LENGTH-WEIGHT RELATIONSHIPS AND SIZE DISTRIBUTIONS OF MEDITERRANEAN SWORDFISH (*XIPHIAS GLADIUS* L.) CAUGHT BY LONGLINERS IN THE MEDITERRANEAN SEA

Paolo Pignalosa[2], Luigi Pappalardo[2], Giorgia Gioacchini[1], Oliana Carnevali[1]

SUMMARY

A total of 2.134 swordfish were collected from Mediterranean Sea during the sampling activity concerning the National Observation and Monitoring Programme 2018.
This work presents a lenght-weight relationships and the monthly size distributions of length and weight classes for the swordfish caught by Italian longline fishery. The length-weight relationships parameters were obtained from the Lower Jaw Fork Length (LJFL) and Round Weight (RWT).
In this study a new equation obtained from data collected during the fishing season 2018 was determined (1) and a last combined L-W equation applicable to the Mediterranean swordfish is also provided (2). The equations obtained in this study are as follow:

1. **$RWT = 5E^{-06} * LJF^{3,2024}$ (R2 = 0,9477)**
2. **$RWT = 7E^{-06} * LJF^{3,1213}$ (R2 = 0,9152)**

The authors intend to show that a wide range of swordfish (juveniles) catches is included between 100-140 cm. In addition, a better statistics value of the swordfish catches was obtained when comparing the data observed in the present study with the results obtained in the similar study carried out in Porticello for the 2018.

KEYWORDS: Xiphias gladius, size composition, size distribution, LJFL, RWT, Mediterranean sea, longline.

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1. Introduction

The swordfish (*Xiphias gladius* L.) is one of the most important species of large pelagic for commercial interest. Swordfish specimens are usually landed in different conditions (Round, Gilled and Gutted etc.) in the different Italian ports.

This study was realized as part of the National Observation and Monitoring Programme 2018 funded by the Italian Ministry of Agricultural, Food and Forestry Policies (Mipaaf) - (General Directorate of Fisheries and Aquaculture), in order to acquire size measurements (length, weight) on swordfish during the sampling period (2018). The data were usually collected from landed fish, in some of the main ports of landing on the Italian coast.

The present study intends to estimate length-weight relationships and to represents the monthly size distributions of lenght and weight classes of the specimens of swordfish catched by the Italian longline fleet, operating in the Mediterranean Sea.

In addition, the authors intend to show the final result obtained by comparing this dataset with data collected in Porticello (Sicily), intended as pilot project, during the same sampling period in order to provide a definitive length-weight relationship and relative equation, and to improve the dataset available for the stock assessment.

2. Materials and Methods

This work was carried out in some of the main ports of landing designated by the Mipaaf on the Italian coast in order to report the catches of Swordfish and Bluefin tuna.
A total of 2.134 measurements were obtained by the national observers involved by OCEANIS s.r.l. and the scientific staff of the Department of Life and Environmental Sciences (DiSVA) - Università Politecnica delle Marche, Ancona (Italy). Data were collected from April to December 2018 from both onboard observations and landings from the Italian fleet operating in the Mediterranean Sea by qualified marine biologists working in Italy.

In collaboration with the maritime authority, for each specimen of swordfish, information on total catches were daily collected at every landing, noting several biometric measurements, such as:

- Lower Jaw-Fork Length (LJFL);
- Total Straight Length (TSL);
- Gill-Gutted Weight (GWT);
- Round Weight (RWT).

LJFL (Lower Jaw Fork Length, nearest cm) which is defined as the distance between tip of the lower jaw of the fork of the tail (Miyake, 1990) and RWT (Round Weight, nearest Kg) are here considered as distribution factors.

The monitoring activities were also carried out directly onboard the fishing vessels in order to collect biological samples (gonads, second anal fin, liver, blood sample, stomach). The size data and the weight data were aggregate by 10 cm and 10 Kg intervals in order to estimate the monthly size distributions and, regarding length-weight relationships, the correlation factor (R^2) was used to evaluate the accuracy of the examined equation.

The results obtained were compared with the data collected in Porticello-Palermo (pilot project), all acquired during the fishing season 2018, in order to provide a total length-weight relationship and relative equation.

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3. Results and Discussion

Total catches observed during the landing activities

From April 2018 to November 2018, intensive sampling was conducted at the major landing site of Italian coast (Table 1 shows the list of the main ports where the monitoring activities were carried out). The value of catches landed in Marsala (687) accounts alone for 32,2 % of the total. Fig. 1 shows the distribution of the catches (N° of specimens of swordfish caught by longline fleet) acquired per month, during the entire period by the National Observers.

The distribution of 2.134 swordfish catches is represented on the basis of the size-lenght classes (cm), for range of 10 cm each (Fig. 2). The samples collected had total length ranging from 78 cm to 245 cm (LJFL) with a mean value of 124,7 cm.
109 specimen of swordfish (5,1%) were landed with size value below the limit of the undersized swordfish established by ICCAT.
The size-length classes included between 100 cm and 140 cm account for 75,4 % of the total catches. Classes above 140 cm all contribute to the remaining 19,5% of the total catch, especially for classes included between 180 cm and 245 cm, whose yield is very low.

Fig. 3 represents the trend of the size-length classes (10 cm each) of swordfish landed by longliners per month, in which the scientific and monitoring activity of the national observers was carried out. The size-lenght distribution shows the highest abundance of size classes collected were included between 110 cm and 140 cm. Those parameters (lines drawn in different shades of blue) account for 75,4% of the total catches. In particular, two prominent peaks are observed: the first one between July and September with the highest value reported in August (100-140 cm classes represents the 80% of the total catches in this period); and the second one in November (100-140 cm classes represents the 89,7% of the total catches in this period). The distribution highlights that the smallest size class (100-110 cm, dark blue) of swordfish juveniles is the most observed during the sampling period. The class 100-110 cm alone accounts for 30% of the total catches observed.

Fig. 4 shows the monthly length frequency distribution of LJFL for swordfish catched from longliners in 2018 season. From April to June (4.a, 4.b e 4.c), sampled fish ranged in size beetween 83 cm to 245 cm, with nearly all fish in two ranges, the first between 100 and 140 cm (53,0 %) and the second from 140 to 190 cm (40,0%). From July to December (4.d, 4.e, 4.f, 4.g, 4.h, 4.i), size of collected fish ranged beetween 78 cm to 230 cm, with nearly all fish (81,3%) in the 100-140 cm range.

Fig. 5 reports the distribution of 2.134 swordfish catches on the basis of the weight classes (Kg), for range of 10 Kg each. The Round Weight has been considered in this study. The samples collected had total round weight ranging from 5,5 Kg to 184,8 Kg (RWT) with a mean value of 28,5 Kg.
30 specimen (1,0%) of swordfish were landed with Round weight value below the limit of the undersized swordfish established by ICCAT.
The weight classes included between 10 Kg and 30 Kg account for 70,0 % of the total catches. Classes above 30 Kg all contribute to the remaining 29,0% of the total catch, especially for classes included between 60 Kg and >100 Kg, whose yield is very low.

Fig. 6 represents the trend of the weight classes (10 Kg each) of swordfish landed by longliners per months. The weight size distribution shows that the highest abundance of weight classes landed were included between 10 Kg and 30 Kg. Those parameters (lines drawn in different shades of blue) account for 70,0 % of the total catches. In particular, two prominent peaks are observed: the first one between July and September with the highest value reported in August (10-30 Kg classes represents the 75,2% of the total catches in this period); and the second one in November (10-30 Kg classes represents the 89,0% of the total catches in this period). The distribution highlights that the smallest size class (10-20 Kg, dark blue) of swordfish juveniles is the most observed during the sampling period. The class 10-20 Kg alone accounts for 44,3% of the total catches observed.

Fig. 7 shows the monthly weight frequency distribution of RWG for swordfish catched from longliners in 2018 season. From April to December (Fig. 7 a, b, c, d, e, f, g, h, i), fish sampled ranged in size beetween 5,5 Kg to 184,8 Kg, with nearly all fish (70%) in the 10-30 Kg range.

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Table 1 shows a summary of the descriptive statistics of the data used in the present study to determine the LJFL-RWT equation.

Fig. 8 shows the LJFL-RWT equation obtained in this study which is described by the following equation:

$$RWT = 5E^{-06}*LJF^{3,2024} \ (R2 = 0,9477)$$

Fig. 9 shows the final LJFL-RWT equation obtained from the union of both the data collected in this study and in Porticello 2018, which is described by the following equation:

$$RWT = 7E^{-06}*LJF^{3,1213} \ (R2 = 0,9152)$$

4. Conclusions

A total of 2.134 swordfish measurements (Lower jaw-fork length LJFL, Round Weight) catched and landed by the Italian longline fleet were observed and collected by national observers in order to appreciate the frequency distribution in the size length and weight classes of the fished swordfish.

Regarding the monthly size and weight frequency distribution, our results showed a high percentage of small swordfish catches during all the sampling period, April-December (LJFL 100-140 cm and <30 Kg RWT) which, on the basis of our new findings regarding the size at first maturity of this species (data not included), should be well considered for further management scenario evaluations as the advice for the minimum catch-at-size.

Results clearly demonstrated that a significant percentage of the landings was composed by juveniles, during the entire sampling period.
The length-weight relationships provided in this study, indicate that the results herein obtained can be a valuable contribution to the advancement of knowledge on the assessment of the swordfish population in the Mediterranean Sea.
Furthermore, these results could be considered as bases of discussion into the catch-at-size analysis in future SCRS swordfish stock assessment sessions.

5. Acknowledgments

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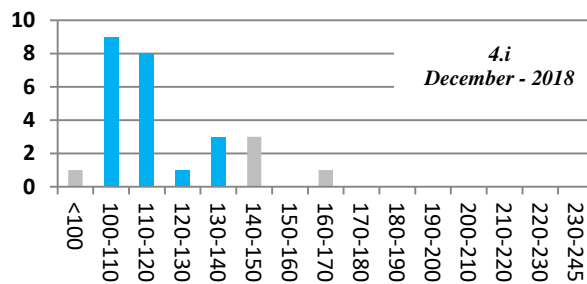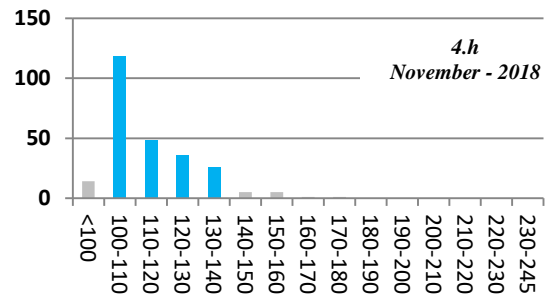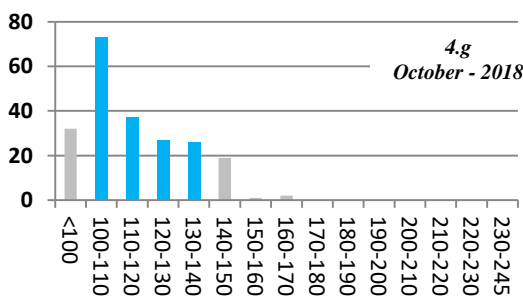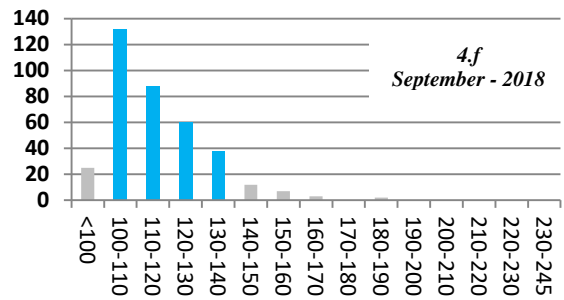[2] *OCEANIS Srl, Ercolano (NA), Italy (oceanissrl@gmail.com)*

Table 1. List of the main ports and relative quantities of landing.

Port of landing	Total catches	Port of landing	Total catches
Catania (CT)	142	S. Maria la Scala (CT)	76
Isola delle Femmine (PA)	139	S. Agata di Militello (ME)	209
Marina di Ragusa (RG)	27	Termini Imerese (PA)	62
Marsala (TP)	687	Giulianova (PE)	252
Milazzo (ME)	191	Pescara (PE)	93
Mondello (PA)	34	Torre Annunziata (NA)	37
Palermo (PA)	27	TRAPS (PORTO PAGLIA, ISOLA PIANA, CAPO ALTANO-**SARDEGNA**)	38
Riposto (CT)	120		

Table 2. Descriptive statistic of the data used in the present study.

Descriptive Statistics	LJFL-RWT dataset (n=2.134)	
	LJFL (cm)	*RWT (Kg)*
Mean	124,7	28,5
Median	119,0	22,0
SD	23,6	20,8
Min	78,0	5,5
Max	245,0	184,8

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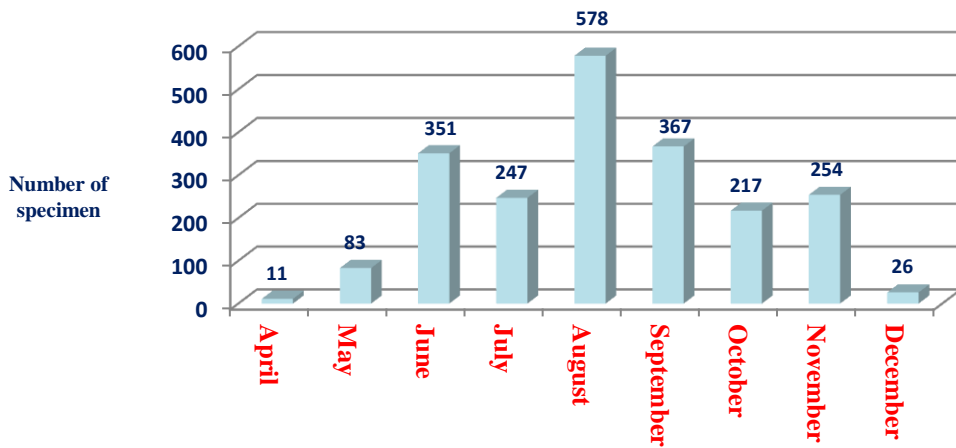
Fig. 1 - Specimens of swordfish caught by longline fleet and landed in the main ports designated by the Mipaaf, during the observing activities carried out by National Observers from April to November 2018
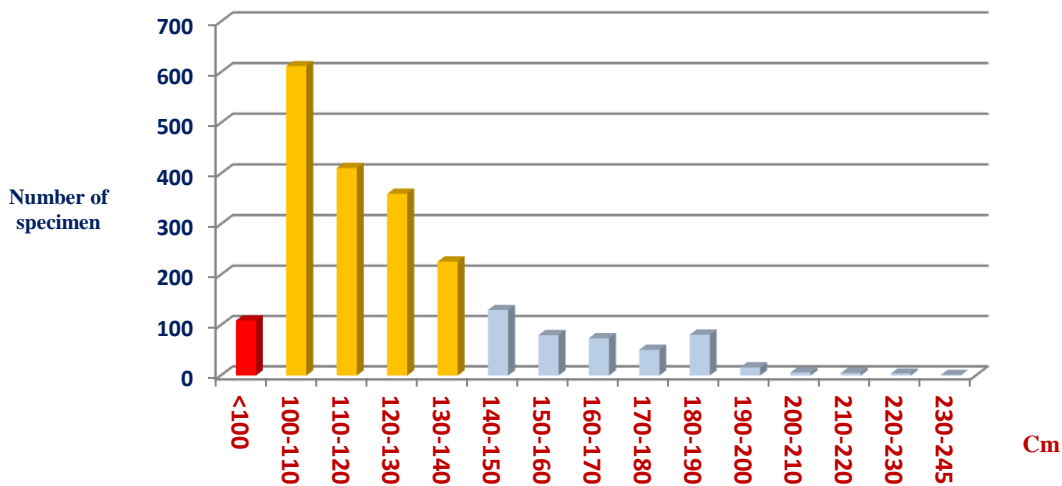
Fig. 2 - Distribution by size-lenght classes (cm) of catches of swordfish. In red undersized swordfish. In orange size-length classes included between 100-140 cm. In light blue remaining total catches
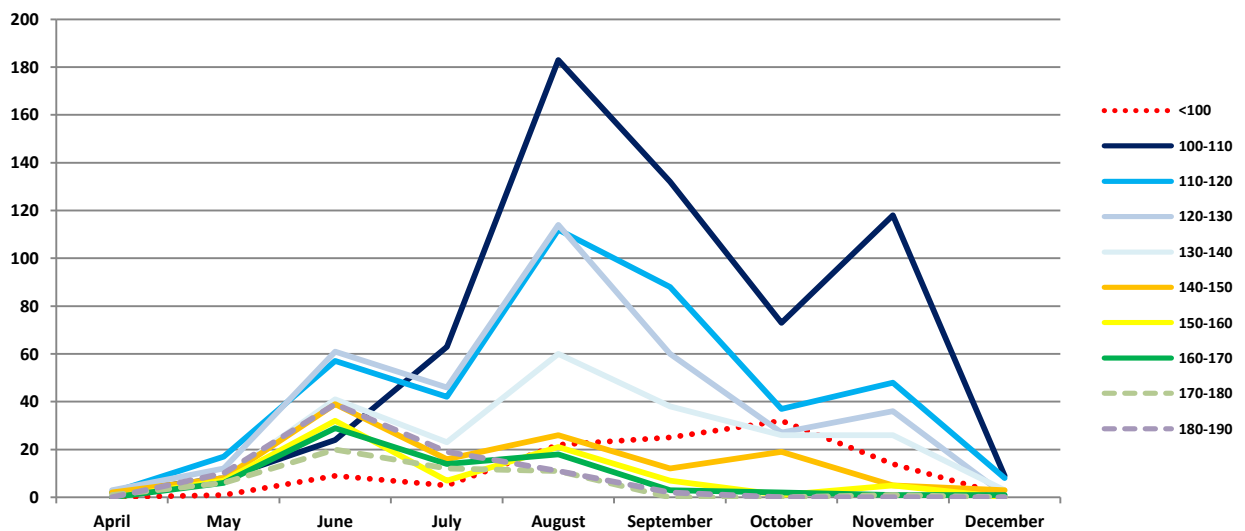
Fig. 3 - Monthly size distribution for lenght classes (cm) of catches

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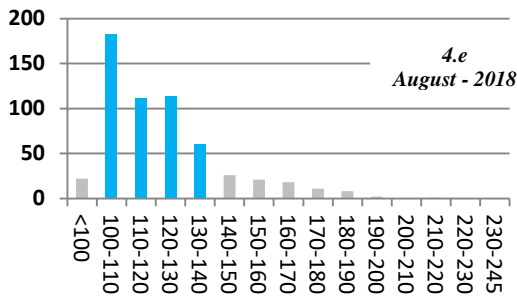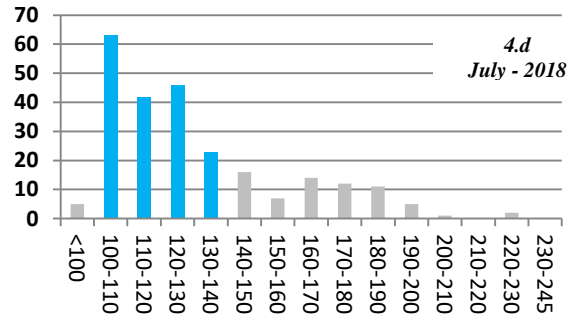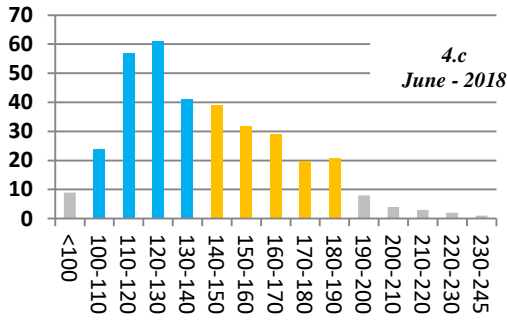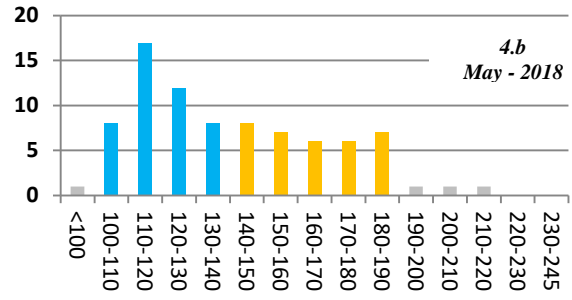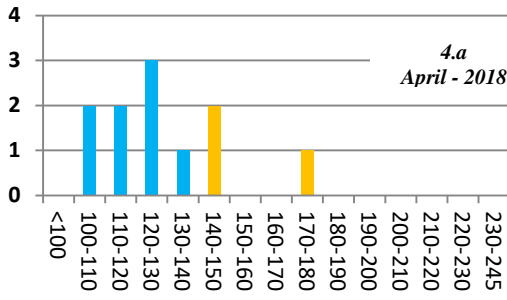
Fig. 4(a, b, c, d, e, f, g, h, i) - Size distribution of length classes (cm) of catches per month

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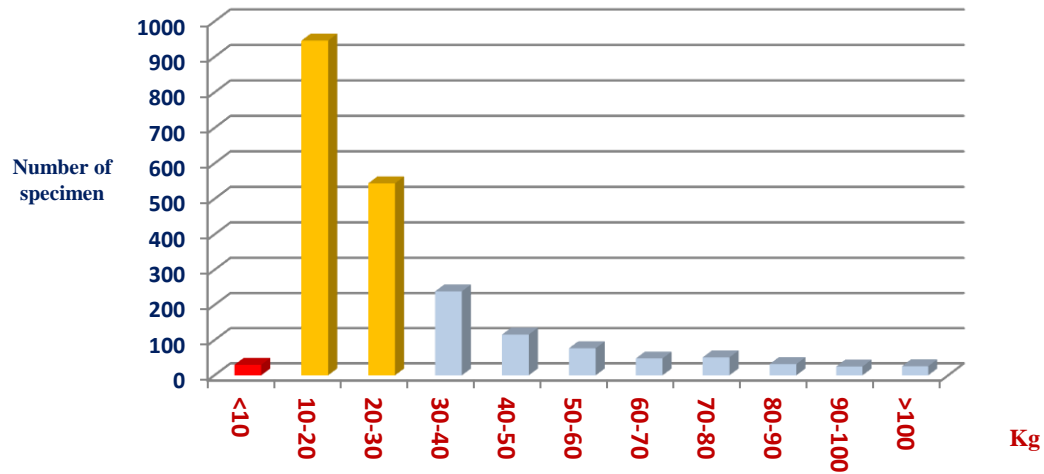[2] *OCEANIS Srl, Ercolano (NA), Italy (oceanissrl@gmail.com)*

Fig. 5 - Distribution by weight classes (Kg) of total catches. In red undersized swordfish. In orange weight classes included between 10-30 Kg. In light blue remaining total catches.
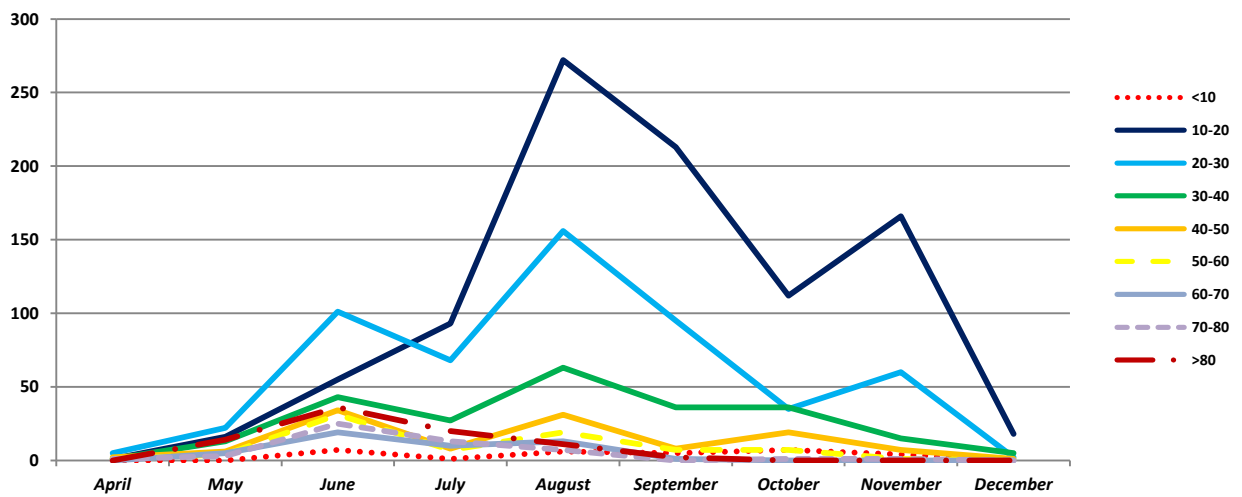

Fig. 6 - Monthly size distribution for weight classes (Kg) of catches

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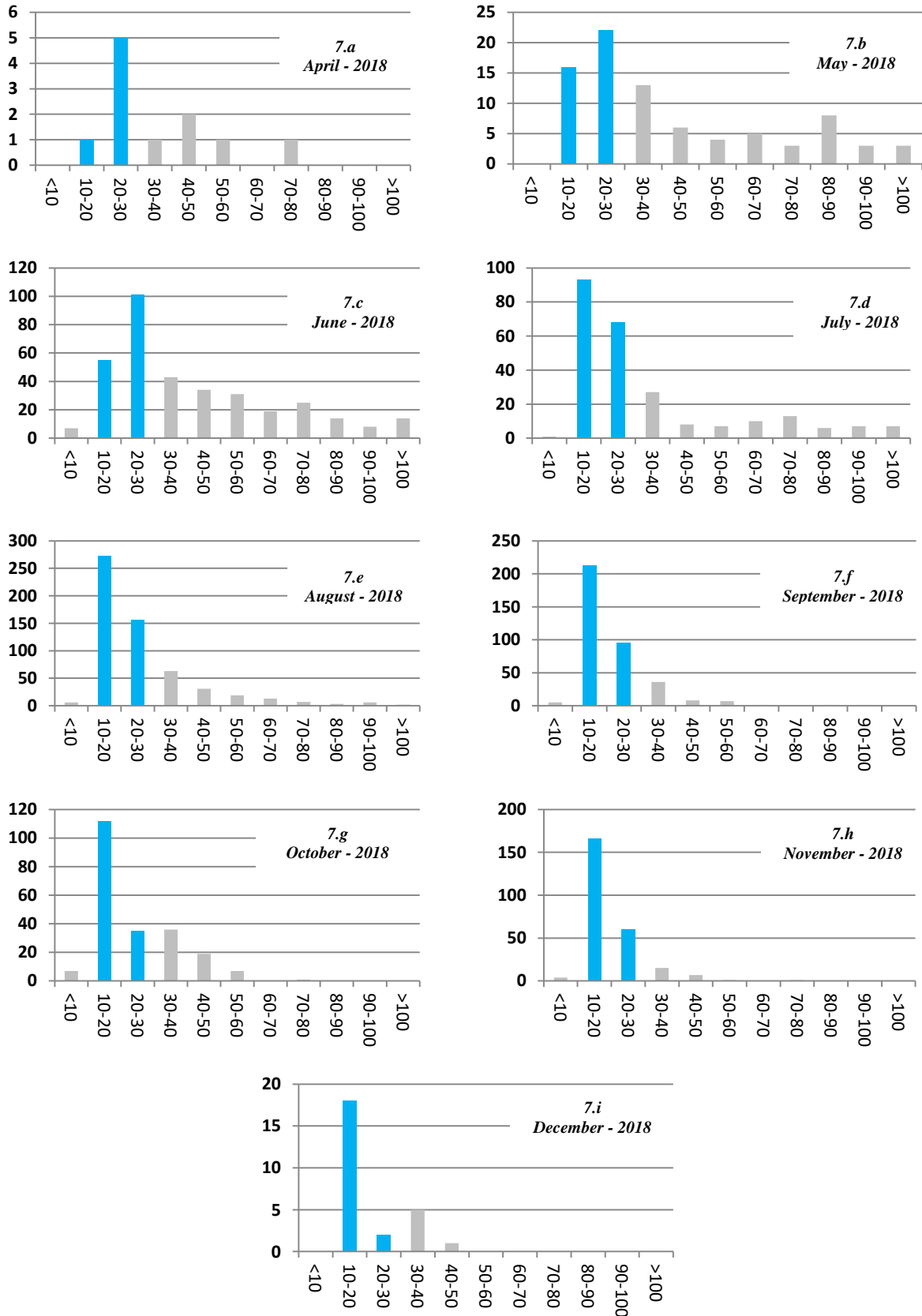[2] *OCEANIS Srl, Ercolano (NA), Italy (oceanissrl@gmail.com)*

Fig. 7(a, b, c, d, e, f, g, h, i) - Size distribution of weight classes (Kg) of catches per month

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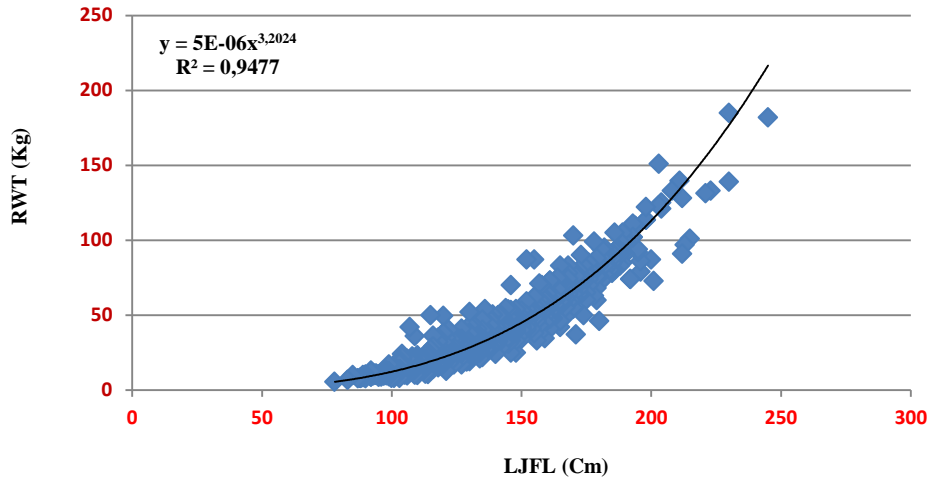[2] *OCEANIS Srl, Ercolano (NA), Italy (oceanissrl@gmail.com)*

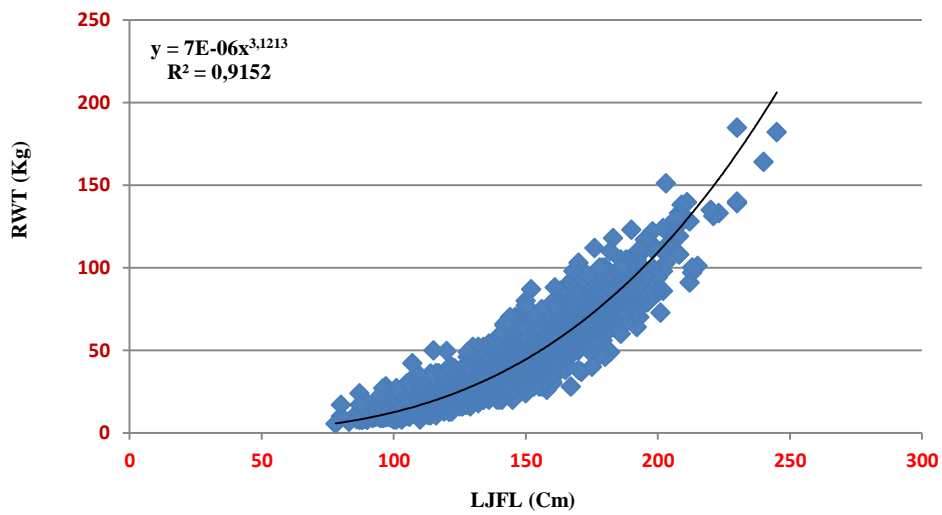*Figure 8. LJFL-RWT relationship (RWT = 5E^{-06}*LJF^{3,2024}, R2 = 0,9477) related to this study*

Figure 9. Total LJFL-RWT relationship (RWT = 7E^{-06}*LJF^{3,1213}, R2 = 0,9152) for the 2018 Mediterranean swordfish

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