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189

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by

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INTRODUCTION

The purpose of these investigations was to determine the amount of fat present in the tissues of the sardine (*Clupea pilchardus* Walb.), in relation to the length, sex, and the stage of maturity of this clupeid species, as well as to supply information on the variation of fat content during the fishing season.

These investigations were carried out on samples of fish collected during the 1949 fishing season, within the period from May 5th to October 26 th. As the sardine fishing in the Adriatic extends, in its major part, during the darks of the moon, and mainly from April to October, the fish used for these investigations were caught in these intervals.

The investigated samples derived from the Mid- and South-Dalmatian regions respectively. The following regions were involved: Kaštela Bay, Poljica Littoral, Split Channel (coast of Brač Island), Hvar Channel (coast of Hvar Island), Pakleni, Vis, Biševo, and Mljet Islands. The localities where the samples were taken are shown on the map placed at the end of this report.

METHODS

1. Collection of Samples

The samples used for analysis of fat content in the sardine tissues were taken from the fishermen's catches. From every catch 100 or more individuals were taken and their total length (including the caudal fin) measured.

Each sample was divided into two groups, one including the individuals the total length of which varied from 12 to 16 cm, and the other consisting of specimens exceeding the length of 16 cm. It was not necessary to put an upper limit for the latter group, the maximal length of the sardine found during these measurements being 189 mm. From every group 6 individuals were taken without selection. These samples were used to establish the relationship between the length and the fat content of the fish.

When dealing with sardine samples intended for obtaining an eventually existing relation between the sex and the fat content, the total length of the individuals and their sex were determined. From the measured fish of a definite length 6 males and 6 females were taken for the purpose of the analysis of the fat content in the tissues.

The condition of the gonads was established with every sample. This was achieved by application of the Hjort scale for the determination of the degree of ripeness of the herring gonads, as adapted by Le Gall (1930), Belloc and Desbrosses (1930), and Furnestin (1939—1943), for the sardine investigation¹⁾. All fish, involved in the samples for fat analysis investigated from May 18th to August 24th inclusively, showed the I and II degrees of maturity.

2. Preparation of Samples for Analysis

Scales, head, tail, gut, and vertebral column were removed from every specimen. The superfluous water and dirt were taken away by means of a cloth. The fillets, prepared in this way, hermetically closed in glass bottles for conservation, were boiled in water for two hours for the purpose of sterilization, because the estimate of fat content was to be carried out later in the laboratory, and not immediately on board. The favourable side of this proceeding consisted therein that it facilitated the homogenization of material prepared for the analysis.

Before starting the analysis, the contents of each conservation bottle were well shaken in the bottle itself in order to avoid waste of fat, which is likely to stick at the wall of the container, and then placed

¹⁾ The degrees I and II indicate the gonads reduced to minimum, the degree VI denotes the ejection of ripe sexual products.

to dry in the drier at a temperature of 80° C to reach the constant weight. Thereupon the dried substance was crushed in the mortar to powder and put into small glass bottles which were then well closed. In this way the samples were prepared for the analysis.

3. *The Analysis*

Two methods were applied at the same time to determine the fat content of each sardine sample, the method of Soxhlet extraction, and the adapted Soxhlet method for serial fat estimation as described by Wimpenny (1938), and from the values resulting by applying both methods we obtained our averages.

The analysis made by the method of Soxhlet extraction was carried out in the following way. A quantity of about 5 g of fish dried up to the constant weight and finely crumbled was exactly weighed in the extraction tube and then extracted by means of ethyl-ether in the Soxhlet apparatus in the course of 24 hours. Upon the evaporation of the ether, favoured by a water bath, the extracted fat was dried at a temperature of 80° C to reach the constant weight.

The method of Soxhlet extraction, being found unfit for serial investigations owing to its taking too much time and requiring considerable quantities of solvent and of material for investigation, the application of another method was at the same time practised. The other method, originated by Meig for the purpose of estimating the fat in the milk, was adapted by Wimpenny to serve the serial estimation of fat content in herring. The applicability of this latter method to the serial estimation of fat content in sardine tissues has thus been tested in the course of these investigations.

The essential difference between the two methods consists therein that by the method of Soxhlet extraction the fat content is being directly established when the extraction has taken place and upon the evaporation of the ether, by weighing the substance in the container, whilst according to Wimpenny the fat content results from the difference between the two weights of the analyzed substance, i. e. before and after the extraction.

Whilst investigating the fat content in the sardine tissues, the Soxhlet method as adapted by Wimpenny has been slightly supplemented. The tubes, containing the material for extraction by this method, were formerly stopped at the bottom with glass wool only.

It happened then that tiny particles of the material passed through the layer of glass wool at the bottom or floated up running over the upper opening of the tube. By using two layers of cotton and one layer of glass wool between them at the bottom of the tube, and some cotton again atop of the material, that occurrence has been eliminated. Before it was used, the cotton was subjected to extraction by means of ethyl ether.

The glass extraction tubes, used for these analyses, measured 7—9 cm in length and 8—10 mm in diameter (Fig. 1). The bottom

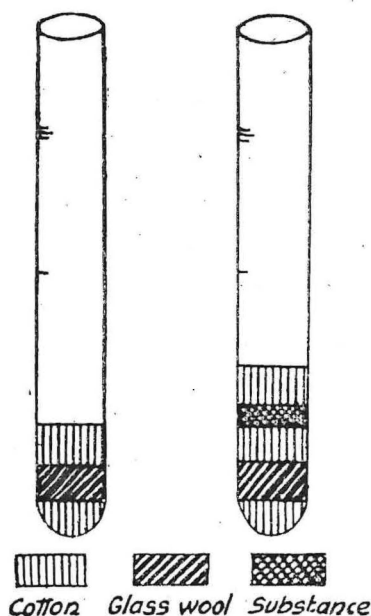


Fig. 1 — Preparation of the glass tubes for extraction.
On the left: the tube stopped on the bottom with layers of cotton, glass wool, and once more cotton.
On the right: the same tube filled with the substance and covered with cotton.

of the tubes, closed by melting, had a hole measuring 2—3 mm in diameter, and was stopped with a layer of pure cotton, then with a layer of glass wool finely ground in a mortar, and over it was placed another layer of cotton. Each of these layers was about 0.5 cm thick. The tube prepared in this way was then dried in the drier at a temperature of 80° C during 48 hours, and thereupon weighed together

with the cotton serving to close the contents of the tube. Next came the material — a quantity of 0.2 to 0.5 g exactly weighed — being put into the tube and stopped with the mentioned piece of cotton. The tubes were tied together in sheaves comprising 6 or more pieces, their number depending on the size of the central part of the Soxhlet apparatus, and then they were put into that part of the apparatus (Fig. 2). After the extraction had taken place in the course of 24

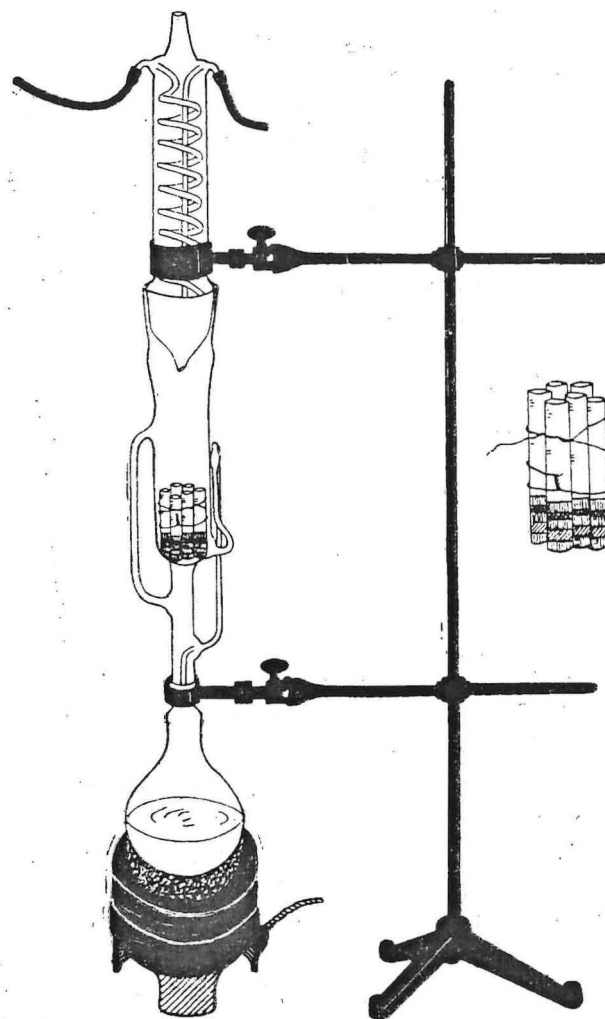


Fig. 2 — Six tubes being extracted at the same time by the Soxhlet apparatus.

hours, the tubes were again dried for 48 hours at a temperature of 80° C and then reweighed.

During the drying of tubes after the extraction had taken place, the rapid evaporation of ether may cause the contents to escape over the top of the tubes. This was avoided by previously drying the tubes at the temperature of the room.

The difference resulting between the second weighing, i. e. of the tubes before the extraction, and the third one, i. e. of the tubes after the extraction, shows the quantity of the extracted fat, which is then expressed in percentage with regard to the weight of the material weighed, that is to the weight of the material dried to the constant weight.

The results obtained by means of both methods were in mutual agreement. The highest difference in the amount of the extracted fat amounted to 0.2 %.

It is necessary to point out that the data resulting from the analyses made to estimate the amount of fat present in the sardine tissues, which are dealt with in the text, as well as in the tables, and in the graphs of this paper, refer to fat contained in 100 g of completely dried material.

DISCUSSION OF RESULTS

1. The Fat Content in Relation to the Length of Fish

The results of the investigation into the fat content in the sardine tissues of the two length groups are shown in Table I. As evident therefrom, the amounts of fat established in the tissues of each of the two groups differ between themselves. In most cases the fat content was found to be higher in fish having a total length of 16 cm upwards than in fish measuring from 12 to 16 cm. This difference was most probably caused by the more intensive growth of smaller fish. Observations made with other kinds of fish resulted in analogous condition with regard to fat content.

The investigations into the Atlantic sardine, carried out by F a g e (1920), resulted in considerable differences between the fat contents in the tissues of the one year old fish and of the individuals beyond that age. The former showed a very low fat content in the tissues in comparison with the latter.

TABLE I. — The Results of the Analysis of Fat Content in 100 g of Dried Substance with Regard to the Length of Fish

Locality	Date	Fat Content of Length Groups		Difference	Average	Mean Value of the Length (Whole Sample)
		≤ 16 cm	> 16 cm			
Vis I. (north-west coast)	5. V. 1949	21.1	17.1	— 4.0	19.1	15.9
Pakleni Is.	18. V. 1949	27.3	32.1	+ 4.8	29.7	15.5
Biševo I.	20. V. 1949	29.6	33.8	+ 4.2	31.7	16.3
Vis I. (north coast)	23. V. 1949	25.2	28.8	+ 3.6	27.0	15.8
Mljet I. (north-west section)	30. V. 1949	23.3	33.1	+ 9.8	28.2	16.5
Vis I. (south coast)	22. VI. 1949	38.9	44.5	+ 5.6	41.7	16.3
Hvar I. (north-west section)	15. VII. 1949	16.8	29.7	+ 12.9	23.3	15.3
Vis I. (north-west coast)	16. VII. 1949	39.2	42.1	+ 2.9	40.7	15.8
Hvar I. (north coast)	25. VII. 1949	27.1	33.1	+ 6.0	30.1	15.4
Poljica Lit.	30. VII. 1949	29.7	36.3	+ 6.6	33.0	15.0
Pakleni Is.	22. VIII. 1949	42.5	48.6	+ 6.1	45.6	16.2
Vis I. (north coast)	24. VIII. 1949	41.6	44.5	+ 2.9	43.1	16.4
Hvar I. (north-west section)	28. IX. 1949	45.5	42.0	— 3.5	43.8	16.4
Vis I. (north coast)	29. IX. 1949	42.0	45.9	+ 3.9	44.0	16.7
Brač I. (west section)	13. X. 1949	37.2	44.3	+ 7.1	40.8	16.2
Brač I. (west section)	26. X. 1949	26.7	35.1	+ 8.4	30.9	14.7

Furnestin (1939—1943) found a relatively low fat content in the immature Gascony Bay sardine in comparison with the amount of fat shown by the two years old individuals.

As evident from Table I, there were two cases where the fat content was found to be higher in the group of smaller individuals. It was possible to explain one of these cases in the paragraph dealing with the influence of sex and the stage of maturity upon the fat content.

The differences of value of the fat content between our two length groups were insignificant in some cases, but sometimes considerable. The greatest difference noticed amounted to 12.9.

2. Variation of Fat Content during the Fishing Season

Table I shows the mean values of fat content in the sardine tissues, computed for both groups. We notice that they vary in a wide range. The lowest mean value amounted to 19.1, and the highest one to 45.6. Some irregularity in the variation of fat content during the fishing season was found. Respectively low values of fat content resulted from samples taken from the May catches, whilst the highest ones were yielded by the samples taken from the August and September catches.

The computed mean value of fat content resulting from samples taken from the May catches amounted to 27.3, whilst the August and September samples yielded 44.1 (tab. II). This fact might be of interest to fish cannig industry. The low fat content in the sardine tissues of the samples taken from the May catches was probably due, in the first place, to the just terminated sexual activity. It is necessary to mention that the spawning of sardine in the region of the Mid-Dalmatian islands takes place in the late fall and in winter (Gamulin, 1948).

TABLE II. — The Monthly Values of Fat Content in 100 g of Dried Substance

Month	Fat Content of Length Groups		Difference	Average
	< 16 cm	> 16 cm		
May	25.3	28.9	3.6	27.1
June	38.9	44.5	5.6	41.7
July	32.0	37.2	5.2	34.6
August	42.1	46.5	4.4	44.3
Septembre	43.8	44.0	0.2	43.9
October	31.9	39.7	7.8	35.8
Average	35.7	40.2	4.5	37.9

Some deterioration of quality during the spawning season or immediately afterwards was observed on several kinds of fish. By analyzing the relation between the weight and the length of individuals Clark (1928) found a decrease of fat content in the California sardine (*Sardinops caerulea*), exceeding 200 mm in length, to take place from January to May. This author revealed the correlation between the variations of the weight-length relationship and the variations of fat content in this clupeid species. During the same time interval Clark was able to observe an increase of fat content in specimens not exceeding 200 mm in length. The spawning season of the California sardine lasts from January to June, reaching its maximal intensity in April and May (Hart, 1938).

In Furnestin's opinion (1939—1943), on the contrary, the accumulation of fat in the Atlantic sardine is dependent, in the first place, upon the hydrologic factors responsible for the distribution of plankton. According to this author, the cause of the decrease of fat content in the sardine is to be sought in the decreasing quantities of zooplankton and in the decreasing temperature during the January—March period. The same author also maintains that the fat quantity was more due to the influence of the feeding conditions than of the physiologic state of fish, and that, consequently, the decrease of fat content in the winter months and the sexual maturing of sardine have no causal connexion but represent a mere coincidence.

The analyses carried out with the samples deriving from the May catches show that the regaining of fat in the tissues of Adriatic sardine took place in May. No analyses as to fat content were, however, made with specimens belonging to the April catches. It seems that the regaining of fat found place in a relatively short time, as it may be judged from the fat content recorded in the sardine sample of June 22nd.

A sudden accumulation of fat after the termination of the sexual activity and of the growth period was found in the Cornish pilchard by Hickling (1945).

The approximate estimate of the periintestinal fat — according to the empiric scale of five degrees (Le Gall, 1930) — made during the comparative biometrical analyses of samples of the Adriatic sardine catches, generally agreed with the chemical estimate of fat content in the tissues. The lowest mean values of the periintestinal fat in sardine were found in May. The increase of this fat was possible to

follow during that month. The highest mean values of the periintestinal fat were recorded in August. A certain decrease of this fat was manifest in September, the fat content of the tissues remaining unaltered. It is not unlikely, therefore, that the consumption of the stored up fat goes at the expense of periintestinal fat in the first place and only then of the fat in the tissues.

Fage (1920) observed that the accumulation of periintestinal fat in the Mediterranean sardine, after the termination of its sexual activity, began in May. In August, the same author was able to find a considerable fat value in the sardine tissues belonging to individuals of an average length of 150 mm. No analysis as to fat content in the tissues having been made with specimens belonging to July and September catches, it remains unknown whether the recorded fat quantity represents the maximal value for Mediterranean sardine.

The minimal fat content in the Gascony Bay sardine was found by Furnestin (1939—1943) to occur in March; its increase began in April to reach the maximal value in November.

The decrease of fat content in the tissues of the Adriatic sardine during the first half of October was of little importance, as shown by the October 13th sample.

One of the reasons for some irregularity of the variation of fat content during the fishing season, established on the basis of its mean values, may be sought in the different length of the individuals composing our length groups. Thus a group measuring from 12 to 16 cm, will contain more larger individuals, provided the whole catch, from which the sample for the analysis was taken, consisted of fish having a greater total length. The same applies to a group of fish measuring from 16 cm upwards. In order to explain the observed irregularity of the variation of fat content in the tissues during the fishing season, mean values of total length were here applied, these being obtained by measuring a greater number of fish whilst carrying out the parallel biometrical analyses of sardine catches. Those values are shown in the last column of Table I. By mutually comparing the mean values of fat content obtained from the analyses of samples with a similar average total length, a greater regularity of variation of fat content becomes noticeable. The length frequency of the individuals composing a sample from which the material for the analysis had been taken, is, therefore, not irrelevant.

Another reason for the irregularity of variation of fat content might have been the different origin of sardine samples.

The mean values of fat content from Table I have been used for the graphical survey of the variation of fat content during the fishing season. (Fig. 3).

The diagram is based upon the mean monthly values of fat content in the sardine tissues. The concerning data are shown in Table

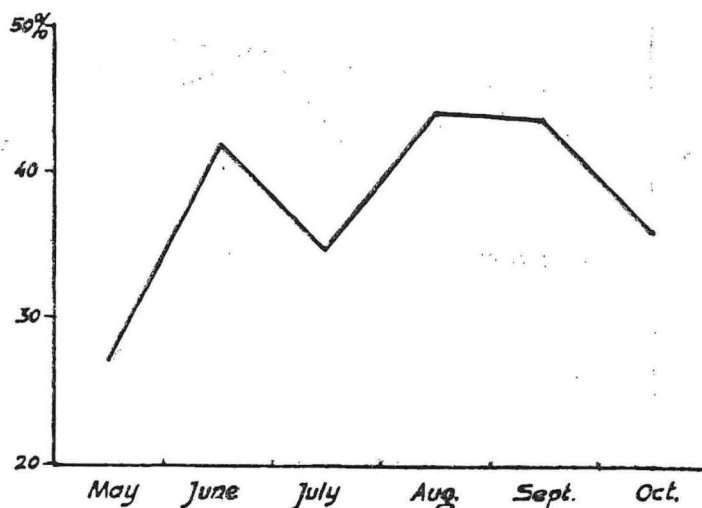


Fig. 3 — Diagram showing the variation of fat content in the sardine tissues during the fishing season.

II. When estimating the mean value of fat content for July, the analysis of July 15th was not taken into consideration, owing to its showing exceptionally low value of fat content. The approximate estimate of periintestinal fat made with the sardine catch sample of July 15th did not show such a low result.

The diagram reveals the minimal fat content of the May sardine samples and the maximal fat value of the August and September ones. It is necessary to point out, however, that the monthly value of fat content for June is based upon the analysis of a single sample. It seems that the low quantity of fat found in the sardine tissues in July is, to some extent, to be explained by the smaller average length of catch samples from which the material for the analysis was taken. It is significant that the decrease of fat content was hardly

noticeable on a sample deriving from the region of Vis Island (July 16th), whilst it was manifest in the highest degree on a sample deriving from the north-west section of Hvar Island (July 15th). The considerable decrease of fat content in October was due to the relatively low mean value of the total length of sardine sample taken on October 26th.

The diagram on Figure 4 is based upon the average monthly

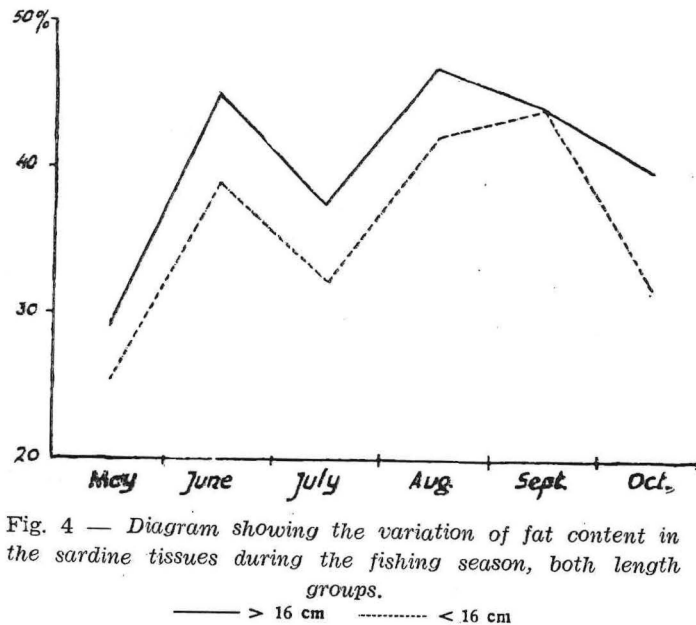


Fig. 4 — Diagram showing the variation of fat content in the sardine tissues during the fishing season, both length groups.

—— > 16 cm - - - - - < 16 cm

values of fat content for each length group of fish separately, that is for the group consisting of individuals of a total length from 12 to 16 cm, and for the other one composed of specimens measuring over 16 cm in length. We notice that the curves follow mainly the similar course. The maximal fat content appeared earlier in the group consisting of larger individuals than in the group composed of smaller ones. In the same way the definite decrease of fat content took place earlier with larger than with smaller fish.

3. The Influence of Sex and the Stage of Maturity upon the Fat Content

The investigation into the fat content in the sardine tissues involved at the same time males and females of the equal total length.

TABLE III. — The Results of the Analysis of Fat Content in 100 g of Dried Substance with Regard to the Sex of Fish

Locality	Date	Length in cms	Fat content		Diffe- rence	Average
			♂ O	♀ +		
Vis I. (north-west coast)	5. V. 1949	15.5-16	18.8	19.7	— 0.9	19.3
Pakleni Is.	18. V. 1949	15.25	24.5	21.9	+ 2.6	23.2
Vis I. (north coast)	23. V. 1949	15.75	30.7	27.9	+ 2.8	29.3
Mljet I. (north-west section)	30. V. 1949	16.75	42.3	35.2	+ 7.1	38.8
Brač I. (north coast)	21. VI. 1949	14.75	36.6	34.4	+ 2.2	35.5
Hvar I. (north-west section)	15. VII. 1949	15.25	20.4	24.3	— 3.9	22.4
Vis I. (north-west coast)	16. VII. 1949	15.75	44.2	39.3	+ 4.9	41.8
Hvar I. (north coast)	25. VII. 1949	15.75	35.4	34.1	+ 1.3	34.8
Poljica Lit.	30. VII. 1949	14.75	30.5	25.8	+ 4.7	28.2
Pakleni Is.	22. VIII. 1949	16.25	46.3	36.3	+ 10.0	41.8
Vis I. (north coast)	24. VIII. 1949	16.25	48.2	41.7	+ 6.5	44.9
Kaštela B.	20. IX. 1949	13.25	11.7	11.6	+ 0.1	11.7
O. Brač I. (west section)	13. X. 1949.	12-16	35.9	38.5	— 2.6	37.2

The results of these analyses are shown in Table III. We learn therefrom that the males and the females of equal total length differed in their fat content. The sardine males usually contained some more fat in the tissues than the females. The difference varied from 0.1 to 10.0. The average difference, involving all the samples with a higher fat content in the tissues of the males, was insignificant, and amounted to 3.8.

It seemed from approximate estimate of periintestinal fat, made during the parallel biometrical analyses of samples taken from the sardine catches, that the males contained more fat than the females.

The smallest difference of fat content in the tissues between the males and females were observed on the September 20th sardine

sample deriving from Kaštela Bay. It is significant that the comparison of the fat content involved here individuals measuring 13.25 cm. This sample contained individuals of the smallest total length in a series of samples used for the parallel analyses of fat content in the males and females of the same length. It is necessary to mention that this sample included individuals which, certainly, did not reach the first sexual maturity.

Three sardine samples, taken on May 5th, July 15th, and October 13th, yielded a reverse relation, that is the females showed a higher fat content in the tissues than the males. Those three samples derived from the period of the minimal fat content, or of its decreasing in the sardine tissues. It should be said here that the stage of sexual ripeness was, for the May 5th sample III, and for the October 13th one III—IV. The stage of ripeness for all the remaining sardine samples, dealt with on Table III, was I—II.

The maximal value of fat content which was possible to establish in the course of these investigations, amounted to 48.2 for males, and 41.7 for females. These data were obtained from the sardine sample of August 24th.

A definite answer to the question whether the stated facts indicate the existence of some difference in fat content between the two sexes at the time of investigation, would be impossible without a previous examination of the amplitude of individual variations as to amount of fat present in the sardine tissues.

Considerable individual differences in the weight - length relationship of California sardine have been found by Clark (1928), which, in his opinion, are not caused by the difference of sex.

According to El Saby (1937), the amount of fat present in the tissues of *Sardinella aurita* and *Sardinella ebba* was not influenced by the difference of sex. This author maintains that the species with a high fat content show considerable individual differences in this respect.

Table III contains also mean values of fat content for both males and females, showing the interdependence between the amount of fat and the length of fish. The maximal mean value of fat content was established for sardine of 16.25 cm total length (sample of August 24th), and the minimal one for sardine of 13.25 cm total length (sample of September 20th). This latter sample yielded an extraordi-

nary low amount of fat present in the tissues, a fact to be explained by the intensive growth of fish of that size.

Analyses made with the individuals of equal total length, caught within a short time interval on different localities, yielded different amounts of fat present in the tissues. This was evident from the samples of July 16th and 25th involving fish of 15.75 cm and fish of 16.25 cm from the samples of August 22nd and 24th. Sardine deriving from the region of Vis Island showed a higher fat content by both comparisons. It follows that fish of equal length, caught within a short time interval on different localities, need not always agree in quality.

Constant local differences as to fat present in young Passamaquoddy herring were found by considering the relationship between the weight and the length of fish (Battle, Huntsman, A. M. Jeffers, G. W. Jeffers, Johnson, Mc Nairn, 1936). This fact lead to the conclusion that there were almost no movements of herring at the time of investigation.

TABLE IV. — The Results of the Analysis of Fat Content in 100 g of Dried Substance of Males and Females in Relation to the Stage of Ripeness

Date	Length in cms	Stage of Ripeness	Fat Content		Diffe- rence	Average
			♂ ○	♀ +		
5. V. 1949	12-16	I-II	20.5	21.6	1.1	21.1
5. V. 1949	15.5-16	III	18.8	19.7	0.9	19.3
5. V. 1949	> 16	IV	16.0	18.2	2.2	17.1
13. X. 1949	12-16	III-IV	35.9	38.5	2.6	37.2

Table IV contains the results obtained by the parallel analysis of fat content in sardine males and females of the same length groups and of the same stage of maturity (sample of May 5th and October 13th). These results show an insignificant overbalance of fat present at that time in the tissues of sardine females in comparison with the males of the same stage of ripeness.

Table IV explains also why a lower amount of fat was present in the group of larger individuals than in the group of smaller ones, both deriving from the sample of May 5th, although the first group included probably more females, which at that time contained more fat in the tissues than the males (Tables I and III). Female sardine does outgrow the male of the same age (Fage, Le Gall 1928, Belloc and Desbrosses, Mužinić S.). The group including larger individuals showed, namely, a more advanced stage of ripeness in comparison with the one consisting of smaller specimens. The influence exercised by the stage of ripeness on the fat content is manifest and so pronounced, that it overweighs the influence of the length and of the eventual sex difference.

Another conclusion follows necessarily from data contained in Table IV. By comparing, namely, the mean values of fat found in fish measuring from 12 to 16 cm belonging to samples of May 5th and October 13th, we see that the October 13th sample shows a by far higher amount of fat at a more advanced stage of ripeness. A state of complete exhaustion is reached by sardine in May, after the termination of its sexual activity, as confirmed by the low fat content in the tissues found in the May 5th sample. It was already mentioned that all the sardine samples taken in May showed a relatively low fat content. The amount of fat was, on the contrary, only insignificantly influenced by the beginning of the sardine ripening. This fact is confirmed by the results obtained from the September 28th and 29th samples, dealt with in Table I. The fat content in the tissues of the individuals contained in these samples was relatively high although their stage of ripeness was III-IV. An insignificant decrease of the amount of the periintestinal fat was found by the biometrical analyses of sardine samples carried out at the same time.

It is maintained by Fage (1920) that the reabsorption of fat by sardine begins as soon as its sexual activity becomes manifest. According to observations made by this author on the Mediterranean sardine, the initial ripening is followed by an insignificant decrease of fat content, as proved by our investigations too.

The reabsorption of the fat reserves by sardine of the west section of the Pyrenean Peninsula — as stated by Ramalho (1933) — begins in October, or even in November, and is followed by a decrease of fish weight and by a gradual development of gonads.

CONCLUSIONS

Basing on investigations dealing with the fat content in the sardine tissues, which were carried out from May to October 1949, with the purpose to establish its relation to the length, sex, and the stage of maturity, as well as to observe the variation of fat content during the fishing season of that clupeid species, the following facts have been recorded:

- 1) During the period of these investigations a somewhat higher amount of fat present in the tissues was generally shown by sardine measuring 16 cm and upwards than by specimens having a total length from 12 to 16 cm.
- 2) The fat content in the sardine tissues varied in a wide range from May to October. The lowest values of this fat could be found in May, and the highest ones in August and September. The minimal amount of fat found in May was probably in connexion with the termination of sexual activity of sardine. The regaining of fat in the tissues could be observed in May, and it took place in a relatively short time. The decrease of the amount of fat present in the sardine tissues in July, as shown by analyses, has not been wholly explained. The fat content in the tissues at the beginning of the sardine ripening was relatively high.
The amount of the periintestinal fat, approximately estimated during the parallel biometrical analyses of sardine catches, showed a similar course in their general features. The highest value of the periintestinal fat could be observed in August, whilst a certain decrease of it was manifest already in September.
- 3) Fish measuring 16 cm and upwards, and those from 12 to 16 cm generally showed a similar course as to the variation of fat content in the tissues during the period extending from May to October. The maximal amount of fat appeared earlier in larger fish than in smaller ones. The same applies also to the definitive decrease of the fat content in the tissues preceding the spawning season.
- 4) Sardine of equal length, caught on different localities during a short time interval, did not show always the same amount of fat present in the tissues.

- 5) During the period of these investigations, the sardine males showed in most cases a somewhat higher fat content in the tissues than the females. The samples yielding a higher amount of fat in females belonged to the time of minimal fat content or of its downward trend. The observed differences between the sexes might, however, have been influenced by the individual variations of fat content.
 - 6) A considerable influence of the advanced stage of maturity (III, IV) on the fat content could be observed in May, that is after the termination of the spawning season. The initial ripening of sardine before the beginning of the spawning season did not notably affect the amount of fat in the tissues and of the periintestinal fat.
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ISTRAŽIVANJE MASTI U TKIVIMA SRDELE
(*CLUPEA PILCHARDUS* WALB.)

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Kratak sadržaj

Izvršena su ispitivanja sadržaja masti u tkivima srdele u odnosu na dužinu, spol i stadij zrelosti, te kolebanja količine masti u toku sezone lova ovog klupeida u 1949. god.

Istraživanja su bila izvršena na srdeli iz područja srednje i južne Dalmacije. Uzorci su potjecali iz vremenskog razmaka od 5. svibnja do 26. listopada.

Mast u tkivima bila je analizirana pomoću dviju metoda uporedo, i to Soxhlet-ove i Soxhlet-ove modificirane po Wimpenny-u. Ova posljednja se kod toga nadopunila. Rezultati, dobijeni putem jedne i druge metode, podudarali su se međusobno.

Rezultati ispitivanja sadržaja masti u tkivima srdele pokazali su, da u vremenu izvan sezone mrijestjenja ribe totalne dužine od 16 cm na više sadrže nešto više masti nego one dužine 12—16 cm.

Zapaženo je kolebanje količine masti u tkivima srdele u širokim granicama od svibnja do listopada. Najniže vrijednosti ove bile su nađene u svibnju, a najviše u kolovozu i rujnu. Vjerovatno je glavni uzrok niskim vrijednostima količine masti kod srdele u svibnju bila iscrpljenost poslije mrijestjenja. Nadoknađivanje masti u tkivima moglo se zapaziti u svibnju, a izvršilo se prilično brzo. Iza porasta količine masti u tkivima u lipnju zapaženo je opadanje iste u srpnju. Početno sazrijevanje srdele prije početka periode mrijestjenja pratio je relativno visok sadržaj masti u tkivima.

Količina periintestinalne masti, koja se određivala aproksimativno prilikom uporednih biometrijskih analiza uzoraka lovina srdele, pokazala je u glavnim crtama sličan tok kolebanja. Međutim, najviši stepen periintestinalne masnoće zapazio se u kolovozu, dok se već u rujnu primijetilo izvjesno opadanje.

Srdele totalne dužine od 16 cm na više i one totalne dužine 12—16 cm pokazale su uglavnom sličan tok kolebanja sadržaja masti u tki-

vima u vremenu od svibnja do listopada. Maksimum količine masti u tkivima i početak definitivnog opadanja ove prije sezone mrijestjenja nastupili su ranije za ribe veće totalne dužine.

Srdele iste dužine, ulovljene u kratkom vremenskom razmaku na različitim mjestima, nisu pokazale uvijek istu količinu masti u tkivima.

U vremenskom razmaku, u kojemu su bila izvršena ispitivanja, mužjaci su sadržavali nešto više masti u tkivima nego ženke. Izuzeci padaju u vrijeme minimalnog sadržaja masti ili opadanje ovog u tkivima srdele. Zapažene razlike između spolova mogle su biti pod utjecajem individualnih varijacija u sadržaju masti kod srdele.



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ИССЛЕДОВАНИЕ ЖИРА В ТКАНЯХ САРДИНКИ
(*CLUPEA PILCHARDUS* WALB.)

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Краткое содержание

В 1949 г. были сделаны исследования содержания жира у сардинки в отношении длины, пола и степени зрелости. Также было исследовано колебание содержания жира в течение сезона ловли этого сельдевого вида в 1949 г.

Исследования были сделаны над сардинкой из пределов средней и южной Далмации. Пробы были из периода времени от 5 мая до 26 октября.

Жир в тканях был исследован при помощи двух методов одновременно, именно по методу Сокслета и по методу Вимпенни, который является изменённым методом Сокслета. Этот последний метод был ещё при этом и дополнен. Результаты, полученные при помощи одного и другого метода, были тождественны.

Результаты исследования содержания жира в тканях сардинки тотальной длиной в 16 см и больше показали, что вне времени икрометания содержится у них немного больше жира чем у сардинок длиной 12—16 см.

Было замечено колебание количества жира в тканях сардинки в широких границах от мая до октября. Самое меньшее количество его было найдено в мае, а самое большее в августе и сентябре. Изнурение после икрометания было, вероятно, причиной маленького количества жира у сардинки в мае. Возмещение жира в тканях можно было заметить в мае, а произошло оно сравнительно быстро. После увеличения количества жира в тканях в июне, замечено его уменьшение в июле. Начальное созревание сардинки до начала периода нереста сопровождалось относительно высоким содержанием жира в тканях.

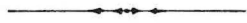
Количество перинтестинального жира, которое определялось приблизительно во время одновременных биометрических анализов.

проб уловов сардинок, показало, главным образом, аналогичное колебание. Между тем самая высокая степень периинтестинальной жирности была замечена в августе, тогда как уже в сентябре замечено известное её уменьшение.

Сардинки тотальной длиной в 16 см и больше и длиной 12—16 см показали, главным образом, аналогичное колебание содержания жира в тканях в период времени от мая до октября. Максимум количества жира в тканях и начало окончательного его уменьшения до сезона нереста наступили раньше у рыб большей тотальной длины.

Сардинки одной и той-же длины из различных мест, пойманные в коротком периоде времени, не всегда показали одинаковое количество жира в тканях.

В периоде времени, в котором были сделаны исследования, у самцов было немного больше жира в тканях, нежели у самок. Исключения появляются во время минимального содержания жира или его уменьшения в тканях сардинки. Разница замеченная у полов могла быть под влиянием индивидуальных различий в содержании жира у сардинки.



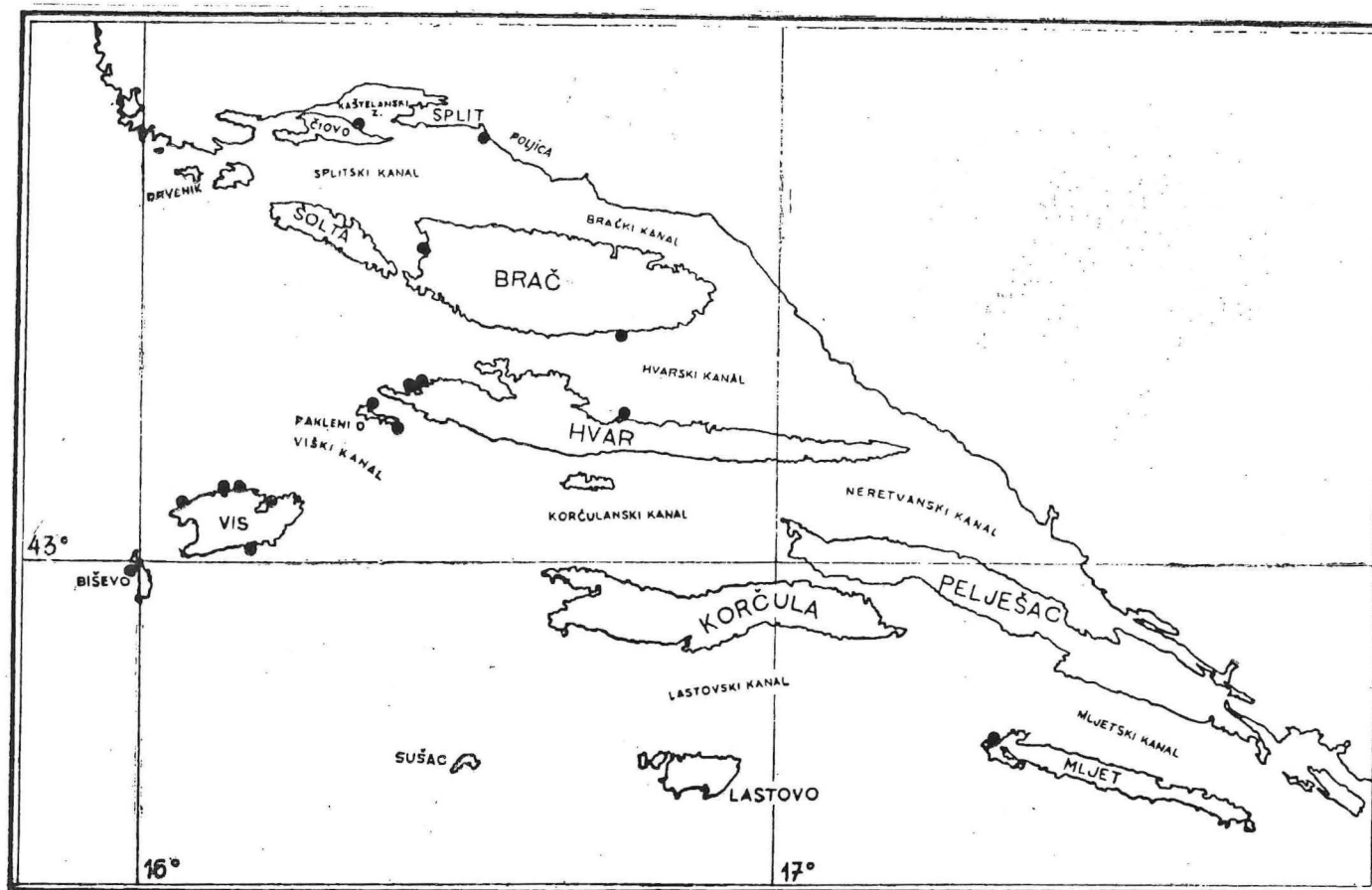


Fig. 5 — The localities where the samples were taken for analysis are shown by black discs.