠOLTANSKI KANAL
SPLITSKI KANAL
BRAČKI KANAL
O. ŠOLTA
Stračinska
Travna
Okrobleskova
Milna
Osibova
Lučica
O. B R A Č
HVARSKI KANAL
Žukova
Lučišće
O. Zečevo
Stiniva Vela
Zavala
H V A R
Brišlova
PAKLENI OTOCI
VIŠKI KANAL
SĆEDARSKI KANAL
O. Šćedro
KORČULANSKI KANAL
Komiža
O. VIS
Dubaka Talaška
Srebrena
Matvadi
O. Biševo
Porat
N
W
E
S

Fig. 9. — *Part of Central Dalmatia showing the tagging localities with black discs and those of recovery with arrows.*

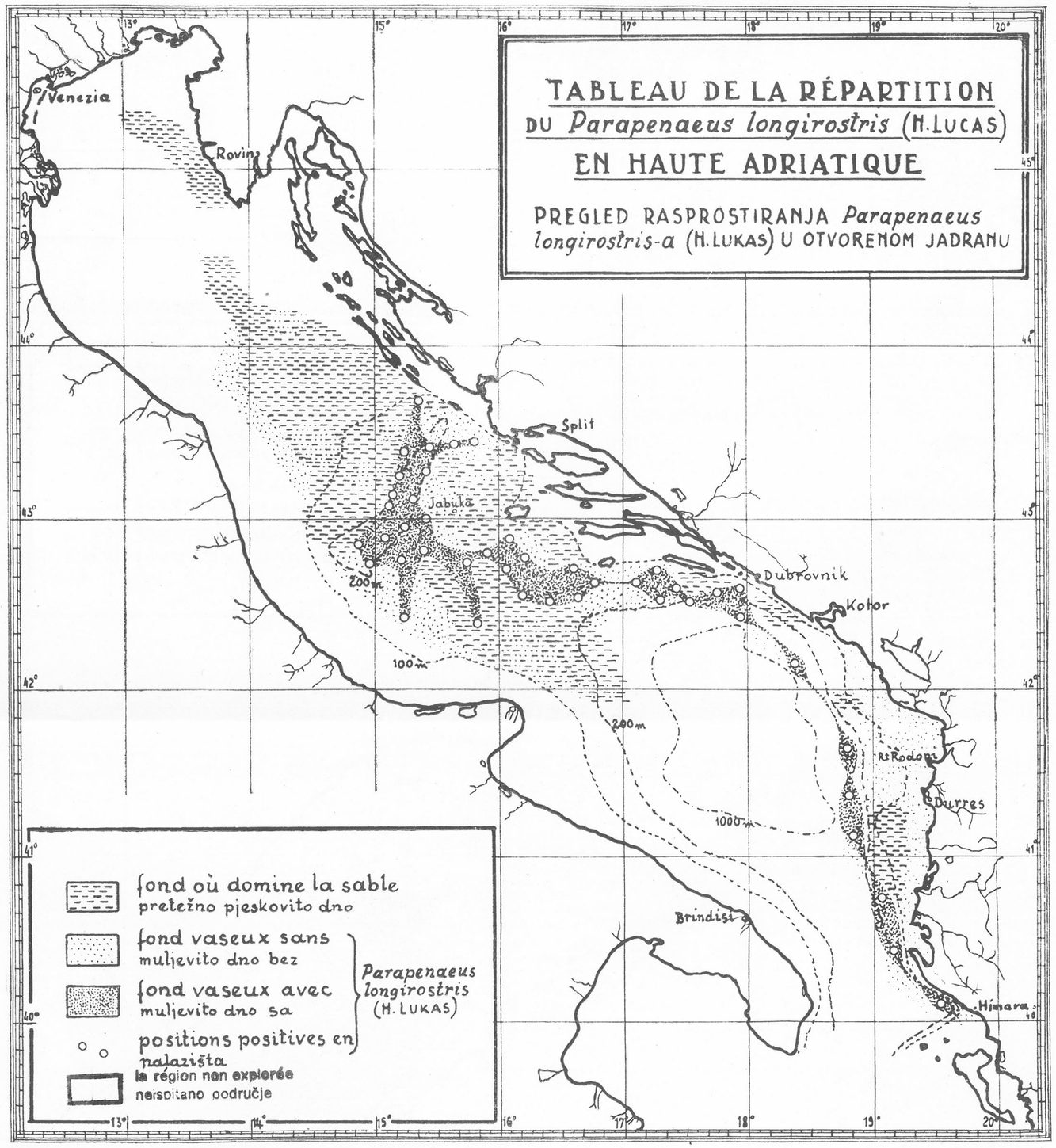
TABLEAU DE LA RÉPARTITION
DU Parapenaeus longirostris (H.LUCAS)
EN HAUTE ADRIATIQUE
PREGLED RASPROSTIRANJA Parapenaeus longirostris-a (H.LUKAS) U OTVORENOM JADRANU
Venezia
Rovinj
Split
Jabuka
Dubrovnik
Kotor
Rt Rodoni
Durres
Brindisi
Himara
100 m
200 m
1000 m
fond où domine la sable
pretežno pjeskovito dno
fond vaseux sans
muljevito dno bez
fond vaseux avec
muljevito dno sa
Parapenaeus longirostris (H. LUKAS)
positions positives en
nalazišta
la région non explorée
nersitano područje
13°
14°
15°
16°
17°
18°
19°
20°
45°
44°
43°
42°
41°
40°

TABLEAU DES CAPTURES DU *Parapenaeus longirostris* (H. Lucas) AU LARGE DE L'ADRIATIQUE EN 1948.—1949.

No. d' ordre	Date	Position		Profondeur au début et à la fin du remorquage en m	Fond	Nombre d' individus
		Lat. N	Long E			
A) Première croisière — A) Prvo krstarenje						
1	27. II. 1948.	43° 27'	15° 46'	180	*vase*	5
2	27. II. 1948.	42° 51·5'	14° 51'	130	„	1
3	29. III. 1948.	43° 41'	15° 24'	115	*vase mélangée d' un peu de sable*	1
4	30. III. 1948.	42° 44·5'	14° 58·5'	240	*vase*	1
5	31. III. 1948.	42° 49·5'	15° 23·5'	192	„	1
6	„	42° 58'	15° 15·5'	210	„	3
7	14. IV. 1948.	43° 28'	15° 40'	181	„	1
8	15. IV. 1948.	43° 17'	15° 25'	193	„	2
9	„	43° 03·5'	15° 07'	264	„	7
10	18. IV. 1948.	42° 27'	15° 15'	153	„	1
11	3. V. 1948.	42° 42'	16° 02·5'	168—172	„	15
12	„	42° 33·5'	16° 11'	170—177	„	5
13	7. V 1948.	42° 32·5'	16° 39'	176—183	„	4
14	8. V. 1948.	42° 37·5'	17° 07'	150—152	„	2
15	9. V. 1948.	42° 31'	16° 25·5'	186—181	„	14
16	10. V. 1948.				*vase mélangée d' un peu de sable*	1
17	15. V. 1948.	42° 38·5'	16° 47'	145—245	*vase*	2
18	17. V. 1948.	42° 30·5'	17° 35'	260—210	„	4
19	23. V. 1948.	42° 25·5'	17° 57·5'	276—154	*vase avec traces de sable*	3
20	27. V. 1948.	42° 09·5'	18° 22'	377—305	*vase*	6
21	3. VI. 1948.	40° 28·5'	19° 09'	356—217	„	1
22	4. VI. 1948.	40° 08·5'	19° 32.5'	236—536	*vase avec traces de sable*	1
23	10. VI. 1948.	40° 43·5'	19° 03'	172—148	„	3
24	13. VI. 1948.	41° 07'	18° 50·5'	266—110	*vase avec un peu de gros sable*	3
25	14. VI. 1948.	41° 21'	18° 49·5'	360—404	*vase mélangée à un peu de sable*	29
26	17. VI. 1948.	41° 39·5'	18° 48·5'	196—155	„	4
27	22. VI. 1948.	42° 31.5'	17° 18·5'	225—183	„	2
28	21. VII. 1948.	42° 46·5'	15° 12'	172—186	*vase*	1
29	„	42° 54·5'	15° 03·5'	186—225	*vate mélangée à un pen de sable*	1
30	22. VII. 1948.	43° 14'	15° 12·5'	216—261	*vase*	2
31	„	43° 09'	15° 10'	260—256	„	12
32	26. VII. 1948.	43° 25·5'	15° 27·5'	199—186	*vase*	2
33	30. VII. 1948.	43° 27'	15° 46'	157—137	„	1	1,57
34	1. VIII. 1948.	42° 45·5'	15° 44'	161—153	„	1	
35	2. VIII. 1948.	43° 00'	15° 27·5'	170—186	*vase mélangée à un peu de sable*	5	
B) Seconde croisière — B) Drugo krstarenje							
36	29. VIII. 1948.	42° 49·5'	15° 23·5'	176—188	*vase*	8	5
37	„	42° 58'	15° 15·5'	210—238	„	3	6
38	„	43° 03·5'	15° 07·5'	256—241	„	3	9
39	7. IX. 1948.	43° 35'	15° 32'	208—199	„	3	
40	8. IX. 1948.	43° 24·5'	15° 17'	220—210	„	11	
41	14. IX. 1948.	42° 49'	15° 55'	156—81	*vase mélangée d' un peu de sable*	1	
42	„	42° 42'	16° 02·5'	167—168	„	5	11
43	9. XI. 1948.	42° 43'	16° 36'	130—149	„	2	
44	13. XI. 1948.	42° 38·5'	16° 47'	150—144	*vase*	2	17
45	15. XI. 1948.	42° 33·5'	16° 11'	170—174	„	11	12
46	„	42° 31'	16° 25·5'	186—175	„	6	15
47	21. XI. 1948.	42° 30·5'	17° 35'	219—254	„	16	18
48	„	42° 31·5'	17° 18'	235—197	*vase mélangée d' un peu de sable*	10	27
49	22. XI. 1948.	42° 41'	17° 17'	128—144	*vase*	1	
50	„	42° 35·5'	17° 26'	164—201	*vase mélangée d' un peu de sable*	6	
51	24. XI. 1948.	42° 36'	17° 57'	125—174	*vase mélangée à un peu de sable*	5	
52	„	42° 33'	17° 46'	190—141	*vase avec traces de sable*	4	
53	28. XI. 1948.	42° 25·5'	17° 57'	276—170	„	7	19
54	11. XII. 1948.	42° 09·5'	18° 22'	333—258	*vase*	1	20
55	22. XII. 1948.	42° 53'	16° 05'	144—137	*vase avec traces de sable*	1	
56	8. I. 1949.	42° 45·5'	15° 44'	161—155	*vase*	9	34
57	9. II. 1949.	43° 27'	15° 46'	152—163	„	1	1,33
58	22. II. 1949.	43° 07·5'	15° 20'	170—196	„	1	
59	10. III. 1949.	43° 25·5'	15° 27·5'	199—192	„	1	32
60	29. III. 1949.	42° 54·5'	15° 03·5'	202—230	*vase mélangée à un peu de sable*	4	29
61	31. III. 1949.	42° 46·5'	15° 12'	158—177	*vase*	2	28
62	„	43° 14'	15° 12·5'	123—216	„	2	30

Voir encore pêche précédente, No. d' ordre