

ON SPECIES COMPOSITION AND LENGTH CHARACTERISTICS IN MIXED SPECIES CATCHES OF PELAGIC FISHES IN THE ADRIATIC

O SASTAVU I DUŽINSKIM KARAKTERISTIKAMA MIJEŠANIH LOVINA
PELAGIJSKIH RIBA U JADRANU

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INTRODUCTION

In the purse and shore seines catches carried out by use of light in the Adriatic the sardine (*Sardina pilchardus* /Walb./) often appear more or less mixed with other pelagic and/or semipelagic fish species. Mixed species also occur in the trawl catches. Such mixing has not been thoroughly studied. For this reason some mixed species samples of purse seine catches taken by use of light in the eastern central Adriatic were analysed as to the species and size composition. Some bottom trawl catches made in the open Adriatic were also studied from this point of view.

An attempt was also made to deduce information on grouping behaviour from both the composition of mixed species samples and catches of pelagic fishes and the observations on grouping behaviour of pelagic fish in aquarium.

1. MATERIAL AND METHODS

44 mixed species samples of commercial catches containing sardine obtained by purse seine and light were used in the study of the species composition and 37 of them for size composition (in some samples the numbers were too small or the size data were not available). The catches were taken in Kaštela Bay, i. e. in shallow waters (not exceeding 46 m), mostly during the fishing season (warmer part of the year) of the 1969—1974 period.

Experimental bottom trawl catches (only occasionally samples) containing mixed pelagic fish were taken during the »Hvar« Fishery Biological Expedition, in 1948 and 1949, almost exclusively in the open, especially central and southern Adriatic up to 400 m depth (the maximum trawling depth reached 382 m and the mean trawling depth 125 m) (Karlovac, O., unpublished data), in shallower waters of the Mid-Dalmatian channels, in 1957 and 1958 (Županović, 1961), and in some parts of the central and southern Adriatic, in the 1954—1955 trawling season (Mužinić, 1956). In all, 102 experimental bottom trawl catches containing mixed pelagic fish were analysed. Some of them included small numbers of individuals.

The length data refer to total length of the fish. In the »Hvar« Expedition catches only the largest and the smallest lengths in cm were recorded and in the fish from the Mid-Dalmatian channels the lengths were not taken. In Tables 3a and c, and in Figures 2.2.2.1 and 3.2.2 referring to bottom trawl catches lower class limits were used.

2. OBSERVATIONAL DATA

2.1. SPECIES COMPOSITION

2.1.1. Samples of catches by light

Data on species composition for the 44 mixed species samples of purse seine catches containing sardine taken in the Kaštela Bay, in the 1969—1974 period, are given in Appendix Table 1. The presence of horse mackerel (*Trachurus* sp.) (semipelagic species) was recorded only from the late 1970 fishing season. Some samples from 1969 and some more from 1970 might, therefore, have contained horse mackerel, but their numbers could have been very small.

The samples usually contained both sardine (*Sardina pilchardus* Walb.) and anchovy (*Engraulis encrasicolus* L.). The numerical proportions of sardine in the analysed samples widely varied. In the 1971—1974 period they ranged from 15.2 to 97.8%, often exceeding 50%. The proportions of anchovy were also very variable. In the same period they ranged from 0.4 to 84.8%, but mostly did not reach 50%. In only a few samples were no anchovy present.

The proportions of sardine in the mixed species samples, from the 1971—1974 period, were similar to each other in 1971, 1973 and 1974, amounting to 57.3, 59.0 and 53.9%; in 1972 this proportion was rather high and reached 73.3%. The proportions of anchovy were higher in 1973 and 1974 (41.0 and 45.2%) than in two previous years (26.9 and 26.6%).

Gilt sardine (*Sardinella aurita* Val.) were recorded only in the 1974 fishing season, mixed with the sardine and anchovy, but their proportions were small.

Horse mackerel occurred in nearly all the sardine samples from the 1971 fishing season, although in variable proportions. In the samples containing *Trachurus* species anchovy were mostly not present.

Bogue (*Boops boops* L.) (semipelagic species) were also sometimes recorded in the samples, mostly in addition to anchovy.

2.1.2. Bottom trawl catches

From bottom trawl catches only sardine, anchovy, mackerel (*Scomber scombrus* L.), Spanish mackerel (*Scomber japonicus* Houtt.) and to some extent (from two series of catches) sprat (*Sprattus sprattus* L.) were used (App. Table 2).

»Hvar« Fishery Biological Expedition, 1948 and 1949

Out of a total of 130 trawl catches including pelagic fish made during the »Hvar« Fishery Biological Expedition, in 1948 and 1949, 52 (40%) contained more than one of the studied species (from the unpublished data of O. Karlovac) (App. Tables 2 and 3a). In 41 (78.8%) out of these 52 catches two pelagic species were recorded and in the remaining 11 (21.2%) three species occurred. Sardine (alone or with another of the studied species) rarely appeared with anchovy (in 8 out of the 41 sardine catches) and more frequently with mackerel (in 17 catches). Anchovy were even more frequently recorded with mackerel (in 23 out of the 39 anchovy catches). Sprat often appeared with anchovy or mackerel (in 10 and 9 out of the 16 sprat catches respectively). All the three catches with Spanish mackerel also contained mackerel.

In the remaining 78 (60%) »Hvar« Expedition trawl catches with pelagic fish containing only one species mackerel was the most frequent species (in 53 out of the 94 mackerel catches); sardine occurred less frequently (in 18 out of the 41 sardine catches); anchovy was rarely found alone (in 7 out of the 39 anchovy catches) and sprat never.

Out of the 11 »Hvar« trawl catches including three species 9 were carried out off the Dugi otok Island, within the 150 m line. In addition to anchovy and mackerel, they mainly contained either sardine or sprat.

The »Hvar« catches containing the studied pelagic fishes mixed were generally small. Out of the 52 such catches 40 contained less than 20 individuals and only 6 more than 50 (App. Table 3a). In these 6 catches one species highly dominated (77.3—99.7%). In three out of them mackerel were dominating by more than 95%.

Mid-Dalmatian channels, 1957 and 1958

Out of the 57 trawl catches with pelagic fish carried out in the Mid-Dalmatian channels, in 1957 and 1958, 29 (50.9%) contained two or more pelagic species (App. Tables 2 and 3b) (from the data of Županović, 1961). In these mixed catches sardine (alone or with another of the studied species) appeared more often with anchovy (in 14 out of the 25 sardine catches) than in the »Hvar« Expedition trawl catches (in 8 out of the 41 sardine catches). Catches with more than two pelagic species were relatively frequent (11 out of the 29 mixed catches).

Out of the 29 catches from the Mid-Dalmatian channels containing mixed pelagic fishes 14 were recorded in the eastern Neretva Channel and in the Mali Ston Channel (shallow waters not exceeding 41 m — nursery ground or its close vicinity), although only 23 out of the 126 trawl catches in all (18.3%) were carried out in these waters. In 9 out of the 14 mixed catches carried out there three (7 catches) or four species (2 catches) were found, this pointing to high overlapping of the horizontal distribution of the studied species in these waters. Out of the 14 catches 11 contained sardine and anchovy, and in 6 out of these mackerel also appeared.

In the remaining 28 (49.1%) catches from the Mid-Dalmatian channels containing pelagic fish sprat alone were the most frequent (in 11 out of the 27 sprat catches) and anchovy the rarest (in only 4 out of the 24 anchovy catches).

The 29 trawl catches from the Mid-Dalmatian channels containing the studied pelagic fishes mixed were mostly larger than those from the »Hvar« Expedition area. Only 12 contained less than 20 and 13 more than 50 individuals (in 10 out of these 13 the numbers exceeded 100 and in 3 they exceeded 1,000) (App. Table 3b). In the 13 catches with numbers exceeding 50 one species mostly highly dominated (71.5—100.0% with two exceptions: 57.7 and 63.6%). Sprat was the most frequent dominating species (in 7 catches) and anchovy the rarest (in 2 catches).

Central and southern Adriatic, the 1954—1955 trawling season

Out of the 35 experimental trawl catches carried out in some parts of the central and southern Adriatic, in the 1954—1955 trawling season, including pelagic fish, 19 (54.3%) contained two or three pelagic fish species (App. Tables 2 and 3c) (Mužinić, 1956).*) In these catches sardine occurred most frequently with anchovy alone (in 9 out of the 27 sardine catches) and more rarely with mackerel alone (in 4 catches). Out of the 19 catches with more than one pelagic species four contained all the three species.

In the remaining 16 (45.7%) catches from the central and southern Adriatic sardine occurred most frequently alone (in 10 catches) and anchovy never.

The catches of the mixed pelagic fishes obtained in the central and southern Adriatic, in the 1954—1955 trawling season, were generally large. Small numbers were much rarer than in the »Hvar« Expedition catches and rarer than in those from the Mid-Dalmatian channels. Out of the 19 catches only 6 contained less than 20 individuals and 8 more than 50 individuals (App. Table 3c).** In 7 out of these 8 catches sardine were dominant by proportions ranging from 56.7 to 88.5%.

2.2. LENGTH CHARACTERISTICS

2.2.1. *Samples of catches by light*

The data on length of the fish from samples of the mixed pelagic fish catches by light from the Kaštela Bay, from the 1969—1974 period, are shown in the Appendix Table 4. The species represented by small numbers (< 10 individuals) from the Appendix Table 1 were left out when pooling the length data. For some samples of mixed pelagic fish catches or their component species length data were not available.

Length data for component species themselves are shown in the Appendix Tables 5a-d.

*) The number of mixed catches would probably be greater if sprat were analysed.

**) One of the mixed catches from the Palagruž Island area contained a few hundred kilograms mackerel. Such mackerel catches were sometimes taken in that area and also contained horse mackerel and bogue.

In Figures 2.2.1.1a-f length distributions for mixed samples are shown and in Figures 2.2.1.2a-f those of the component species. The distributions of species represented by small numbers (< 10 individuals) were left out and those of species represented by numbers ranging from 10 to 39 are given by thin lines.

Length range

The individual lengths of fish from all the mixed species samples of catches obtained by light ranged from 7.6 to 20.3 cm (App. Table 4). The lengths of component species ranged as follows: in sardine from 7.6 to 19.2 cm, in anchovy from 7.6 to 16.9 cm, in horse mackerel from 12.2 to 20.3 cm and in bogue from 8.2 to 17.5 cm (App. Tables 5a-d).

The length ranges in the individual samples of mixed species catches by light varied from 3.0 to 10.5 cm, but mostly from 5.0 to 8.7 cm (in one sample the range was taken from half-centimeter data) (App. Table 4). The widest length ranges were recorded in 1971, 1974 and 1970.

The length ranges of the component species were mostly smaller than those of the mixed samples (App. Tables 5a-d). In sardine, they varied from 2.8 to 7.5 cm with two exceptions (10.2 and 10.5 cm), but mostly from 3.5 to 4.8 cm; in anchovy, they varied from 1.6 to 7.9 cm and had a more dispersed distribution than in sardine.

The yearly range of individual lengths varied in sardine much more than in anchovy, i. e. from 5.7 (1973) to 11.0 cm (1971) (the ranges for 1970 and 1974 were also wide: 10.8 and 10.5 cm respectively) and in anchovy from 5.3 (1972) to 8.1 cm (1969).

Mean length

A rather wide range of mean lengths was recorded in the mixed species samples of catches obtained by light, i. e. from 10.9 to 17.6 cm (App. Table 4). It was the same with the mean lengths of both the sardine and anchovy from the mixed samples which ranged from 10.6 to 17.6 cm and from 9.3 to 15.7 cm respectively (App. Tables 5a and b). In the horse mackerel mostly rather large mean lengths were recorded (17.1—17.6 cm with one exception of 14.5 cm) and in the bogue only small ones (10.4, 10.2 and 12.9 cm) (App. Tables 5c and d).

With very few exceptions the mean lengths of sardine were larger than the mean lengths of anchovy from the same mixed samples.

However, the size of mixed fish, as well as that of component species varied from one year to the other. The largest mean lengths in sardine were recorded in 1971 and the largest mean lengths of anchovy in 1972.

Length distribution

Only a few samples of mixed catches obtained by light showed symmetrical length distributions (Figs. 2.2.1.1a-f). In some samples, besides the dominating mode, another more or less marked mode appeared.

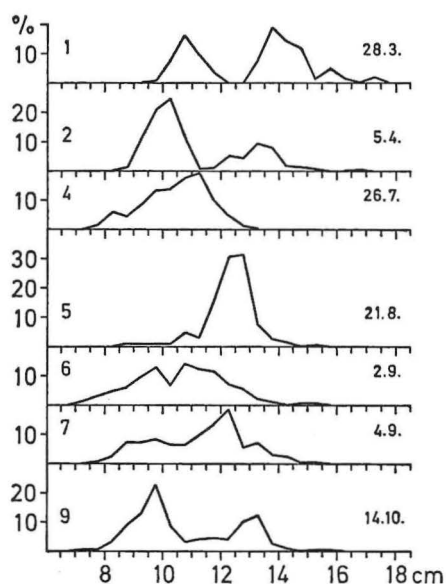


Fig. 2.2.1.1a. Length distribution of fish in mixed samples of catches by light from Kaštela Bay, 1969

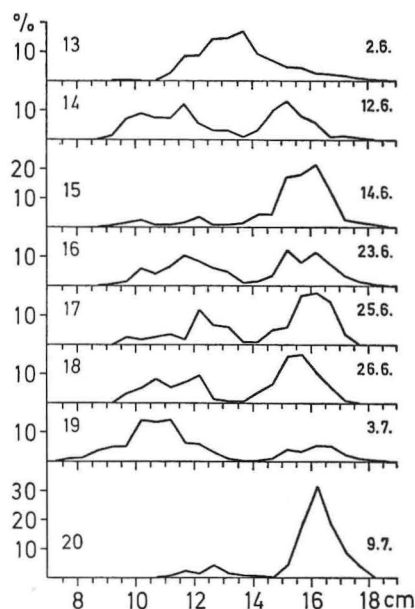


Fig. 2.2.1.1b. Length distribution of fish in mixed samples of catches by light from Kaštela Bay, 1970

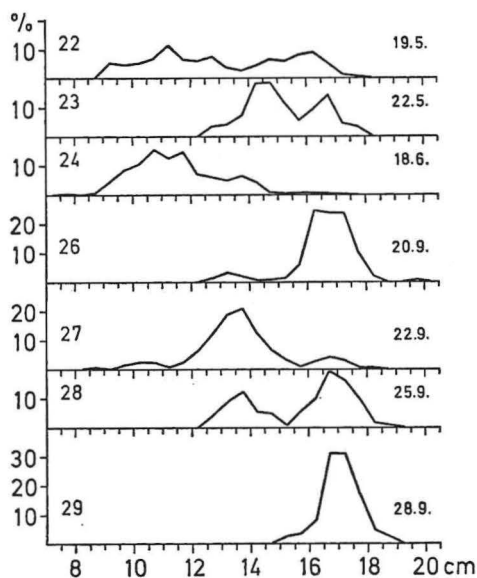


Fig. 2.2.1.1c. Length distribution of fish in mixed samples of catches by light from Kaštela Bay, 1971

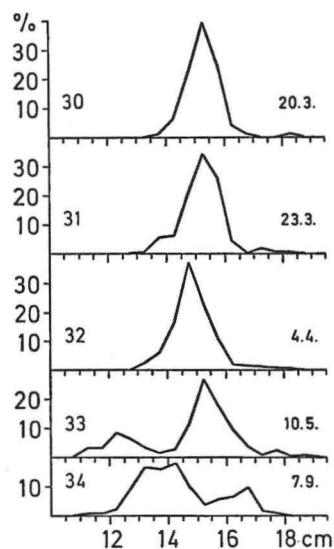


Fig. 2.2.1.1d. Length distribution of fish in mixed samples of catches by light from Kaštela Bay, 1972

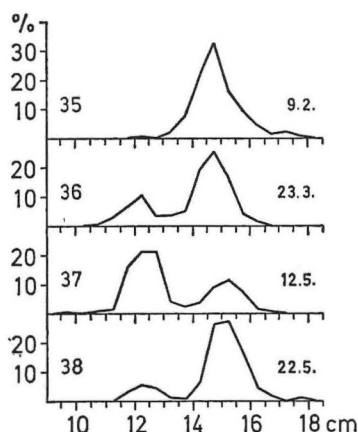


Fig. 2.2.1.1e. Length distribution of fish in mixed samples of catches by light from Kaštela Bay, 1973

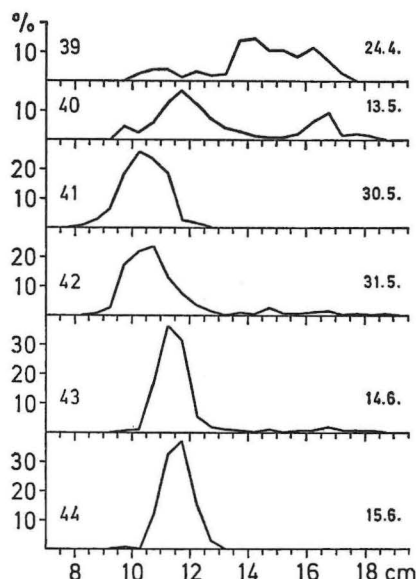


Fig. 2.2.1.1f. Length distribution of fish in mixed samples of catches by light from Kaštela Bay, 1974

Component species from only some samples were similar to each other by their mean and modal lengths; in some other samples marked differences were recorded between the species (Figs. 2.2.1.2a-f).

Sardine and anchovy from mixed samples showed various degrees of overlapping in the length distribution, from none or insignificant to a nearly complete overlapping (Figs. 2.2.1.2a-f). The length distribution of sardine and horse mackerel (*Trachurus* sp.) in the samples Nos. 26 and 29 highly overlapped, but in the samples Nos. 24 and 28 the length distributions largely differed (Fig. 2.2.1.2c).

In the samples containing three species two of them sometimes showed more similar length distributions (Fig. 2.2.1.2a, Nos. 7 and 9). However, one species sometimes occupied a rather intermediate position in relation to the other two species (Fig. 2.2.1.2c, No. 24).

In some samples the dominant mode of one component species agreed with one secondary or the unique mode of the other species (Figs. 2.2.1.2a, c and e).

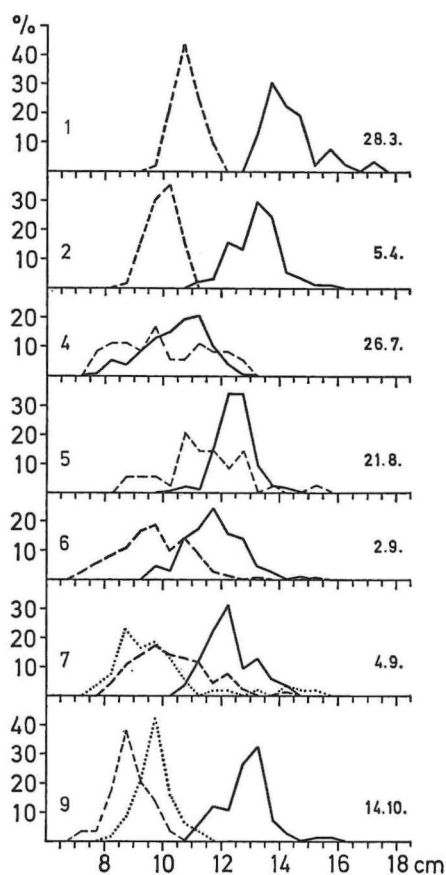


Fig. 2.2.1.2a. Length distributions of component species from mixed samples of catches by light from Kaštela Bay, 1969 (species represented by small numbers is given by thin lines)

— Sardine
 - - - - - Anchovy
 Bogue

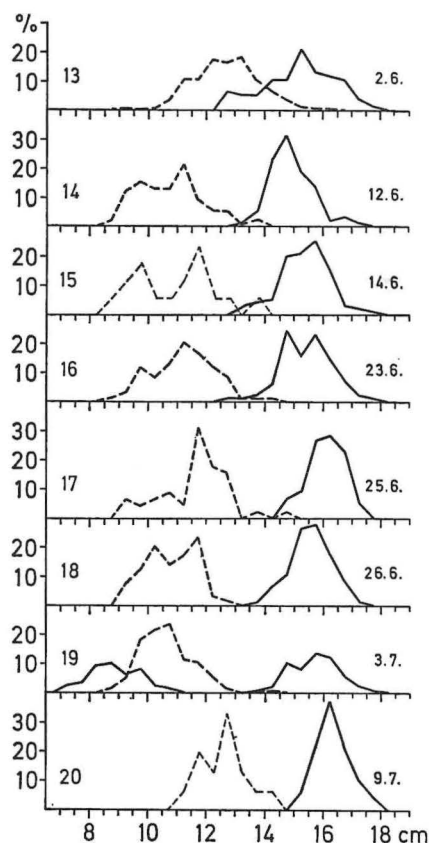


Fig. 2.2.1.2b. Length distributions of component species from mixed samples of catches by light from Kaštela Bay, 1970 (species represented by small numbers is given by thin lines)

— Sardine
 - - - - - Anchovy

Length variation

The standard deviation of length for mixed samples of the Kaštela Bay catches by light from the 1969—1974 period varied from 0.51 to 2.56 cm (App. Table 4). However, the values exceeding 2.00 cm were rare excepted those from 1970 which were generally high, ranging from 1.45 to 2.56 cm, but mostly from 2.27 to 2.56 cm.

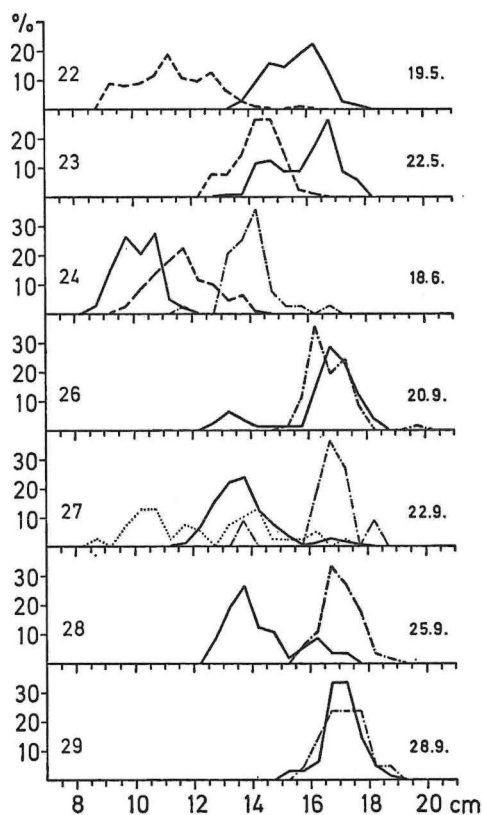


Fig. 2.2.1.2c. Length distributions of component species from mixed samples of catches by light from Kaštela Bay, 1971 (species represented by small numbers are given by thin lines)

—— Sardine
 ----- Anchovy
 - . - . - Horse mackerel
 Bogue

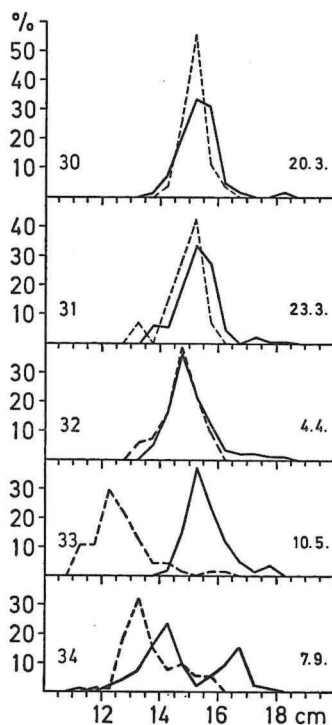


Fig. 2.2.1.2d. Length distributions of component species from mixed samples of catches by light from Kaštela Bay, 1972 (species represented by small numbers are given by thin lines)

—— Sardine
 ----- Anchovy

The coefficients of length variation for mixed species samples of the Kaštela Bay catches by light carried out in the 1969—1974 period ranged from 3.8 to 21.3%, the values exceeding 15.0% being rare (App. Table 4).

Conversely, the standard deviations of length for component species were generally lower: in sardine, from 0.50 to 3.49 cm, with only five values (3.49, 1.68, 1.94, 2.30 and 2.53 cm) exceeding 1.40 cm (37 samples in all); in anchovy, from 0.40 to 1.75 cm, with only two values (1.54 and 1.75 cm) exceeding 1.40 cm (33 samples in all); in horse mackerel, from 0.62 to 0.79 cm and one exception of 1.14 cm (5 samples in all); in bogue, very different, i. e. 1.68, 0.60 and 2.14 cm (3 samples in all) (Tables 5a-d).

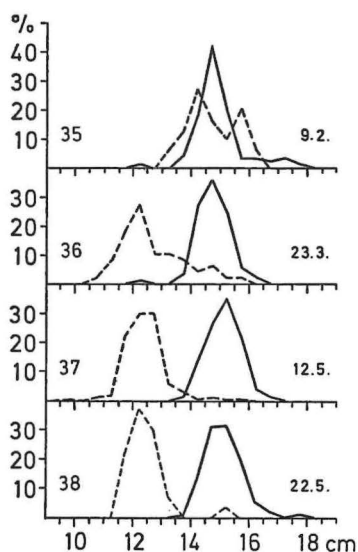


Fig. 2.2.1.2e. Length distributions of component species from mixed samples of catches by light from Kaštela Bay, 1973 (species represented by small numbers is given by thin lines)

— Sardine
- - - - - Anchovy

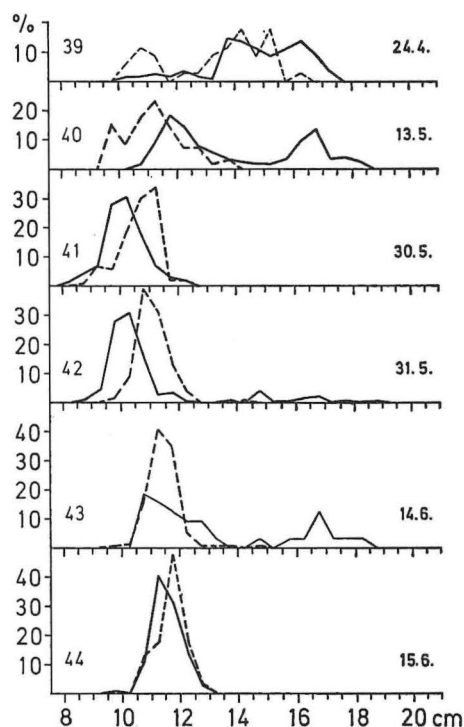


Fig. 2.2.1.2f. Length distributions of component species from mixed samples of catches by light from Kaštela Bay, 1974 (species represented by small numbers are given by thin lines)

— Sardine
- - - - - Anchovy

The length variation coefficients for component species ranged: in sardine from 3.6 to 26.5%, in anchovy from 2.5 to 14.7% and in horse mackerel from 3.5 to 6.6%; in bogue this coefficient amounted to 16.2, 5.9 and 16.6% (App. Tables 5a-d).

2.2.2. Bottom trawl catches

Only data on length range were available for mixed pelagic fish caught by bottom trawl in the »Hvar« Expedition area, 1948 and 1949 (App. Table channels, 1957 and 1958. In the mixed pelagic fish from the bottom trawl 3a), while no length data were taken in the fish trawled in the Mid-Dalmatian catches carried out in the central and in part southern Adriatic in the 1954—

1955 trawling season all individual lengths were recorded (App. Tables 3c and 6).

Length range

The individual lengths of fish from all the mixed pelagic fish species from the bottom trawl catches of the »Hvar« Expedition, in 1948 and 1949, showed a wide range, i. e. from 4 to 37 cm or, if the Spanish mackerel were excluded, to 32 cm (App. Table 3a). The range was much smaller in component species: in sardine from 8 to 19 cm, in sprat from 4 to 13 cm, in anchovy from 10 to 20 cm and in mackerel from 13 to 32 cm.

The individual lengths of fish from the mixed pelagic fish catches taken by bottom trawl in the central and in part southern Adriatic, in the 1954—1955 trawling season, ranged from 8 to 26 cm (centimeter length data) (App. Table 3c). The component species showed smaller length ranges: in sardine from 9 to 19 cm, in anchovy from 8 to 18 cm and in mackerel from 15 to 26 cm.

The length ranges in the pelagic fishes mixed trawled during the »Hvar« Expedition varied from 1—25 cm, but mostly from 1 to 9 cm (App. Table 3a). The length ranges recorded in nearly all the catches from the central and in part southern Adriatic obtained during the 1954—1955 trawling season fell between 1 and 9 cm (App. Table 3c). Some wide length ranges in the »Hvar« mixed pelagic fish species were due to a more frequent occurrence of mackerel and their bigger size in some of the »Hvar« catches, as well as in part to the appearance of large Spanish mackerel in these catches.

Mean length

The mean lengths of larger pelagic fish catches (those with component species represented by numbers less than 10 were not taken) obtained by bottom trawl in the central and in part southern Adriatic, during the 1954—1955 trawling season, varied from 11.1 to 17.6 cm (App. Table 6). The mean lengths for component species ranged: in sardine from 10.9 to 16.6 cm, in anchovy from 11.3 to 16.4 and in mackerel they were 19.5 and 18.3 cm (App. Tables 7a-c).

Length distribution and variation

Some of the mixed pelagic fish catches performed in the central and in part southern Adriatic, during the 1954—1955 trawling season, showed rather asymmetrical length distributions (Fig. 2.2.2.1). An example is the catch No. 3 containing sardine and anchovy. The catch was trawled in the Split Channel at the end of November. At that locality some sardine catches taken by light showed heterogeneous length distribution in the spring and autumn months (Mužinić, unpublished data).

Mackerel, being generally larger than sardine and anchovy, increased the length range of the catch and changed the length distribution as shown, e. g., by catches Nos. 14 and 15 (Fig. 2.2.2.1). Notwithstanding, in catch No. 14 the

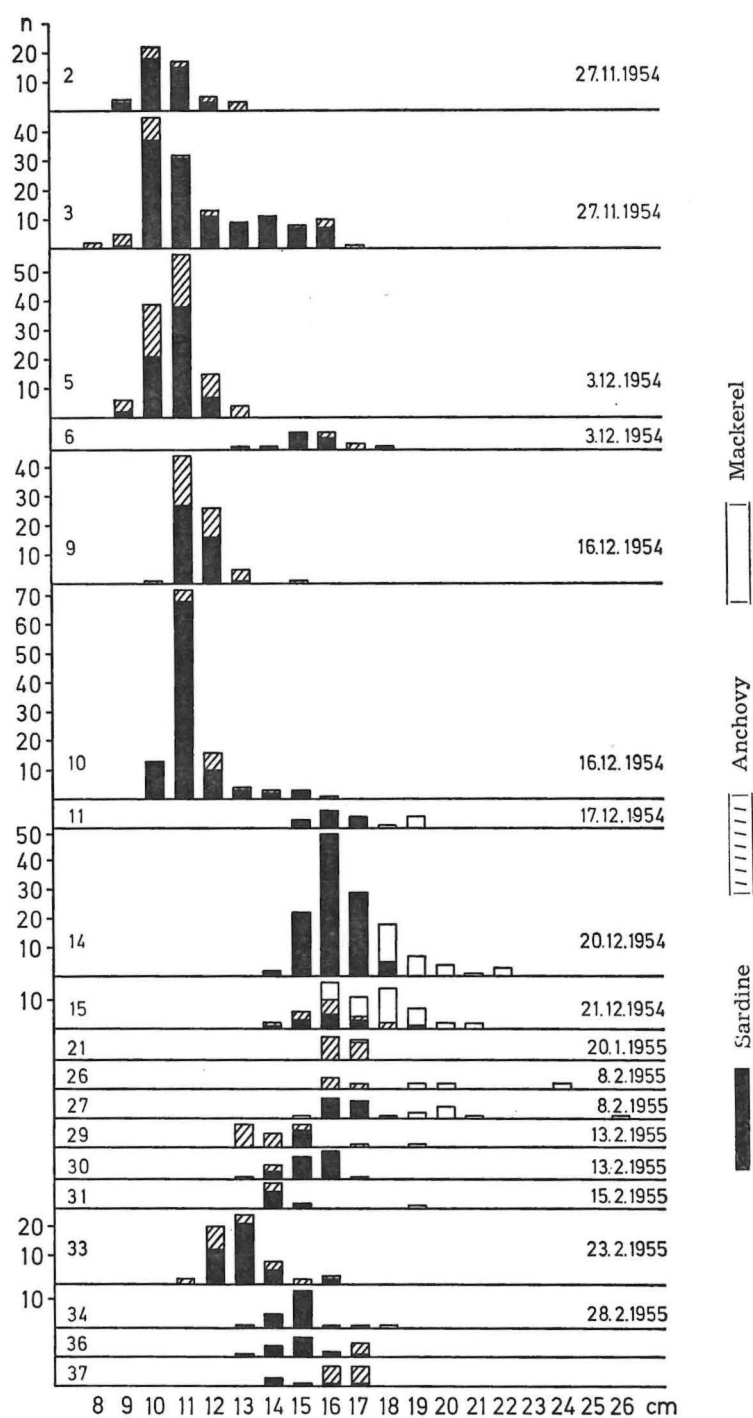


Fig. 2.2.2.1. Length distributions of component species from mixed bottom trawl catches of pelagic fishes in the 1954—1955 trawling season

length distribution of mackerel seemed, to some extent, complementary with respect of the sardine distribution.

The standard deviation of length for bottom trawl catches of mixed pelagic fishes varied from 0.75 to 2.07 cm, with only three values exceeding 1.10 cm (1.54, 1.58 and 2.07 cm) (App. Table 6). The variation coefficients of these catches ranged from 6.3 to 17.0% and with one exception to 9.2%.

The standard deviations of length for component species from mixed trawl catches of pelagic fishes varied: in sardine, from 0.54 to 1.89 cm and with one exception to 1.24 cm; in anchovy, from 0.96 to 2.84 cm and with one exception to 1.44 cm; in mackerel, they amounted to 1.26 and 1.30 cm (App. Tables 7a-c). The length variation coefficients in component species ranged: in sardine, from 4.0 to 15.4% and with one exception to 9.2%; in anchovy, from 6.8 to 24.3% and with one exception to 11.4%; in mackerel, they reached 6.5 and 7.1%.

3. DISCUSSION

3.1. SPECIES COMPOSITION

The mixed species samples of purse seine catches carried out by means of light in the Kaštela Bay, in the 1969—1974 period, usually contained sardine and anchovy. Bogue (semipelagic species) were also sometimes present in the samples. Horse mackerel (semipelagic species) might have occurred more regularly, but they were only later taken into account.

The proportions of all these component species greatly varied.

In mixed species samples of the pelagic fish catches by light from the Kaštela Bay mackerel rarely appear. In the samples of such catches analysed in the 1969—1974 period they were never found.

The annual proportions of sardine and anchovy in the mixed species samples from the 1971—1974 period showed some differences. The proportion of sardine in 1972 was high and those of anchovy were higher in 1973 and 1974 than in two previous years.

Unfortunately, the samples of the pelagic fish catches carried out by light in the channel and open waters could not be analysed as to the species composition. However, during the sardine tagging work mackerel were often found in open central and in part southern Adriatic with sardine, while bogue only sometimes occurred with sardine; anchovy, Spanish mackerel and horse mackerels (*Trachurus* sp.) rarely occurred with sardine.

Grubišić (1962) recorded, mostly in open waters, that in large sardine catches by light the proportions of other species rarely reached about 10%, while in small catches they might exceed 50%.

Bottom trawl catches containing the studied pelagic fishes mixed were not rare. Their proportions in the three series of experimental trawl catches amounted to 40.0, 50.9 and 54.3% of all the catches containing pelagic fish (App. Table 2).

Mixed bottom trawl catches of the studied fishes were less frequent in the »Hvar« Expedition area (40%) than in the other two areas investigated (50.9 and 54.3%), which could be due to the fact that the »Hvar« Expedition

worked mostly at greater depths in which the smallest pelagic fishes were scarce. Within the »Hvar« area mackerel in general were caught at greater bottom depths (mean 124.2 m) than those at which sardine (89.2 m), anchovy (97.9 m) and especially sprat (68.7 m) were found (Mužinić, 1973) (Table 3.1.1).*) Moreover, mackerel alone were recorded, within this area, at greater

Table 3.1.1. Data on mean bottom depths at which the pelagic fishes were recorded during the »Hvar« Fishery Biological Expedition, 1948 and 1948 (from the unpublished data of O. Karlovac).

	Number of catches	Depth, m
Mackerel alone	53	131.7
Mackerel with other species, Spanish mackerel excluded	39	110.4
All mackerel	94	124.2
Sardine alone or with other species, mackerel excluded	24	73.8
Sardine with mackerel (alone and mixed)	17	109.8
All sardine	41	89.2

sea bed depths (mean 131.7 m) than those at which mackerel were caught with other pelagic species, Spanish mackerel excluded (mean 110.4 m). Conversely, sardine alone or with other pelagic fishes, except mackerel, were caught, within the »Hvar« area, at much smaller bottom depths (mean 73.8 m) than those at which they occurred with mackerel, alone or mixed (109.8 m).

Shallower waters are those of higher overlapping horizontal distribution of the studied species, but especially of small species, sardine and anchovy. In the shallowest inshore waters (nursery grounds) the highest overlapping of the horizontal distribution of sardine, anchovy and, to some extent, of sprat seems to occur.

Pelagic species mixed were very frequent in the »Hvar« bottom trawl catches carried out north of the Jabuka Pit. In some catches anchovy and mackerel appeared there offshore nearer to the eastern Adriatic coast with sardine and nearer to the western Adriatic coast with sprat. Moreover, sardine were recorded there in March, while sprat occurred in July and August. One sardine spawning ground was recorded in the winter-time off the Dugi otok Island, nearer to the eastern Adriatic coast (Gamulin, 1954; Karlovac, J., 1958). The spawning of sprat in this region is not known (the sprat and sardine have a similar spawning season). On the other hand sardine were never found in the trawl catches from July and August (about two thirds of the July and August »Hvar« trawl catches were taken in shallow waters north of the Jabuka Pit). The question arises, therefrom, is it at all possible to speak about an overlapping of the horizontal distribution of sardine and sprat off the Dugi otok Island, where their presence could, moreover, alternate in time.

Mixed pelagic fishes appeared often in the »Hvar« bottom trawl catches from the Palagruž Island area. Out of the 11 »Hvar« catches carried out in the vicinity of the Palagruž Island 7 contained more than one species. Out of

*) The depths recorded for sardine, anchovy and sprat would be even lower if the »Hvar« Expedition had also controlled shallower waters.

the 5 catches performed in this area during the 1954—1955 trawling season 3 contained mixed pelagic fish species. In the Palagruž Island area a spawning ground of sardine (Gamulin, 1954; Gamulin and J. Karlovac, 1956; Karlovac, J., 1964, 1969) and mackerel (Gamulin, 1954; Mužinić, 1956; Hure, 1960, 1961) was found. Moreover, the sardine and mackerel eggs were taken in the same catches (December 1950 /Gamulin, 1954/; at the beginning of 1959 and 1960 /Hure, 1960, 1961/). In the area adult anchovy were also recorded (Mužinić, 1956), this pointing to their wintering ground.

The most northern Adriatic could not be investigated in this regard. However, mixed pelagic fishes appear in the catches from that area. Lissner (1939) used to find mackerels with sardines in the same catches from the western Istra Peninsula waters during the 1937 and 1938 fishing seasons. Zavodnik (1970) recorded there the sardine, sprat and anchovy eggs in the same catch from November 1968. Some overlapping in the distribution of pelagic fishes in the most northern Adriatic was shown by Gamulin (1964), and Štirn and Kubik (1974).

The numbers of individuals in the bottom trawl catches containing pelagic mixed fish species from the »Hvar« Expedition area were the smallest and those from the central and in part southern Adriatic were the largest. The various types of trawls and trawling techniques might have had some effects on the proportions of pelagic fishes in the catches. Nevertheless, the results obtained when analyzing the trawling data are in accordance with our knowledge of the ecology of the species dealt with.

In larger catches of pelagic fish (> 50 individuals) within the bottom trawl catches mostly one species highly dominated in both open and coastal waters. The predominance was not so marked in intermediate channel waters.

From all the studied pelagic species anchovy most rarely occurred alone in the bottom trawl catches. It seems also to be the same with the samples of the catches carried out by light.

Anchovy appeared in the samples of catches by light or in the bottom trawl catches either with sardine or with mackerel and even with both of them, in spite of their different physiological state (anchovy spawn in warmer part of the year; sardine spawn mostly in winter and mackerel exclusively at that time).

A common appearance of two or more pelagic fishes in mixed species samples of catches by light and in bottom trawl catches does not necessarily mean that the species involved were originally grouping together. The mono-specific groups might have been drawn together by similar behaviour or preferences. Two pelagic fishes often appear under the light used to attract the fish. S. Mužinić (1936) mentioned that under an attracting light sardine often appeared with mackerel and anchovy with Spanish mackerel. This probably referred to channel and open waters. According to Grubišić (1962), in these waters shoaling sardine keep under the light separately from shoaling anchovy, Spanish mackerel and horse mackerels (*Trachurus* sp.). Grubišić also mentioned that sardine tolerate the presence of mackerel and bogue in such conditions better.

A continuous concentration of anchovy, horse mackerel (*Trachurus* sp.) and some sardine shoals (»bancs«) was detected in August by echo-sounder off the Morocco coast and verified by a catch; in September large mixed

shoals («bancs») of sardine, anchovy and horse mackerel were recorded (the catch was not successful) (Furnestin, 1953).

As mixed bottom trawl catches of the studied species were rather frequent it could hardly be supposed that one or two further species were generally taken during hauling the trawl. In any event, in the trawled areas the fishes were probably not far from each other and could be caught together during one haul even if not grouped. Near the Palagruž Island itself sardine and anchovy might keep, to some extent, closer to each other, as both species prefer lower depths.

3.2. LENGTH CHARACTERISTICS

3.2.1. Samples of catches by light

The largest mean lengths of sardine from mixed species samples of catches by light were recorded in 1971 (in 4 out of 7 samples they exceeded 16.0 cm, one of them reaching even 17.6 cm). It happened just in the year in which low proportions of sardine in such samples were found.

The largest mean lengths of anchovy from mixed species samples of catches by light were observed in 1972 (in 3 out of 5 samples they exceeded 15.0 cm), i. e. in the year of low proportions of anchovy in such samples.

The length variation in the mixed species samples of catches taken by light was in part rather large (standard deviation in about 50% of samples > 1.50 cm) (App. Table 4). Large variation in length (standard deviation mainly > 1.80 cm) was shown by samples containing species which were very different in mean length as it happened in the 1970 fishing season when large sardine (15.4—16.6 cm with one exception) contrasted with small anchovy (11.2—12.5 cm with one exception) (App. Tables 5a and b).

Kaštela Bay is also an area where sardine and anchovy normally occur, but also horse mackerel (*Trachurus* sp.) and bogue. Young sardines have often been recorded there (Mužinić, 1954; Karlovac, J., 1967), but young anchovies as well (Mužinić, 1956; Sinovčić, 1978). In addition, some large sardines also immigrate into Kaštela Bay from open waters (Mužinić, 1950, 1954). All these are the sources of the length variation in the mixed species samples from Kaštela Bay.

Both sardine and anchovy seem to have some similar environment preferences. Smaller sardine were recorded in shallower waters of Kaštela Bay (Mužinić, 1954) and, according to fishermen, it is the same with the anchovy. They both feed on plankton and react to artificial light.

Conversely, nearly all the component species from the mixed samples of catches by light showed much smaller standard deviations (mainly < 1.40 cm), although among a few exceptions very high values as those for sardine in samples Nos. 19, 40 and 43 (3.49, 2.30 and 2.53 cm respectively) were recorded (App. Tables 5a-d).

The question arises whether the component species from the mixed samples were grouping together coherently in natural conditions or only aggregating under the light.

One group of mixed samples is represented by two-species samples Nos. 29 (sardine and horse mackerel), 30—32 and 44 (sardine and anchovy) showing

small length variation (standard deviations reached 0.76 cm). Their component species showed standard deviations similar to that of mixed samples (up to 0.81 cm) and high overlapping length distributions (App. Tables 4, 5a-c, Figs. 2.2.1.2a, d and f). For such cases common permanent shoaling of the two species may be presumed even if the swimming speed in component species would be somewhat different.

The second group represented by two-species samples, such as Nos. 5, 6, 13, 23, 34 and 35 (in all of these sardine and anchovy), with larger length standard deviations (0.85—1.49 cm) contained species also showing rather large standard deviations (0.60—1.40 cm) and partially overlapping length distributions (App. Tables 4, 5a and b, Figs. 2.2.1.2a-e).

The third group of mixed samples is represented by two-species samples Nos. 1, 2, 14—18, 20, 22 (in all of these sardine and anchovy), 28 (sardine and horse mackerel), 33, 37 and 38 (in all of these sardine and anchovy) with mainly large standard deviations (1.46—2.48 cm with one exception of 1.18 cm) which contained two species showing in part rather large standard deviations (0.47—1.38 cm), especially in anchovy and none or very little overlapping in the length distributions (App. Tables 4, 5a-c, Figs. 2.2.1.2a-e). The difference between the unique or dominating modes of the component species amounted at least to 3 cm. When dealing earlier with some of these mixed samples it was supposed that, at such markedly varied length composition, the fish did not form permanent coherent common groups (Mužinić, 1977). They could have aggregated or formed separate shoals which became mixed during capture. However, in three of these mixed samples (Nos. 15, 20 and 38) one species was badly represented (< 20%) (App. Table 1) and the question may be put as to whether in such small proportions this species, at markedly different length composition, might for some time coexist with other species in a common group and even shoal with it. In all the three cases it was smaller anchovy which were scarce and it could not be advantageous for them to shoal with sardine which were larger.

In Figure 3.2.1 the length distributions for component species from mixed samples Nos. 9, 13, 34 and 37 are compared with the length distributions for available one-species samples obtained about the same dates. It can be seen that even each of two-sized sardine from the mixed sample No. 34 were separately caught. They could, therefore, exist as independent units. This was probably even more true for sardine from the two-species samples Nos. 19, 40 and 43 which showed two largely separated unique or dominant modes, contrasting to mainly unimodal anchovy length distribution which overlapped only one part of the sardine length distributions (Figs. 2.2.1.2b and f). The two species were extremely different as to the length variation (App. Tables 5a and b). It does not seem likely that sardine from these mixed samples as a whole form permanent coherent groups, shoals, at such markedly varied length composition. This was also supposed before for one-species samples on the basis of the aquarium observations (Mužinić, 1977). Small and large sardines rarely formed an integrated shoal in the aquarium and only under some adverse influence.

On the other hand, one part of sardines from the two-species samples Nos. 40 and 43 could have shoaled with similar sized anchovies from the same samples.

In aquarium conditions sardines aggregated and shoaled with anchovies and both species behaved together, consequently, like monospecific groups (Mužinić, 1966). Mixed aggregation was often observed in the initial phase of their life in aquarium. Anchovies, being more vulnerable than sardines,

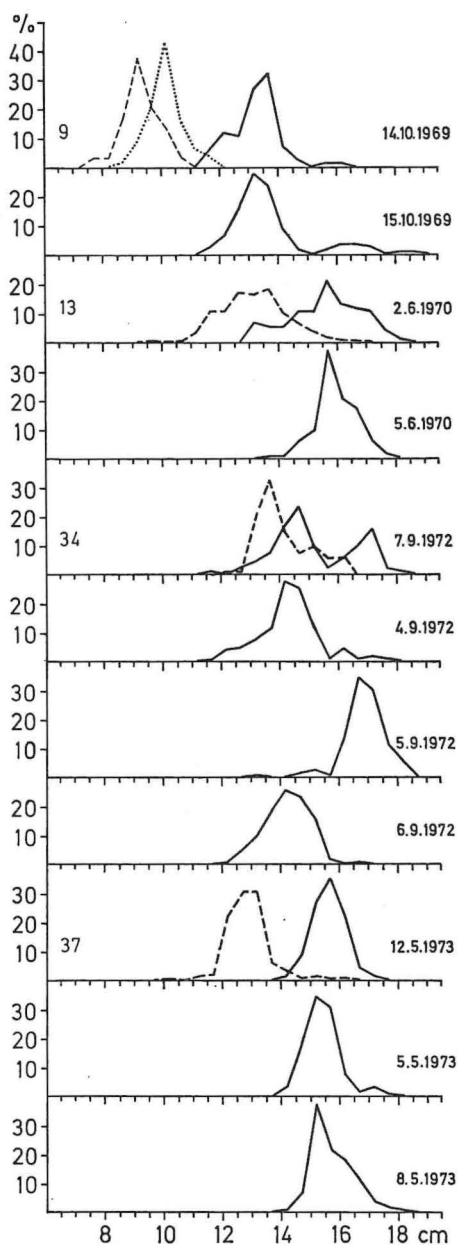


Fig. 3.2.1. Length distributions of component species from some mixed samples of catches by light from Kaštela Bay compared with those of single-species samples of catches taken about the same dates

—— Sardine
 - - - - - Anchovy
 Bogue

usually showed high initial mortalities and small numbers survived shoaled with sardines. Large sardines, kept for several months in aquarium, where they swam clockwise in a ring-shaped formation or in a typical shoal, mixed with new smaller anchovies represented by a nearly equal numerical proportion, both species moving circularly in the same direction and showing traces of horizontal segregation only when disturbed (Mužinić, unpublished observations). The fish were rather crowded and any tendency to segregation would probably not have been well-marked. The species markedly differed as to the size, their initial mean total length amounting to 15.8 (sardine) and 12.2 cm (anchovy), but they were similar in length variation (standard deviations of 1.13 and 1.03 cm respectively). The standard deviation of both species length distributions when pooled was large — it reached 1.96 cm — due to little overlap in length distributions of the species. The dominant modes of the species differed by 3 cm.

Much later when the number of anchovies was four times smaller than the number of sardines, the species were found slowly swimming in an integrated shoal (Mužinić, unpublished observations).

The three-species samples (Nos. 7, 9, 24 and 27) belong, to some extent, to the third group of mixed samples (App. Tables 4, 5a-d, Figs. 2.2.1.2a and c). In these samples there were two species with none or very little overlap in length distribution. These mixed samples contained one species which was badly represented ($< 20\%$) and in sample No. 27 there were even two such species (App. Table 1). The scarce species was the smallest in length (bogue in sample No. 7 and anchovy in sample No. 9), the largest (horse mackerel in sample No. 24), and the largest and in part the smallest (horse mackerel and bogue respectively in sample No. 27). In three out of the four three-species samples the best represented species had more or less an intermediate position. For sardine which were the largest in samples Nos. 7 and 9 there were probably no difficulties in shoaling with slower swimming smaller anchovy and bogue. It could have been the same with the horse mackerel from samples Nos. 24 and 27. But, for small anchovy and bogue from sample No. 9 it would have been rather difficult to keep up with larger sardine. Moreover, while the homogeneous length distribution (standard deviation 0.60 cm) in bogue from sample No. 9 points to a shoaling unit, the very heterogeneous length distribution in bogue from sample No. 27 does not give an impression of any coherence tendency among them.

Tardent (1962) observed that sardine in aquarium shoal with other species, mainly when the number of sardines was small. This author also noticed that sardine mostly shoaled with small horse mackerel.

Personal observations showed that in aquarium conditions bogue were to some extent aggressive to sardine. Fin damage in sardine was larger and more persistent in the presence of bogue and any individual of this species had to be eliminated (Mužinić, 1966). Horse mackerel were also undesirable in tanks in which sardine were kept. This adverse effect was also noticed during sardine tagging (Mužinić, 1950) and in sardine used as bait for tunnies (La Tourasse, 1951). Sardine shoaling with bogue and horse mackerels might, therefore, be temporary and take place either under some adverse influence or when reacting to similar environment preferences.

3.2.2. Bottom trawl catches

The variation of length in the bottom trawl catches of mixed pelagic fishes (these were obtained in the central and in part southern Adriatic during the 1954—1955 trawling season) was moderate (standard deviations: 0.75—1.58 cm, catch No. 3 with standard deviation of 2.07 cm being excluded) (App. Table 6). Such mixed fish might have been grouping and even shoaling together at lower temperatures since all the catches were taken between the end of November 1954 and February 1955. The fish would have been less active and might have kept grouped with a length variation with which it would be impossible at higher temperatures.

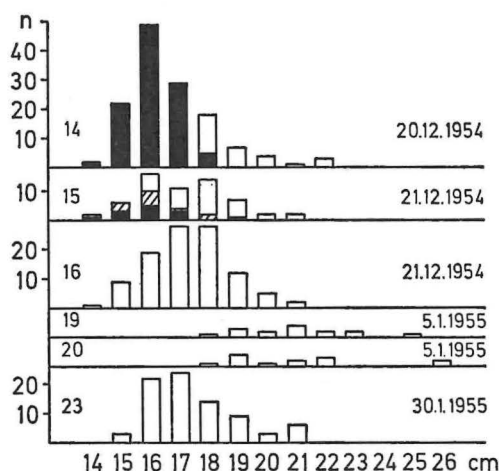


Fig. 3.2.2. Length distributions of component species from mixed bottom trawl catches of pelagic fishes compared with those of single-species catches taken in the same 1954—1955 trawling season

■ Sardine ▨ Anchovy □ Mackerel

In Figure 3.2.2. the length distributions of mixed pelagic fish catches Nos. 14 and 15 are given together with those of one-species catches Nos. 16 and 20, and those of mixed catches Nos. 19 and 23 in which one of the two species could not be measured due to damages (No. 19 unmeasurable anchovy and No. 23 unmeasurable sardine). The last catch was not enough representative, as some small mackerel were included, but it did not essentially change the original length distribution, i. e. the real mode might have been 18 instead of 17 cm.

Catches Nos. 14, 15, 16 and 23 showed some similarity in length range (14—22, 14—21, 14—21 and 15—21 cm), mean length (17.2, 17.6, 17.8 and 18.0 cm) and standard deviation (1.54, 1.58, 1.40 and 1.53 cm), although the first two catches were mixed (sardine with mackerel, and sardine with anchovy and mackerel) (App. Tables 3c and 6). Conversely, the fish from catches Nos. 19 and 20 were larger (means: 21.4 and 21.8 cm) and more variable in length

(standard deviations: 1.92 and 2.69 cm), although their length distributions refer only to one species, i. e. mackerel (in catch No. 19 the anchovy were not measurable).

The length distribution of mixed catch No. 15 was highly symmetrical and bimodal, the first mode being due to sardine and anchovy together, and the second one to mackerel. The mean length of both sardine and anchovy was 16.4 cm and that of mackerel 18.3 cm.

In mixed catch No. 14 the component species, sardine and mackerel, differed even more in mean length (16.6 and 19.5 cm respectively).

Catches Nos. 15, 16 and 23 were taken at the same place near Palagruž Island. The fish from all the three catches probably behaved similarly, i. e. they might shoal together in spite of bimodality in the length distribution of catch No. 15 due to difference between sardine and anchovy on the one hand and mackerel on the other (the difference in the mean length amounted to 1.9 cm). The difference in swimming speed must also have existed, but its effect might have been small at lower temperatures.

Catch No. 14 contained, besides sardine, small number of mackerel (20.7%) with a difference in the mean length amounting to 2.9 cm. However, small number of mackerel could have adapted without difficulty to the swimming speed of the smaller sardines and shoaled with them at least for some time, especially at lower temperatures.

Besides large length variation in the mixed fish from catch No. 3 (standard deviation 2.07 cm), both sardine and anchovy, especially the latter, also showed large length variation (standard deviations: 1.89 and 2.84 cm respectively). In this case also larger individuals of both species could have adapted to the swimming speed of smaller fish and shoaled with them at lower temperatures. But, it is also possible that the bottom trawl could have caught separate groups which became mixed in the net during capture.

Finally, the question arises as to what extent the mixed pelagic fish catches taken by bottom trawls were representative of the population in the area. In spite of the various types of trawl used in the Adriatic most have small-meshed cod ends which retain rather small fish. This is why 10 out of the 52 »Hvar« Expedition catches with mixed pelagic fish also included sardine and sprat measuring less than 10 cm in total length. We did not expect to find small individuals well-represented in the »Hvar« catches, the Expedition having worked almost exclusively in open waters of the central and southern Adriatic.

In the catches from the central and in part southern Adriatic taken in the 1954—1955 trawling season small sardines measuring 9—10 cm and anchovies measuring 8—9 cm in total length were also recorded.

4. SUMMARY

Mixed species samples of pelagic fish catches obtained by seine and light in the shallow coastal waters of the eastern central Adriatic (Kaštela Bay), in the 1969—1974 period, usually contained sardine and anchovy, but in very variable proportions. In most of these samples sardine was the dominant species. The proportions of horse mackerel and bogue only rarely exceeded those of the sardine.

The proportions of sardine and anchovy in mixed samples of catches by light (1971—1974) also varied from year to year. The proportions of sardine were highest in 1972 and those of anchovy in 1973 and 1974.

Mixed pelagic fishes were not uncommon in the bottom trawl catches taken in the channel Mid-Dalmatian waters, in 1957 and 1958, their proportion amounting to 50.9%. The proportion was smaller (40.0%) in the bottom trawl catches from the Fishery Biological Expedition »Hvar« which worked mainly in the open Adriatic, in 1948 and 1949. Such proportions might point out to the fact that mixed pelagic fish species were not in part accidentally taken by trawls, i. e. during their hauling.

The mixed pelagic fishes were more frequent in the demersal catches from shallow waters due to a preference of lesser depths in three (sardine, sprat and anchovy) out of the five species.

In shallow waters of the central and in part southern Adriatic sardine often appeared in the bottom trawl catches with anchovy. On the other hand, the catches from more open areas rarely contained sardine and anchovy together. These sardine occurred more frequently with mackerel and this was even more true for anchovy. In the bottom trawl catches anchovy rarely appeared alone.

Judging from the mixed catches of the pelagic fish species caught by bottom trawl, the highest overlapping of the horizontal distribution of sardine and anchovy seems to occur on their common nursery grounds which show the least depths. However, mixed pelagic fishes in the bottom trawl catches also frequently occurred north of the Jabuka Pit and in the Palagruž Island area.

The proportions of component species from mixed pelagic fish catches obtained by bottom trawl also greatly varied. In some of the more abundant catches of pelagic fishes the dominant species represented more than 95% of the catch. In such catches from deeper waters mackerel dominated and in those from shallower waters it was mostly sardine.

Mean total lengths of the mixed species samples of pelagic fish catches obtained by light in the coastal eastern Adriatic, in the 1969—1974 period, ranged from 10.9 to 17.6 cm, and of sardine and anchovy from 10.6 to 17.6 cm and from 9.3 to 15.7 cm respectively.

Mean lengths of sardine from mixed species samples were mostly larger than those of anchovy from the same samples.

The largest mean lengths of sardine were observed in 1971 and those of anchovy in 1972, i. e. in the years of their low proportions in mixed species samples.

The range of length variation in the mixed species samples of pelagic fish catches carried out by light was rather large (standard deviations: 0.51—

—2.56 cm). Some of them showed small standard deviations of length (< 0.80 cm), similar to those of component species, and highly overlapping length distributions in these species.

Contrasting sharply to these samples were those with large standard deviations of length (mainly > 1.50 cm), mostly very different from those of component species and, consequently, with none or very little overlap in the length distributions of these species.

On the basis of aquarium observations on sardine and, to some extent, on sardine and anchovy kept together, it was supposed that the species from the first samples formed coherent common groups in natural conditions and those from the latter samples did not shoal together but only aggregated. Some of the latter samples were probably taken from coherent shoals of the species which became mixed during the capture operation.

Of course, there were mixed species samples representing transitions between the mentioned two groups of samples. Such samples show moderate length variation and partially overlapping length distributions of their component species. If these species shoal together it might be only temporarily. Such groups would easily break with an increase of swimming speed.

It was also supposed that species from mixed samples of the pelagic fish catches represented by larger individuals, but in low proportions may coexist with small well-represented individuals of other species in coherent groups. Conversely, such coexistence could hardly be realized by small badly represented individuals and it would, moreover, not be advantageous to them. Two-sized monospecific individuals would probably behave similarly.

Finally, on the basis of some aquarium experiences it was presumed that common shoaling of sardine and horse mackerel (*Trachurus* sp.) would be only temporary.

It would follow that a relatively small number out of numerous mixed samples of pelagic fish catches by light was taken from permanently coherent mixed shoals, while many others originated from aggregations or temporary, labile shoals. Some of mixed samples were probably taken from separate stable shoals of the species which became mixed during capture.

Individual total lengths of mixed pelagic fishes and component species trawled during the »Hvar« Expedition, in 1948 and 1949, were somewhat greater than those of the fish trawled in the central and in part southern Adriatic, during the 1954—1955 season.

Mean total lengths of the mixed catches of pelagic fishes from the 1954—1955 trawling season ranged from 11.1 to 17.6 cm, those of sardine from 10.9 to 16.6 cm and those of anchovy from 11.3 to 16.4 cm. These catches mainly showed moderate length variation (standard deviations from 0.75 to 1.58 cm with one exception). The largest standard deviations of the length recorded in them were similar to those of the one-species catches. On the basis of the standard deviation values and distributions of the length shown by these mixed pelagic fishes a common shoaling for the species from most of these catches was presumed in so much more as the catches were taken in the colder part of the year, when the fish is generally less active.

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APPENDIX TABLES

Table 1. Data on species composition for mixed samples of catches by light from Kaštela Bay (percentage data in parentheses)

28

Sample No.	Date	Sardine	Gilt sardine	Anchovy	Number of fish Horse mackerels	Bogue	Total
1	28. 3. 1969	89 (62.7)	—	53 (37.3)			142
2	5. 4. 1969	89 (31.6)	—	193 (68.4)			282
3	12. 4. 1969	142 (86.1)	—	23 (13.9)			165
4	26. 7. 1969	280 (88.6)	—	36 (11.4)			316
5	21. 8. 1969	200 (85.5)	—	34 (14.5)			234
6	2. 9. 1969	115 (40.4)	—	170 (59.7)			285
7	4. 9. 1969	155 (51.3)	—	93 (30.8)		54 (17.9)	302
8	5. 9. 1969	190 (94.5)	—	6 (3.0)		5 (2.5)	201
9	14. 10. 1969	83 (37.6)	—	29 (13.1)		109 ((49.3)	221
10	13. 5. 1970	135 (77.6)	—	39 (22.4)			174
11	14. 5. 1970	127 (94.1)	—	8 (5.9)			135
12	26. 5. 1970	131 (97.8)	—	3 (2.2)			134
13	2. 6. 1970	76 (17.1)	—	369 (82.9)			445
14	12. 6. 1970	95 (42.0)	—	131 (58.0)			226
15	14. 6. 1970	94 (84.7)	—	17 (15.3)			111
16	23. 6. 1970	82 (49.7)	—	83 (50.3)			165
17	25. 6. 1970	74 (62.2)	—	45 (37.8)			119
18	26. 6. 1970	93 (59.2)	—	64 (40.8)			157
19	3. 7. 1970	146 (42.0)	—	202 (58.1)			348
20	9. 7. 1970	89 (79.5)	—	15 (13.4)	6 (5.4)	2 (1.8)	112
21	8. 9. 1970	69 (38.6)	—	37 (20.7)	—	73 (40.8)	179
22	19. 5. 1971	76 (40.2)	—	112 (59.3)	1 (0.5)	—	189
23	22. 5. 1971	106 (53.5)	—	91 (46.0)	—	1 (0.5)	198
24	18. 6. 1971	110 (29.0)	—	230 (60.7)	39 (10.3)	—	379
25	12. 7. 1971	261 (97.8)	—	1 (0.4)	5 (1.9)	—	267
26	20. 9. 1971	77 (51.3)	—	—	73 (48.7)	—	150

No. 11

Table 1. *continued*

27	22. 9. 1971	176 (78.2)	—	—	11 (4.9)	38 (16.9)	225
28	25. 9. 1971	57 (46.3)	—	—	66 (53.7)	—	123
29	28. 9. 1971	63 (75.0)	—	—	21 (25.0)	—	84
30	20. 3. 1972	69 (71.9)	—	27 (28.1)	—	—	96
31	23. 3. 1972	197 (93.4)	—	14 (6.6)	—	—	211
32	4. 4. 1972	100 (59.9)	—	67 (40.1)	—	—	167
33	10. 5. 1972	157 (70.7)	—	64 (28.8)	1 (0.5)	—	222
34	7. 9. 1972	93 (64.1)	—	52 (35.9)	—	—	145
35	9. 2. 1973	86 (64.2)	—	48 (35.8)	—	—	134
36	23. 3. 1973	89 (65.0)	—	48 (35.0)	—	—	137
37	12. 5. 1973	68 (31.1)	—	151 (69.0)	—	—	219
38	22. 5. 1973	151 (84.8)	—	27 (15.2)	—	—	178
39	24. 4. 1974	117 (77.5)	—	34 (22.5)	—	—	151
40	13. 5. 1974	132 (70.2)	—	56 (29.8)	—	—	188
41	30. 5. 1974	146 (57.5)	1 (0.4)	107 (42.1)	—	—	254
42	31. 5. 1974	164 (58.6)	11 (3.9)	105 (37.5)	—	—	280
43	14. 6. 1974	32 (15.2)	—	178 (84.8)	—	—	210
44	15. 6. 1974	109 (63.7)	1 (0.6)	61 (35.7)	—	—	171

Table 2. Data on species composition of catches of pelagic fishes taken by bottom trawl

1 — »Hvar« Fishery Biological Expedition, 1948 and 1949 (from the unpublished data of O. Karlovac)

2 — Mid-Dalmatian channels, 1957 and 1958 (from the data of Županović, 1961)

*) 3 — Central and southern Adriatic, the 1954—1955 trawling season (from the data of Mužinić, 1956)

	Sardine	Sprat	Anchovy	Mackerel	Spanish mackerel		Total
1	18	—	7	53	—		78
2	6	11	4	7	—		28
3	10	—	—	6	—		16

	Sardine Sprat	Sardine Anchovy	Sardine Mackerel	Sprat Anchovy	Sprat Mackerel	Anchovy Mackerel	Mackerel Spanish mackerel	
1	2	4	12	5	3	13	2	41
2	2	6	2	3	4	1	—	18
3	—	9	4	—	—	2	—	15

	Sardine Sprat Anchovy	Sardine Sprat Mackerel	Sardine Anchovy Mackerel	Sprat Anchovy Mackerel	Anchovy Mackerel Spanish mackerel	
1	—	1	4	5	1	11
2	1	1	4	2	—	8
3	—	—	4	—	—	4

	Sardine Sprat Anchovy Mackerel	
1	—	—
2	3	3
3	—	—

*) Sprat were not analysed.

Table 3a. Data on species composition and length for mixed bottom trawl catches of pelagic fishes from the »Hvar« Fishery Biological Expedition, 1948 and 1949 (from the unpublished data of O. Karlovac)

Station No.	Date	Mean depth m	Number of fish							Length range, cm					
			Sardine	Sprat	Anchovy	Mackerel	Spanish mackerel	Total	Sardine	Sprat	Anchovy	Mackerel	Spanish mackerel	All	
1	5. 3. 1948	30.0	—	1	—	1	—	2	—	13	—	32	—	13—32	
9	8. 3. 1948	72.0	1	—	—	2	—	3	14	—	—	20, 21	—	14—21	
28	15. 3. 1948	100.0	3	—	—	9	—	12	13, 14	—	—	20, 21	—	13—21	
35	15. 3. 1948	110.0	1	—	1	1	—	3	16	—	15	21	—	15—21	
36	15. 3. 1948	124.5	3	—	—	8	—	11	15, 17	—	—	22—24	—	15—24	
88	19. 4. 1948	124.0	1	—	—	5	—	6	15	—	—	22—24	—	15—24	
114	7. 5. 1948	179.5	1	—	—	2	—	3	17	—	—	22, 23	—	17—23	
102	9. 5. 1948	131.0	—	—	3	9	—	12	—	—	16, 17	21, 22	—	16—22	
103	9. 5. 1948	157.0	—	—	1	1	—	2	—	—	19	22	—	19—22	
143	28. 5. 1948	33.5	171	—	11	—	—	182	8—16	—	10—13	—	—	8—16	
147	28. 5. 1948	46.0	—	8	3	—	—	11	—	12, 13	13, 14	—	—	12—14	
154	31. 5. 1948	36.5	2	—	12	—	—	14	12, 14	—	12—15	—	—	12—15	
151	11. 6. 1948	29.0	10	—	—	1	—	11	8—12	—	—	17	—	8—17	
146	16. 6. 1948	105.0	5	2	—	—	—	7	13—15	12, 13	—	—	—	12—15	
144	18. 6. 1948	39.0	13	20	—	—	—	33	8—10	11—13	—	—	—	8—13	
148	18. 6. 1948	36.0	11	—	1	—	—	12	8, 9	—	11	—	—	8—11	
110	17. 7. 1948	75.5	—	—	1	6	—	7	—	—	16	18—22	—	16—22	
12	23. 7. 1948	75.0	—	1	2	—	—	3	—	13	12, 13	—	—	12—13	
17	23. 7. 1948	81.5	—	3	5	4	—	12	—	12, 13	12—14	13—15	—	12—15	
31	23. 7. 1948	93.5	—	1	4	—	—	5	—	13	13—15	—	—	13—15	
32	26. 7. 1948	97.5	—	—	12	16	—	28	—	—	13—15	14—26	—	13—26	
39	26. 7. 1948	117.0	—	—	9	7	1	17	—	—	12—15	25—27	37	12—37	
29	15. 8. 1948	92.5	—	—	2	1	—	3	—	—	13	15	—	13—15	
30	16. 8. 1948	99.5	—	—	31	19	—	50	—	—	13—16	14—17	—	13—17	
1	21. 8. 1948	31.5	—	1	1	—	—	2	—	9	11	—	—	9—11	
6	24. 8. 1948	63.0	—	5	8	—	—	13	—	4—12	12—15	—	—	4—15	
7	25. 8. 1948	69.5	—	1	—	7	—	8	—	9	—	13—15	—	9—15	
9	25. 8. 1948	72.0	—	1	1	2	—	4	—	9	12	24, 27	—	9—27	
14	26. 8. 1948	78.0	—	2	11	6	—	19	—	9, 10	11—13	17—20	—	9—20	
20	26. 8. 1948	81.0	—	228	12	38	—	278	—	9—13	11—13	13—22	—	9—22	

Table 3a. *continued*

27	27.	8.	1948	82.0	—	—	1	1	—	2	—	—	12	18	—	12—18
34	27.	8.	1948	100.0	—	3	1	5	—	9	—	10	12	14—16	—	10—16
44	7.	9.	1948	203.5	—	—	—	7	1	8	—	—	—	18—26	25	18—26
52	11.	9.	1948	185.5	—	—	—	2	1	3	—	—	—	22	36	22—36
89	14.	9.	1948	119.0	—	—	4	107	—	111	—	—	15—17	15—19	—	15—19
94	14.	9.	1948	118.0	3	—	—	2	—	5	16	—	—	16	—	16
80	20.	9.	1948	108.0	2	—	—	1	—	3	15, 16	—	—	15	—	15—16
82	29.	9.	1948	52.0	1	2	—	2	—	5	14	11, 12	—	19, 20	—	11—20
107	7.	11.	1948	134.0	—	—	1	10	—	11	—	—	16	15—22	—	15—22
99	15.	11.	1948	172.0	—	—	1	9	—	10	—	—	17	16—21	—	16—21
103	15.	11.	1948	158.5	—	—	4	18	—	22	—	—	14—16	15—19	—	14—19
106	15.	11.	1948	180.5	7	—	1	15	—	23	16—19	—	20	15—21	—	15—21
123	22.	11.	1948	136.0	1	—	—	1	—	2	16	—	—	20	—	16—20
82	23.	12.	1948	50.5	1	—	2	—	—	3	12	—	12, 13	—	—	12—13
110	17.	2.	1949	168.0	3	—	—	62	—	65	16—19	—	—	15—27	—	15—27
109	18.	2.	1949	132.5	2	—	—	1	—	3	15, 16	—	—	15	—	15—16
115	18.	2.	1949	210.0	—	—	1	350	—	351	—	—	16	15—25	—	15—25
12	26.	3.	1949	76.0	5	—	—	8	—	13	12, 13	—	—	20—27	—	12—27
18	26.	3.	1949	77.0	14	—	85	11	—	110	12—15	—	12—15	16—18	—	12—18
25	27.	3.	1949	80.0	4	—	13	4	—	21	12, 13	—	12—15	16—21	—	12—21
32	27.	3.	1949	97.5	—	—	10	8	—	18	—	—	14—16	17—19	—	14—19
17	28.	3.	1949	81.5	—	1	—	1	—	2	—	13	—	25	—	13—25

Table 3b. Data on species composition for mixed bottom trawl catches of pelagic fishes taken in the Mid-Dalmatian channels, 1957 and 1958 (from the data of Županović, 1961)

Station No.	Date	Mean depth m	Sardine	Number of fish			Total
				Sprat	Anchovy	Mackerel	
1	26. 6. 1957	58.0	—	9500	—	1	9501
9	1. 7. 1957	37.5	2	—	5	—	7
9	29. 7. 1957	37.5	1	—	1	—	2
1	2. 9. 1957	58.0	1	825	—	—	826
4	3. 9. 1957	85.0	—	1	2	—	3
5	3. 9. 1957	68.5	—	58	1	—	59
4	6. 10. 1957	85.0	—	1	—	4	5
1	7. 10. 1957	58.0	—	141	—	1	142
5	7. 10. 1957	68.5	—	1500	11	10	1521
1	6. 11. 1957	58.0	2	—	5	—	7
5	9. 11. 1957	68.5	55	508	2	1	566
9	11. 11. 1957	37.5	45	—	—	33	78
10	11. 11. 1957	29.5	40	—	70	—	110
9	9. 12. 1957	37.5	9	17	—	2	28
10	9. 12. 1957	29.5	32	93	4	1	130
1	7. 1. 1958	58.0	—	1	—	1	2
4	8. 1. 1958	85.0	—	—	1	2	3
9	9. 12. 1957	37.5	9	17	—	2	28
10	9. 1. 1958	29.5	4	—	14	—	18
7	6. 2. 1958	72.0	28	—	1	—	29
9	6. 2. 1958	37.5	—	10	2	1	13
6	7. 2. 1958	85.5	1	—	—	1	2
1	3. 4. 1958	58.0	—	21	1	—	22
9	6. 5. 1958	37.5	4	13	3	—	20
4	4. 6. 1958	85.0	87	20	—	—	107
9	6. 6. 1958	37.5	1249	—	11	3	1263
10	6. 6. 1958	29.5	85	—	3	2	90
9	1. 7. 1958	37.5	3	—	2	1	6
10	2. 7. 1958	29.5	4	—	2	2	8

Table 3c. Data on species composition and length for mixed bottom trawl catches of pelagic fishes taken in some parts of the central and southern Adriatic, in the 1954—1955 trawling season (from the data of Mužinić, 1956)

34

Catch No.	Date	Depth m	Number of fish				Length range, cm			
			Sardine	Anchovy	Mackerel	Total	Sardine	Anchovy	Mackerel	All
2	27. 11. 1954	(57)	39	12	—	51	9—12	9—13	—	9—13
3	27. 11. 1954	(63)	114	22	—	163	9—16	8—17	—	8—17
* 5	3. 12. 1954	(35)	68	52	—	120	9—12	9—13	—	9—13
6	3. 12. 1954	(83)	13	4	—	17	13—18	16—17	—	13—18
9	16. 12. 1954	20	44	33	—	77	11—13	10—15	—	10—15
* 10	16. 12. 1954	30	100	+ 13	—	113	10—16	11—14	—	10—16
11	17. 12. 1954	73	13	—	5	18	15—17	—	18, 19	15—19
14	20. 12. 1954	(80)	107	—	28	135	14—18	—	18—22	14—22
* 15	21. 12. 1954	110	13	12	35	60	14—19	14—18	16—21	14—21
19	5. 1. 1955	110	—	++ 11	15	26	—	—	18—25	18—25
21	20. 1. 1955	(83)	—	14	1	15	—	16, 17	17	16—17
* 23	30. 1. 1955	—	++ 33	—	81	114	—	—	15—21	15—21
26	8. 2. 1955	120	++ 2	6	6	14	—	16, 17	19—24	16—24
27	8. 2. 1955	(120)	14	—	9	23	16—18	—	15—26	15—26
29	13. 2. 1955	82	6	16	1	23	15	13—17	19	13—19
30	13. 2. 1955	(82)	22	3	—	25	14—17	13, 14	—	13—17
31	15. 2. 1955	82	8	3	1	12	14, 15	14	19	14—19
** 33	23. 2. 1955	46	40	19	—	59	12—16	11—16	—	11—16
*** 34	28. 2. 1955	(85)	21	—	1	22	13—17	—	18	13—18
36	—	—	15	+ 5	—	20	13—17	17	—	13—17
37	—	—	6	12	—	18	14—17	16, 17	—	14—17

* Sample

** Two successive catches

*** Three successive catches

+ One individual unmeasurable

++ Unmeasurable

No. 11

Table 4. Data on length for mixed species samples of catches by light from Kaštela Bay, 1969—1974 (in missing samples the length data were not available or the numbers were less than 10)

Sample No.	Date	Number of fish	Range cm	Length data		
				Mean cm	Standard deviation cm	Coefficient of variation %
1	28. 3. 1969	142	*10.0—17.5	13.5	1.87	13.8
2	5. 4. 1969	282	9.2—17.2	11.5	1.63	14.1
4	26. 7. 1969	316	8.3—13.4	10.9	1.11	10.1
5	21. 8. 1969	234	9.3—15.7	12.8	0.86	6.7
6	2. 9. 1969	285	7.6—15.5	11.1	1.49	13.5
7	4. 9. 1969	302	8.2—15.6	11.7	1.57	13.4
9	14. 10. 1969	221	7.9—16.4	11.3	1.75	15.5
13	2. 6. 1970	445	9.7—18.4	13.6	1.45	10.6
14	12. 6. 1970	226	9.0—17.7	13.0	2.27	17.4
15	14. 6. 1970	111	9.1—18.1	15.2	1.86	15.2
16	23. 6. 1970	165	9.3—18.0	13.8	2.32	16.8
17	25. 6. 1970	119	9.6—17.8	14.9	2.32	15.6
18	26. 6. 1970	157	9.6—17.8	14.1	2.48	17.5
19	3. 7. 1970	348	7.6—18.1	12.0	2.56	21.3
20	9. 7. 1970	104	11.0—17.9	15.8	1.46	9.2
22	19. 5. 1971	188	9.5—18.0	13.6	2.38	17.5
23	22. 5. 1971	197	13.0—18.3	15.7	1.26	8.0
24	18. 6. 1971	379	8.2—17.5	12.1	1.56	12.9
26	20. 9. 1971	150	13.2—20.3	17.1	1.12	6.6
27	22. 9. 1971	225	9.3—18.5	14.2	1.58	11.1
28	25. 9. 1971	123	13.1—19.2	16.3	1.66	10.2
29	28. 9. 1971	84	15.7—19.2	17.6	0.67	3.8
30	20. 3. 1972	96	14.4—18.5	15.8	0.60	3.8
31	23. 3. 1972	211	13.7—18.7	15.7	0.72	4.6
32	4. 4. 1972	167	13.7—18.6	15.4	0.76	4.9
33	10. 5. 1972	221	11.5—19.1	15.2	1.58	10.3
34	7. 9. 1972	145	11.8—18.0	14.9	1.36	9.1
35	9. 2. 1973	134	12.6—18.0	15.4	0.85	5.5
36	23. 3. 1973	137	11.3—16.7	14.5	1.28	8.8
37	12. 5. 1973	219	10.4—17.1	13.8	1.46	10.6
38	22. 5. 1973	178	12.0—18.3	15.3	1.18	7.7
39	24. 4. 1974	151	10.6—20.1	15.0	1.79	12.0
40	13. 5. 1974	188	10.0—18.6	13.6	2.36	17.3
41	30. 5. 1974	252	8.7—12.7	10.9	0.74	6.8
42	31. 5. 1974	274	9.6—18.0	11.5	1.57	13.6
43	14. 6. 1974	210	10.3—18.5	12.2	1.27	10.4
44	15. 6. 1974	170	10.3—13.3	12.1	0.51	4.2

* Only half centimeter data were available.

Table 5a. Data on length of sardines from the mixed species samples of catches by light from Kaštela Bay, 1969—1974

Sample No.	Date	Number of fish	Range cm	Length data		
				Mean cm	Standard deviation cm	Coefficient of variation %
1	28. 3. 1969	89	*13.5—17.5	14.9	0.91	6.1
2	5. 4. 1969	89	11.7—17.2	13.7	0.86	6.2
4	26. 7. 1969	280	8.3—13.0	11.0	1.03	9.4
5	21. 8. 1969	200	10.8—14.7	12.9	0.60	4.7
6	2. 9. 1969	115	10.3—15.1	12.3	0.93	7.6
7	4. 9. 1969	155	11.3—14.9	12.8	0.81	6.4
9	14. 10. 1969	83	11.6—16.4	13.3	0.82	6.1
13	2. 6. 1970	76	13.2—18.4	15.7	1.22	7.8
14	12. 6. 1970	95	13.9—17.7	15.4	0.73	4.7
15	14. 6. 1970	94	13.8—18.1	15.9	0.84	5.3
16	23. 6. 1970	82	13.3—18.0	15.9	0.90	5.7
17	25. 6. 1970	74	15.0—17.8	16.6	0.63	3.8
18	26. 6. 1970	93	14.2—17.8	16.1	0.70	4.3
19	3. 7. 1970	146	7.6—18.1	13.2	3.49	26.5
20	9. 7. 1970	89	15.0—17.9	16.4	0.59	3.6
22	19. 5. 1971	76	14.3—18.0	16.1	0.89	5.5
23	22. 5. 1971	106	13.8—18.3	16.5	1.08	6.6
24	18. 6. 1971	103	8.2—12.4	10.6	0.70	6.6
26	20. 9. 1971	77	13.2—18.8	16.9	1.39	8.2
27	22. 9. 1971	176	12.0—18.4	14.2	1.12	7.8
28	25. 9. 1971	57	13.1—17.8	14.8	1.22	8.3
29	28. 9. 1971	63	15.7—19.2	17.6	0.65	3.7
30	20. 3. 1972	69	14.4—18.5	15.8	0.60	3.8
31	23. 3. 1972	197	14.0—18.7	15.8	0.72	4.6
32	4. 4. 1972	100	14.0—18.6	15.6	0.81	5.2
33	10. 5. 1972	157	14.5—19.1	16.1	0.75	4.6
34	7. 9. 1972	93	11.8—18.0	15.3	1.39	9.1
35	9. 2. 1973	86	12.6—18.0	15.4	0.84	5.5
36	23. 3. 1973	89	12.9—16.7	15.3	0.58	3.8
37	12. 5. 1973	68	14.3—17.1	15.7	0.56	3.6
38	22. 5. 1973	151	14.3—18.3	15.7	0.63	4.0
39	24. 4. 1974	117	10.7—17.9	15.3	1.68	11.0
40	13. 5. 1974	132	11.4—18.4	14.4	2.30	15.8
41	30. 5. 1974	146	8.7—12.7	10.7	0.71	6.7
42	31. 5. 1974	164	9.0—19.2	11.4	1.94	17.0
43	14. 6. 1974	32	11.0—18.5	13.6	2.53	18.6
44	15. 6. 1974	109	10.3—13.3	12.0	0.50	4.2

* Only half centimeter data were available.

Table 5b. Data on length of anchovies from the mixed species samples of catches by light from Kaštela Bay, 1969—1974

Sample No.	Date	Number of fish	Range cm	Length data		Coefficient of variation %
				Mean cm	Standard deviation cm	
1	28. 3. 1969	53	*10.0—12.0	11.3	0.47	4.1
2	5. 4. 1969	193	9.2—11.4	10.5	0.50	4.7
4	26. 7. 1969	36	8.3—13.4	10.5	1.54	14.7
5	21. 8. 1969	34	9.3—15.7	11.7	1.40	12.0
6	2. 9. 1969	170	7.6—15.5	10.2	1.22	12.0
7	4. 9. 1969	93	8.5—14.9	10.8	1.20	11.2
9	14. 10. 1969	29	7.9—10.8	9.3	0.65	7.0
13	2. 6. 1970	369	9.7—16.5	13.2	1.08	8.2
14	12. 6. 1970	131	9.0—14.4	11.3	1.13	10.0
15	14. 6. 1970	17	9.1—14.2	11.3	1.38	12.2
16	23. 6. 1970	83	9.3—14.9	11.7	1.09	9.3
17	25. 6. 1970	45	9.6—15.0	12.1	1.15	9.5
18	26. 6. 1970	64	9.6—13.1	11.3	0.87	7.7
19	3. 7. 1970	202	9.1—14.7	11.2	0.91	8.1
20	9. 7. 1970	15	11.0—14.1	12.5	0.80	6.4
22	19. 5. 1971	112	9.5—16.1	11.9	1.31	11.0
23	22. 5. 1971	91	13.0—16.7	14.8	0.76	5.2
24	18. 6. 1971	230	9.8—14.8	12.2	1.03	8.4
30	20. 3. 1972	27	14.9—16.5	15.7	0.40	2.5
31	23. 3. 1972	14	13.7—16.0	15.2	0.60	3.9
32	4. 4. 1972	67	13.7—16.4	15.2	0.63	4.1
33	10. 5. 1972	64	11.5—16.8	13.1	1.00	7.6
34	7. 9. 1972	52	12.3—16.4	14.2	0.93	6.6
35	9. 2. 1973	48	13.5—16.8	15.2	0.84	5.6
36	23. 3. 1973	48	11.3—16.2	13.2	1.14	8.6
37	12. 5. 1973	151	10.4—16.0	12.9	0.88	6.9
38	22. 5. 1973	27	12.0—15.9	12.9	0.72	5.6
39	24. 4. 1974	34	10.6—16.9	13.8	1.75	12.7
40	13. 5. 1974	56	10.0—14.1	11.7	1.03	8.8
41	30. 5. 1974	106	9.2—12.7	11.2	0.66	5.8
42	31. 5. 1974	99	10.2—14.6	11.6	0.60	5.2
43	14. 6. 1974	178	10.3—15.0	11.9	0.55	4.6
44	15. 6. 1974	61	11.1—13.0	12.2	0.49	4.1

* Only half centimeter data were available.

Table 5c. Data on length of horse mackerels (*Trachurus* sp.) from the mixed species samples of catches by light from Kaštela Bay, 1971

Sample No.	Date	Number of fish	Range cm	Length data		
				Mean cm	Standard deviation cm	Coefficient of variation %
24	18. 6. 1971	39	12.2—17.1	14.5	0.79	5.4
26	20. 9. 1971	73	15.7—20.3	17.2	0.70	4.1
27	22. 9. 1971	11	14.0—18.5	17.1	1.14	6.6
28	25. 9. 1971	66	16.0—19.2	17.5	0.62	3.5
29	28. 9. 1971	21	16.3—19.2	17.6	0.69	3.9

Table 5d. Data on length of bogues (*Boops boops* /L./) from the mixed species samples of catches by light from Kaštela Bay, 1969 and 1971

Sample No.	Date	Number of fish	Range cm	Length data		
				Mean cm	Standard deviation cm	Coefficient of variation %
7	4. 9. 1969	54	8.2—15.6	10.4	1.68	16.2
9	14. 10. 1969	109	8.5—11.8	10.2	0.60	5.9
27	22. 9. 1971	38	9.3—17.5	12.9	2.14	16.6

Table 6. Data on length for the mixed bottom trawl catches of pelagic fishes taken in some parts of the central and southern Adriatic, in the 1954—1955 trawling season (from the data of Mužinić, 1956)

Catch No.	Date	Number of fish	Range cm	Length data		
				Mean cm	Standard deviation cm	Coefficient of variation %
2	27. 11. 1954	51	9.3—13.9	11.1	0.97	8.7
3	27. 11. 1954	136	8.2—17.0	12.2	2.07	17.0
* 5	3. 12. 1954	120	9.2—13.1	11.3	0.85	7.5
9	16. 12. 1954	77	10.9—15.9	12.0	0.75	6.3
* 10	16. 12. 1954	113	10.4—16.2	11.8	1.09	9.2
14	20. 12. 1954	135	14.8—22.7	17.2	1.54	9.0
* 15	21. 12. 1954	60	14.2—21.4	17.6	1.58	9.0
** 33	23. 2. 1955	59	11.5—16.4	13.5	1.10	8.1

* Sample

** Two successive catches

Table 7a. Data on length of sardines from the mixed bottom trawl catches of pelagic fishes taken in some parts of the central and southern Adriatic, in the 1954—1955 trawling season (from the data of Mužinić, 1956)

Catch No.	Date	Number of fish	Range cm	Length data		
				Mean cm	Standard deviation cm	Coefficient of variation %
2	27. 11. 1954	39	9.3—12.1	10.9	0.68	6.2
3	27. 11. 1954	114	9.8—16.3	12.3	1.89	15.4
* 5	3. 12. 1954	68	9.8—12.8	11.2	0.68	6.1
9	16. 12. 1954	44	11.0—13.1	11.8	0.54	4.0
* 10	16. 12. 1954	100	10.4—16.2	11.8	1.09	9.2
14	20. 12. 1954	107	14.8—18.9	16.6	0.85	5.1
* 15	21. 12. 1954	13	14.8—19.1	16.4	1.24	7.6
** 33	23. 2. 1955	40	12.0—16.4	13.5	0.94	7.0

* Sample

** Two successive catches

Table 7b. Data on length of anchovies from the mixed bottom trawl catches of pelagic fishes taken in some parts of the central and southern Adriatic, in the 1954—1955 trawling season (from the data of Mužinić, 1956)

Catch No.	Date	Number of fish	Range cm	Length data		
				Mean cm	Standard deviation cm	Coefficient of variation %
2	27. 11. 1954	12	9.9—13.9	11.7	1.33	11.4
3	27. 11. 1954	22	8.2—17.0	11.7	2.84	24.3
* 5	3. 12. 1954	52	9.2—13.1	11.3	1.04	9.2
9	16. 12. 1954	33	10.9—15.9	12.1	1.01	8.3
* 10	16. 12. 1954	13	11.3—14.8	12.4	0.96	7.7
* 15	21. 12. 1954	12	14.2—18.2	16.4	1.11	6.8
** 33	23. 2. 1955	19	11.5—16.2	13.3	1.44	10.8

* Sample

** Two successive catches

Table 7c. Data on length of mackerels from the mixed bottom trawl catches of pelagic fishes taken in some parts of the central and southern Adriatic, in the 1954—1955 trawling season (from the data of Mužinić, 1956)

Catch No.	Date	Number of fish	Range cm	Length data		
				Mean cm	Standard deviation cm	Coefficient of variation %
14	20. 12. 1954	28	18.3—22.7	19.5	1.26	6.5
* 15	21. 12. 1954	35	16.4—21.4	18.3	1.30	7.1

* Sample

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O SASTAVU I DUŽINSKIM KARAKTERISTIKAMA MIJEŠANIH LOVINA PELAGIJSKIH RIBA U JADRANU

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KRATAK SADRŽAJ

Izvršena je analiza sastava 44 miješanih uzoraka lovina plivarice ostvarenih pomoću umjetnog svjetla u Kaštelanskom zaljevu u razdoblju 1969—1974. s obzirom na vrste, a od toga je 37 uzoraka ispitano s obzirom na dužinske karakteristike. S obzirom na prisutnost pelagijskih riba, a dijelom i na njihove dužinske karakteristike analizirano je i 100 eksperimentalnih lovina vuče izvršenih za vrijeme Ribarstveno-biološke ekspedicije »Hvar«, 1948. i 1949, najvećim dijelom u otvorenom, osobito srednjem i južnom Jadranu, na srednjoj dubini vučarenja od 125 m (najveća dubina vučarenja iznosila je 382 m) (Karlovac, O., neobjavljeni podaci), za vrijeme vučarenja u plićim vodama srednjodalmatinskih kanala, 1957. i 1958. (Županić, 1961), te u srednjem i dijelom južnom Jadranu, u sezoni vučarenja 1954—1955. (Mužinić, 1956). Međutim, samo za lovine iz sezone vučarenja 1954—1955. postojali su potpuni podaci o dužini (za lovine izvršene u toku Ekspedicije »Hvar« zabilježene su samo ekstremne dužine)*).

Iz podataka o sastavu i strukturi uzoraka i lovina sastavljenih od dviju ili više pelagijskih riba pokušalo se, na osnovi opažanja o njihovu ponašanju u akvarijskim uvjetima, nešto zaključiti i o njihovu ponašanju u prirodi.

Miješani uzorci lovina pelagijskih riba dobijenih pomoću svjetla u Kaštelanskom zaljevu, u razdoblju 1969—1974, sadržavali su obično srdelu (*Sardina pilchardus* /Walb./) i brgljuna (*Engraulis encrasicolus* /L./), i to u različitim proporcijama (tab. 1). U najvećem dijelu uzoraka prevladavala je srdela. Zastupljenost semipelagijskih riba šnjura (*Trachurus* sp.), odnosno bukve (*Boops boops* /L./) rijetko je premašivala zastupljenost srdele.

Udio srdele i brgljuna u miješanim uzorcima lovina pelagijskih riba dobijenih pomoću svjetla bio je različit u pojedinim godinama (1971—1974). Najveće vrijednosti udjela srdele zabilježene su u uzorcima iz 1972, a najveće vrijednosti udjela brgljuna u onima iz 1973. i 1974.

Miješane pelagijske ribe nisu bile rijetke u lovinama dubinske vuče iz kanalskih voda srednje Dalmacije ostvarenim 1957. i 1958. (tab. 2). One su,

*) Svi podaci o dužini odnose se na totalnu dužinu ribe. Kod lovina vuče upotrijebljene su dijelom (tab. 3a i c, sl. 2.2.2.1. i 3.2.2) donje granice dužinskih razreda.

naime, bile ustanovljene u 50,9% lovina. Nešto slabije bile su one zastupljene u lovinama dubinske vuče izvršenim za vrijeme Ribarstveno-biološke ekspedicije »Hvar« u otvorenom Jadranu u 1948. i 1949. Takva zastupljenost miješanih pelagijskih riba u lovinama dubinske vuče mogla bi govoriti u prilog činjenici da one nisu bile dijelom slučajno ulovljene vučom, tj. u toku samog dizanja mreže.

Češće pojavljivanje dviju ili više pelagijskih riba u demerzalnim lovinama iz plitkih voda može se objasniti preferencijom triju vrsta (srdela, papalina i brgljun) za manje dubine.

U plitkim vodama srednjeg i dijelom južnog Jadrana srdela se u demerzalnim lovinama iz sezone vučarenja 1954—1955. često nalazila s brgljunom. Naprotiv, lovine iz otvorenijih voda rijetko su sadržavale srdelu i brgljuna zajedno. U lovinama iz tih voda srdela se često pojavljivala sa skušom. Još u većoj mjeri vrijedilo je to za brgljuna. U demerzalnim lovinama brgljun je rijetko dolazio sam.

Sudeći prema miješanim lovinama pelagijskih riba dobijenim pri demerzalnom lovu, čini se da najveća sličnost horizontalne raspodjele srdele i brgljuna postoji u najplićim, užim obalnim vodama u kojima se stalno zadržavaju njihovi mladi primjerci. Međutim, dvije ili više pelagijskih riba susretale su se često i u demerzalnim lovinama iz područja sjeverno od kotline Jabuke i u vodama Palagruža.

Udio pojedinih vrsta u miješanim lovinama pelagijskih riba ostvarenim pomoću dubinske vuče znatno je varirao (tab. 3a-c). U nekim takvim obilnijim lovinama jedna je vrsta znala dominirati i s više od 95%. U takvim lovinama iz dubljih voda dominirala je skuša, a u onim iz plićih voda najvećim dijelom srdela.

Totalna dužina pojedinih primjeraka iz miješanih uzoraka lovina pelagijskih riba iz Kaštelanskog zaljeva, koje su dobijene pomoću svjetla, u razdoblju 1969—1974, kretala se od 7,6 do 20,3 cm (kod srdele od 7,6 do 19,2 cm, a kod brgljuna od 7,6 do 16,9 cm). Srednja totalna dužina tih uzoraka kretala se od 10,9 do 17,6 cm (tab. 4). Srednja totalna dužina srdele kretala se od 10,6 do 17,6 cm, a brgljuna od 9,3 do 15,7 cm (tab. 5a i b).

Srednje vrijednosti dužine srdele iz miješanih uzoraka bile su najvećim dijelom veće od srednjih vrijednosti dužine brgljuna iz istih uzoraka (tab. 5a i b).

Najveće srednje dužine srdele zabilježene su u 1971, a brgljuna u 1972, tj. u godinama u kojima je njihov udio u miješanim uzorcima lovina bio malen.

Varijacija dužine u miješanim uzorcima lovina pelagijskih riba dobijenih pomoću svjetla u Kaštelanskom zaljevu bila je vrlo različita (standardne devijacije kretale su se od 0,51 do 2,56 cm, ali uglavnom ispod 2,00 cm) (tab. 4). Kod pojedinih vrsta ona je općenito bila manja (< 1,40 cm) (tab. 5a-d). Neki miješani uzorci (br. 29—32 i 44) pokazali su niske vrijednosti standardne devijacije dužine (< 0,80 cm) slične onima sastavnih vrsta i raspodjelu dužine tih vrsta koja se u znatnoj mjeri podudarala (tab. 4 i 5a-c, sl. 2.2.1.2a, d i f).

Od tih uzoraka jako su se razlikovali uzorci (br. 1, 2, 14—18, 20, 22, 28, 33, 37 i 38) većinom s visokim vrijednostima standardne devijacije dužine (uglavnom > 1,50 cm) koje su najvećim dijelom bile znatno različite od vrijednosti zabilježenih kod sastavnih vrsta (tab. 4, 5a-c). Prema tome, raspodjela dužine sastavnih vrsta iz tih miješanih uzoraka pokazala je nikakvo ili vrlo slabo podudaranje (sl. 2.2.1.2.a-e).

Na osnovi akvarijskih opažanja na srdeli, a donekle i na srdeli i brgljunu držanim zajedno pretpostavljeno je da vrste iz prvih uzoraka tvore u prirodnim uvjetima koherentne grupe, a da se one iz drugih uzoraka ne grupiraju zajedno u jata, već tvore agregacije. Neki od tih drugih uzoraka potjecali su vjerojatno od koherentnih jata pomiješanih u toku samog lova.

Bilo je također pretpostavljeno da vrste iz miješanih uzoraka s dosta znatnom varijacijom dužine, predstavljene velikim primjercima, ali u malim proporcijama (br. 15, 20 i 38) (tab. 1, 4, 5a i b, sl. 2.2.1.1b i e, 2.2.1.2.b i e) mogu koegzistirati s malim dobro zastupljenim primjercima drugih vrsta u koherentnim grupama. Naprotiv, takvu koegzistenciju mogli bi teško ostvariti mali slabo zastupljeni primjerci i ona, što više, ne bi ni predstavljala prednost za njih. Primjerci dviju veličina iste vrste ponašali bi se slično.

Naravno, bilo je i miješanih uzoraka lovina pelagijskih riba pomoću svjetla koji predstavljaju prijelaz između dviju spomenutih skupina uzoraka (br. 5, 6, 13, 23, 34 i 35) (tab. 4, 5a i b, sl. 2.2.1.2.a-e). Takvi miješani uzorci pokazali su umjerenu varijaciju dužine i djelomično podudaranje raspodjele dužine sastavnih vrsta. Ako te vrste, pri takvoj dužinskoj strukturi, uopće tvore zajednička jata, to može biti samo privremeno, jer bi se jata lako razbijala pri povećanju brzine kretanja ribe.

Najposlije, na osnovi nekih akvarijskih iskustava pretpostavljeno je da je zajedničko formiranje jata srdele i šnjura (*Trachurus* sp.) samo privremeno.

Slijedilo bi da je srazmjerno mali dio od mnogobrojnih miješanih uzoraka lovina pelagijskih riba dobijenih pomoću svjetla potjecao od permanentno koherentnih miješanih jata. Mnogi drugi miješani uzorci potjecali su vjerojatno od agregacija ili privremenih, nepostojanih jata ili pak od stabilnih jata vrsta pomiješanih za vrijeme samog lova.

Totalna dužina primjeraka pelagijskih riba ulovljenih pri demerzalom lovu za vrijeme Ekspedicije »Hvar«, 1948. i 1949, kretala se od 4 do 37 cm, dok se ona srdele kretala od 8 do 19 cm, brgljuna od 10 do 20 cm, a skuše od 18 do 32 cm (tab. 3a). Naprotiv, odgovarajuće individualne totalne dužine pelagijskih riba iz miješanih lovina dubinskom vučom u srednjem i dijelom južnom Jadranu, u sezoni vučarenja 1954—1955, bile su manje i iznosile su od 8 do 26 cm, one srdele od 9 do 19 cm, brgljuna od 8 do 18 cm, a skuše od 15 do 26 cm (tab. 3c).

Srednje vrijednosti totalne dužine obilnijih miješanih lovina pelagijskih riba vučom iz sezone 1954—1955. kretale su se od 11,1 do 17,6 cm, one srdele od 10,9 do 16,6 cm, a brgljuna od 11,3 do 16,4 cm (tab. 6, 7a i b). Te su lovine pokazale uglavnom umjerenu varijaciju dužine (standardne devijacije od 0,75 do 1,58 cm s jednom iznimkom) (tab. 6). Najviše vrijednosti standardne devijacije zabilježene kod njih bile su slične onima ustanovljenim kod lovina u kojima je bila zastupljena samo jedna vrsta. Na osnovi takve varijacije dužine i raspodjele dužine (sl. 2.2.2.1 i 3.2.2) pretpostavljeno je zajedničko grupiranje vrsta iz većeg dijela tih lovina, utoliko više što su lovine dobijene u hladnijem dijelu godine, kada je riba općenito slabo aktivna.