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Fisheries status of the trawlers by- catch from Alexandria, Egypt

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ABSTRACT

The aim of this study is to investigate the by catch from the Egyptian Mediterranean trawlers off Alexandria during the period from March 2018 and May 2019. The catch per unit effort (CPU) ranged from 4 Kg / hr in autumn to 9 Kg / hr in summer. Invasive species reached 44 in number; 43 species of Red Sea origin and one species of Atlantic Ocean origin. The by catch was represented by one elasmobranch, 80 boney fishes and 14 invertebrates belonging to 4 phyla; 5 classes; 22 orders and 56 families. Eight families of fish were dominated and constituted the high rank of percentage during the period of investigation. 12 species were prevailing the by catch and constituted the high percentages namely: *Spicara smaris* (22.575%); *Boops boops* (12.922 %); *Nemipterus randalli* (8.943 %); *Spicara maena* (4.865 %); *Synchiropus sechellensis* (4.864 %); *Diplodus vulgaris* (4.504 %); *Lepidotrigla cavillone* (3. 313 %); *Upeneus pori* (3.225 %); *Pagellus erythrinus* (3.192 %); *Mullus barbatus* (1.804 %); *Terapon puta* (1.235 %) and *Ariosoma balearicum* (1.038 %). Nine species occurred during the four seasons; 18 species were represented during three seasons; 17 species occurred in two seasons, while forty nine species were represented in one season. The biological studies on the most economical by-catch species showed there were three species belonged to one year of life, eight species had two years of life and one species was found belonging to age group three.

INTRODUCTION

Generally, both discarded catch and non-target catch are considered to be a by-catch **(Alverson *et al.*, 1994)**. The impacts of fishing activities, especially trawling on the marine environment have been of great concern to the sustainable management of marine resources. The term by- catch means the retained catch of non target species, while the term discard catch or discards denotes the portion of the by catch returned to the sea **(Alsayes *et al.* , 2009)**. The global discards between 2010 and 2014 were estimated by 9.1 million tones. About 46 % (4.2 million tones) of this total discards were from the bottom

trawls **FAO, (2019)**. The volume of the non-target fishery in the Mediterranean is in the order of 230 000 tons' per year, (about 18% from the total catches and more than 40% from the bottom trawler with a medium percentage of about 15–39% in the Eastern Mediterranean area, **FAO,(2018).** Documented studies of by catch or trash catch in the Egyptian Mediterranean waters were conducted by many authors**: Rizkalla (1995); Faltas *et al*. (1998); El-Mor *et al*. (2002); Alsayes *et al*.(2009); Mehanna, *et al*.(2014). Rizkalla *et al*. (2016) and Ragheb *et al*. (2019).**

MATERIALS AND METHODS

Seasonal sampling was carried out from the commercial trawler operating at the west of Alexandria during the period between March 2018 and May 2019 west of Alexandria (Fig. 1). The vessel specifications: Length = 23 meter, Horse power = 230 h/p, Fisher men= 5 men. Depth of fishing operations ranged from 35 to 55 meter. Total number of hauls was 40. The coordinates of the fishing operations were given in Table (1). Samples were taken fresh to the lab, classified, identified and sorted according to the key of **Whitehead *et al.*, (1986)**; nomenclature were **Akel and Karachle (2017)** and **World Register of Marine Species (2019)**. Total length of each fish was measured in centimeter and the corresponding weight was recorded in gram. Calculating the length weight relationship was achieved according to the power equation adopted by **Le Cren (1951)**:

$W = a L^b$, where W = weight of fish in grams, L = fish length in centimeter and a & b are constants estimated by the least square method. The condition factor (K) was calculated according to the equation of **Fulton (1902)**:

$K = 100 * W / L^3$, where W= total weight in gram; L = total length in centimeter. Back calculated lengths at ages were computed using the length frequency distribution given by **Bhattacharya (1943)**.

Fig. 1. A map showing the fishing operations area during March /May 2018-2019.

RESULTS

1. Species composition:

. From Table (1), it is evident that catch per unit effort (CPU) was 9 Kg / hr in summer; 7 Kg / hr in winter; 6 Kg / hr in spring and 4 Kg / hr in autumn. Invasive species reached 10 in winter; 7 species in spring; 21 species in summer and 6 species in autumn. Trawling depth ranged between 35 meter and 55 m . Overall 95 species, involving both Pisces and invertebrates, were identified in the by catch obtained during the period between March 2018 and May 2019 (Table 2). From the Table, the by catch was represented by one elasmobranch, 80 boney fishes and 14 invertebrates belonging to 4 phyla; 5 classes; 22 orders and 56 families. It was found 43 species of Red Sea origin and one species of Atlantic Ocean origin.

Table 1. Trawling survey analysis during 2018-2019.

	Winter	Spring	Summer	Autumn
Total number of hauls	13	12	15	10
Coordinates	31° 09' 143"N 29° 31' 984" E	31° 11' 946" N 29° 41' 890" E	31° 09' 134" N 29° 31' 984" E	31° 06' 72" N 29° 28 ' 065" E
Catch per hour (kg/h)	7 Kg/hr	6 Kg/hr	9 Kg/hr	4 Kg/hr
Depth of trawling	35 m	40 m	45 m	55 m
Immigrant species	10	7	21	6

Table 2. By- catch species composition obtained from the bottom trawler operated in Alexandria during 2018- 2019.

Species	
Phylum: Chordata	**Family: Siganidae**
Class: Elasmobranchii	*Siganus rivulatus* Forsskål & Niebuhr,1775 *
Order: Rajiformes	**Family: Sparidae**
Family: Rajiidae	*Boops boops* (Linnaeus, 1758)
Raja miraletus Linnaeus, 1758	*Diplodus cervinus* (Lowe, 1838)
Class: Actinopteri	*Diplodus puntazzo* (Walbaum, 1792)
Order: Anguiliformes	*Diplodus sargus sargus* (Linnaeus, 1758) *
Family: Congridae	*Diplodus vulgaris* (Geoffroy Saint-Hilaire,1817)
Ariosoma balearicum (Delaroche, 1809)	*Pagellus acarne* (Risso, 1827)
Conger conger (Linnaeus, 1758)	*Pagellus erythrinus* (Linnaeus, 1758)
Family: Ophichthidae	*Pagrus pagrus* (Linnaeus, 1758)
Ophichthus rufus (Rafinesque, 1810)	*Sparus aurata* Linnaeus, 1758
Order: Atheriniformes	*Spondyliosoma cantharus* (Linnaeus, 1758)
Family: Atherinidae	**Family: Sphyraenidae**
Atherinomorus lacunosus (Forster, 1801) *****	*Sphyraenidae chrysotaenia* Klunzinger,1884 *
Order: Aulopiformes	*Sphyraena sphyraena* (Linnaeus, 1758)
Family: Synodontidae	**Family:Terapontidae**
Saurida lessepsenianus Russell,Golani&Tikochinski,2015*	*Terapon puta* Cuvier, 1829 *
Synodus saurus (Linnaeus, 1758)	**Family: Trichiuridae**
Synodus synodus (Linnaeus, 1758)	*Trichiurus lepturus* Linnaeus, 1758 *
Order: Beryciformes	**Family : Uranoscopidae**
Family: Holocentridae	*Uranoscopus scaber Linnaeus,* 1758
Sargocentron rubrum (Forsskål, 1775) *	**Order: Pleuronectiformes**

Order: Clupeiformes	**Family : Bothidae**
Family : Clupeidae	*Bothus podas* (Delaroche, 1809)
Sardinella aurita Valenciennes, 1847	**Family: Citharidae**
Sardinella maderensis (Lowe, 1838)	*Citharus linguatula* (Linnaeus, 1758)
Family: Dussumieriidae	**Family: Soleidae**
Dussumieria elopsoides Bleeker, 1849 *	*Microchirus ocellatus* (Linnaeus, 1758)
Etrumeus golanii DiBattista, Randall & Bowen,2012 *	*Microchirus variegatus* (Donovan, 1808)
Family: Engraulidae	*Solea aegyptiaca* Chabanaud, 1927 *
Engraulis encrasicolus (Linnaeus, 1758) *	*Pegusa impar* (Bennett, 1831**)**
Order : : Gadiformes	*Solea solea* (Linnaeus, 1758)
Family: Merlucciidae	*Synapturichthys kleinii* (Risso, 1827)
Merluccius merluccius (Linnaeus, 1758)	**Order: Scorpaeniformes**
Order: Mugiliformes	**Family: Dactylopteridae**
Family: Mugilidae	*Dactylopterus volitans* (Linnaeus, 1758)
Liza aurata (Risso, 1810) *	**Family: Scorpaenidae**
Order : Ophidiiformes	*Scorpaena notata* Rafinesque, 1810
Family: Ophidiidae	*Scorpaena scrofa* Linnaeus, 1758
Ophidion barbatum Linnaeus, 1758	**Family : Triglidae**
Order: Perciformes	*Chelidonichthys lucerna* (Linnaeus, 1758)
Family: Apogonidae	*Lepidotrigla cavillone* (Lacepède, 1801)
Apogon imberbis (Linnaeus, 1758)	*Trigla lyra* Linnaeus, 1758
Apogonichthyoides pharaonis (Bellotti, 1874) *	*Trigloporus lastoviza* (Bonnaterre, 1788)
Apogonichthyoides taeniatus (Cuvier, 1828) *	**Order: Syngnathiformes**
Ostorhinchus fasciatus (White, 1790) *	**Family : Centriscidae**
Jaydia smithi Kotthaus, 1970 *	*Macroramphosus scolopax* (Linnaeus, 1758)

Continued

Family :Blenniidae	**Family : Fistulariidae**
Parablennius tentacularis (Brünnich, 1768)	*Fistularia commersonii* Rüppell, 1838 *****
Family: Callionymidae	**Order: Tetraodontiformes**
Callionymus filamentosus Valenciennes, 1837 *	**Family: Monocanthidae**
Synchiropus sechellensis Regan, 1908 *	*Stephanolepis diaspros* Fraser-Brunner, 1940 *
Family: Carangidae	*Stephanolepis hispidus* (Linnaeus, 1766)
Alepes djedaba (Forsskål, 1775) *	**Family : Tetraodontidae**
Seriola fasciata (Bloch, 1793) *** ***	*Lagocephalus sceleratus* (Gmelin, 1789) *
Trachurus mediterraneus (Steindachner, 1868)	*Lagocephalus suezensis* Clark & Gohar, 1953 *
Trachurus trachurus (Linnaeus, 1758)	*Torquigener flavimaculosus* Hardy & Randall, 1983 *
Family: Centracanthidae	**Order : Zeiformes**
Centracanthus cirrus Rafinesque, 1810	**Family : Zeidae**
Spicara flexuosa Rafinesque, 1810	*Zeus faber* Linnaeus, 1758
Spicara maena (Linnaeus, 1758)	**Invertebrates**
Spicara smaris (Linnaeus, 1758)	**Phylum: Mollusca**
Family: Cepolidae	**Class : Cephalpoda**
Cepola macrophthalma (Linnaeus, 1758)	**Order: Myopsida**
Family: Gobiidae	**Family: Loliginidae**
Gobius paganellus Linnaeus, 1758	*Loligo reynaudii* (d'Orbigny [in Ferussac&d'Orbigny],1839-1841)*****
Gobius niger Linnaeus, 1758	**Order: Octopoda**
Family :Haemulidae	**Family: Octopodidae**
Pomadasys incisus (Bowdich, 1825) *	*Octopus vulgaris* (Cuvier, 1797)
Family: Labridae	**Order: Sepiida**
Coris julis (Linnaeus, 1758)	**Family: Sepiidae**
Xyrichtys novacula (Linnaeus, 1758)	*Sepia officinalis (Linnaeus, 1758)*
Family: Leiognathidae	**Class: Gastropoda**

Equulites klunzingeri (Steindachner, 1898) *	**Order: Neogastropoda**
Family: Moronidae	Family: Muricidae
Dicentrarchus punctatus (Bloch, 1792)	*Murex brevispina* (Lamarck, 1822*)* *
Family: Mullidae	**Phylum: Arthropoda**
Mullus barbatus barbatus Linnaeus, 1758 *	**Subphylum: Crustacea**
Mullus surmuletus Linnaeus, 1758 *	**Class: Malacostraca**
Parupeneus forsskali (Fourmanoir & Guézé, 1976) *	**Order: Decapoda**
Upeneus moluccensis (Bleeker, 1855) *	**Family : Calappidae**
Upeneus pori Ben-Tuvia & Golani, 1989 *	*Calappa granulata* **(Linnaeus, 1758)**
Family: Nemipteridae	**Family: Portunidae**
Nemipterus japonicus (Bloch, 1791) *	*Portunus segnis* (Forskål, 1775) *
Nemipterus randalli Russell, 1986 *	**Family: Polybiidae**
Family : Pomacanthidae	*Liocarcinus vernalis* (Risso, 1827)
Chromis chromis (Linnaeus, 1758)	**Family: Penaeidae**
Family: Scaridae	*Metapenaeopsis aegyptia* Galil & Golani, 1990 *
Sparisoma cretense (Linnaeus, 1758)	*Metapenaeus stebbingi* (Nobili, 1904) *
Family: Sciaenidae	*Trachysalambria curvirostris* (Burkenroad, 1934) *
Argyrosomus regius (Asso, 1801) *	**Order: Stomatopoda**
Umbrina cirrosa (Linnaeus, 1758)	**Family: Squillidae**
Family: Scombridae	*Erugosquilla massavensis* (Kossmann, 1880) *
Scomber japonicus Houttuyn, 1782 *	*Squilla mantis* (Linnaeus, 1758)
Scomberomorus tritor (Cuvier, 1832)	**Phylum: Echinodermata**
Family: Serranidae	**Class : Echinoidea**
Serranus cabrilla (Linnaeus, 1758) *	
Serranus hepatus (Linnaeus, 1758)	

2. Catch composition:

Table (3), shows the catch composition by number, length range, average length, weight range and average weight for the by-catch obtained from Alexandria during March 2018 and May 2019. The total number of fish individuals reached 9147 with total weight of 121875 g. It is evident from the table that the economic species constituted 76.96 % in number and 76.28 % in weight of the total by-catch whereas the non – economic species formed 23.04 % and 23.72 % in number and weight respectively. From Table (3) and Fig. (2), it is obvious that eight families of fish were dominated and constituted the high rank of percentage during the period of investigation: Centracanthidae (28.41 %); Nemipteridae (9.17%); Carangidae (6.85%); Mullidae (6.06%); Callionymidae (5.71%); Triglidae (3.53%); Apogonidae (1.08 %) and Congridae (1.07%). Also, from table (3) and Fig. (3), it is evident that 12 species were prevailing the by-catch and constituted the high percentages namely: *Spicara smaris* (22.575%); *Boops boops* (12.922 %); *Nemipterus randalli* (8.943 %); *Spicara maena* (4.865 %); *Synchiropus sechellensis* (4.864 %); *Diplodus vulgaris* (4.504 %); *Lepidotrigla cavillone* (3. 313 %); *Upeneus pori* (3.225 %); *Pagellus erythrinus* (3.192 %); *Mullus barbatus* (1.804 %); *Terapon puta* (1.235 %) and *Ariosoma balearicum* (1.038 %).

Seasonally, Table (4), shows the seasonal occurrence with respect to the whole period of investigation. Nine species occurred during the four seasons; 18 species were represented during three seasons (They were found repeatedly as follows: 12 in winter; 12 in spring; 11 in summer and 13 in i autumn respectively); 17 species occurred in two seasons (They were found repeatedly as follows: 10 in winter; 6 in spring; 12 in summer and 6 in i autumn respectively) while forty nine species were represented in one season only (They were found repeatedly as follows: 8 in winter; 7 in spring; 26 in summer and 12 in i autumn respectively). Seasonal number percentages were found to be 45.671 % in summer; 19.45 % in spring; 18.25 % in autumn and 16.635 % in winter (Fig.4). From the same figure, seasonal weight percentages were 29.112 % in spring; 27.28 % in autumn; 23.03 % in summer and 19.876 % in winter.

Table 3. Catch composition of by catch (number, percentages, length range and average length in cm, weight percentages and average weight in gram) obtained from bottom trawlers operated in Alexandria during 2018– 2019.

Species	No.	%	L (cm)	Av. L. (cm)	Wt (g)	%	Av wt. (g)
Raja miraletus	3	0.033	28-36	32.7	596	0.489	198.7
Ariosoma balearicum	95	1.038	10-56	23.1	2459	2.017	25.9
Conger conger	3	0.033	25-32	29.3	111	0.091	37
Ophichthus rufus	1	0.0109	15	15	12	0.01	12
Atherinomorus lacunosus	1	0.0109	10	10	11	0.009	11
Saurida lessepsenianus	4	0.044	9-22	16.5	139	0.114	34.8
Synodus saurus	19	0.208	5-14	11	229	0.188	12.1
Synodus synodus	32	0.350	13-19	16	1189	0.976	37.2
Sargocentron rubrum	13	0.142	11-13	12	337	0.277	26
Sardinella aurita	7	0.077	11-15	13.3	122	0.100	17.4
Sardinella maderensis	3	0.033	14-15	14.5	66	0.054	22
Dussumieria elopsoides	3	0.033	13-14	13.5	45	0.037	15
Etrumeus golanii	11	0.120	16-22	18.7	698	0.573	63.5
Engraulis encrasicolus	7	0.077	9	9	22	0.018	3.1
Merluccius merluccius	2	0.022	30	30	415	0.341	415
Liza aurata	32	0.350	12-18	14.7	734	0.602	25.3
Ophidion barbatum	2	0.022	19-20	19.5	68	0.056	34
Apogon imberbis	10	0.109	7-10	8.3	92	0.076	9.1
Apogonichthyoides pharaonis	4	0.044	7-9	8	40	0.033	10
Apogonichthyoides taeniatus	23	0.251	5-9	7.5	185	0.152	8.1
Ostorhinchus fasciatus	36	0.394	9-11	10	563	0.462	15.6
Jaydia smithi	27	0.295	7-13	9.2	613	0.503	22.7
Parablennius tentacularis	1	0.0109	13	13	22	0.018	22
Callionymus filamentosus	77	0.864	5-17	10.7	456	0.374	5.9

Synchiropus sechellensis	445	4.864	5-12	9	3457	2.837	7.8
Alepes djedaba	1	0.0109	12	12	19	0.016	19
Seriola fasciata	15	0.163	12-17	14.5	474	0.389	31.6
Trachurus mediterraneus	613	6.702	7-20	12.7	9536	7.824	15.6
Trachurus trachurus	17	0.186	9-19	11.4	208	0.171	12.2
Centracanthus cirrus	10	0.109	10-17	14.5	135.8	0.111	13.6
Spicara flexuosa	79	0.864	8-12	16	1387	1.138	17.6
Spicara maena	445	4.865	8-17	12.8	7072	5.802	15.9
Spicara smaris	2065	22.575	5-17	11.5	19865	16.299	9.6
Cepola macrophthalma	1	0.011	12	12	7	0.006	7
Gobius paganellus	2	0.022	10	10	21	0.017	21
Gobius niger	18	0.196	7-11	9	161	0.132	9.4
Pomadasys incisus	37	0.404	11-15	13	1018	0.835	27.5
Coris julis	5	0.054	13-15	14.3	125	0.103	25
Xyrichtys novacula	6	0.066	8-17	13	143	0.117	23.8
Equulites klunzingeri	7	0.077	8	8	35	0.029	5
Dicentrarchus punctatus	2	0.022	11	11	26	0.021	13
Mullus barbatus barbatus	165	1.804	7-14	11.5	1524	1.251	9.2
Parupeneus forsskali	4	0.044	7-10	8.5	24	0.020	6
Mullus surmuletus	36	0.394	8-16	10.2	420	0.345	11.7
Upeneus moluccensis	54	0.590	6-16	11.1	473	0.388	8.8
Upeneus pori	295	3.225	7-14	11	2285	1.875	7.8
Nemipterus japonicus	21	0.2295	5-13	9	168	0.137	8
Nemipterus randalli	818	8.943	6-16	10.2	9951	8.165	12.2
Chromis chromis	20	0.219	8-10	9	292	0.240	14.6
Sparisoma cretense	4	0.044	13-16	14.5	171	0.140	42.8
Argyrosomus regius	48	0.525	8-16	12.3	1111	0.912	23.7
Umbrina cirrosa	31	0.339	9-14	11.2	425	0.349	14.7
Scomber japonicus	3	0.033	15-16	15.5	86	0.070	28.7
Scomberomorus tritor	12	0.131	14-17	15.5	320	0.263	26.7

Serranus cabrilla	38	0.415	9-19	14.4	1207	0.990	31.8
Serranus hepatus	47	0.514	5-9	7.6	461	0.378	9.9
Siganus rivulatus	5	0.054	15-19	16.8	305	0.250	61
Boops boops	1182	12.922	8-16	11.8	13085	10.736	11.1
Diplodus cervinus	5	0.054	9-11	10	100	0.082	20
Diplodus puntazzo	12	0.131	8-17	11	219	0.180	18.3
Diplodus sargus sargus	4	0.044	20-24	22	709	0.582	177.3
Diplodus vulgaris	412	4.504	5-24	12.5	8460	6.941	20.5
Pagellus acarne	7	0.077	10-16	14.3	233	0.191	33.3
Pagellus erythrinus	292	3.192	6-14	10.4	4137	3.394	14.2
Pagrus pagrus	20	0.219	7-20	13.4	690	0.566	34.5
Sparus aurata	2	0.022	19	19	169	0.139	84.5
Spondyliosoma cantharus	18	0.196	15-24	14.4	1737	1.425	96.5
Sphyraena chrysotaenia	18	0.196	10-23	19.6	414	0.340	23
Sphyraena sphyraena	1	0.0109	11	11	10	0.008	10
Terapon puta	113	1.235	10-17	12.8	2240	1.838	19.8
Trichiurus lepturus	10	0.109	33-53	44.1	621	0.510	62.1
Uranoscopus scaber	2	0.022	17-27	22	234	0.192	117
Bothus podas	617	6.745	7-14	11.1	7434	6.100	12.1
Citharus linguatula	79	0.864	4-17	11.1	1422	1.167	18
Microchirus ocellatus	16	0.175	8-13	10.7	328	0.269	20.5
Microchirus variegatus	1	0.0109	8	8	5	0.004	5
Solea aegyptiaca	77	0.842	10-14	12	1225	1.005	15.9
Pegusa impar	2	0.022	13-17	15	57	0.047	28.5
Solea vulgaris	1	0.0109	11	11	10	0.008	10
Synapturichthys kleinii	1	0.0109	12	12	18	0.0148	18
Dactylopterus volitans	1	0.0109	9	9	8	0.007	8
Scorpaena notata	1	0.0109	10	10	21	0.017	21
Scorpaena scrofa	1	0.0109	12	12	34	0.028	34
Chelidonichthys lucerna	14	0.153	12-16	13.3	311	0.255	22.2

Lepidotrigla cavillone	303	3.313	7-11	9.5	3406	2.795	11.4
Trigla lyra	1	0.0109	10	10	11	0.009	11
Trigloporus lastoviza	5	0.054	10-15	12.2	98	0.080	19.5
Macroramphosus scolopax	1	0.0109	4	4	2	0.0016	2
Fistularia commersonii	2	0.022	25-59	42	423	0.347	211.5
Stephanolepis diaspros	84	0.918	2-16	10.2	738	0.606	8.8
Stephanolepis hispidus	2	0.022	9-14	11.5	56	0.046	28
Lagocephalus sceleratus	3	0.033	8-13	10.5	66	0.054	22
Lagocephalus suezensis	33	0.360	9-14	11.2	634	0.520	19.2
Torquigener flavimaculosus	16	0.175	5-10	7.5	117	0.096	7.3
Zeus faber	3	0.033	16-20	18	257	0.211	85.7

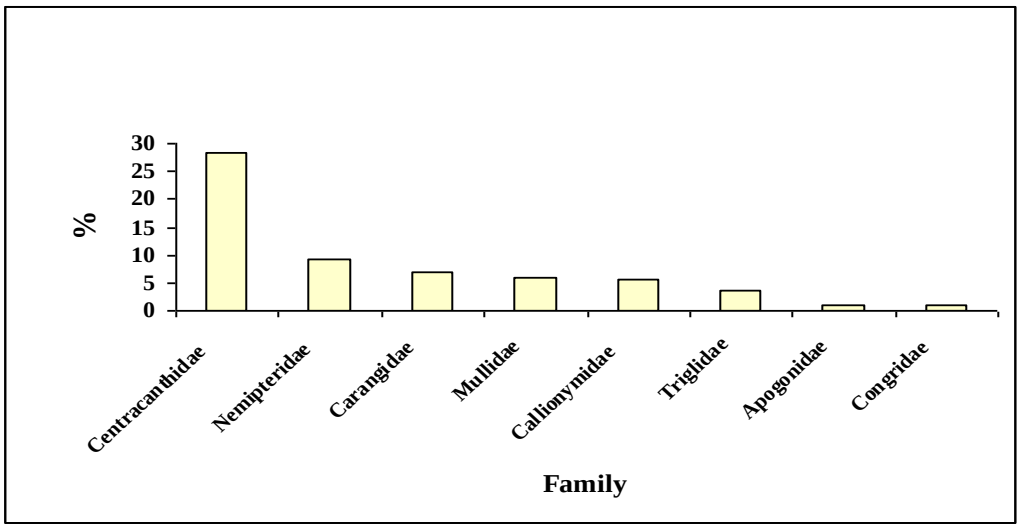

Fig. 2. Percentage of the most dominant families off Alexandria 2018-2019.

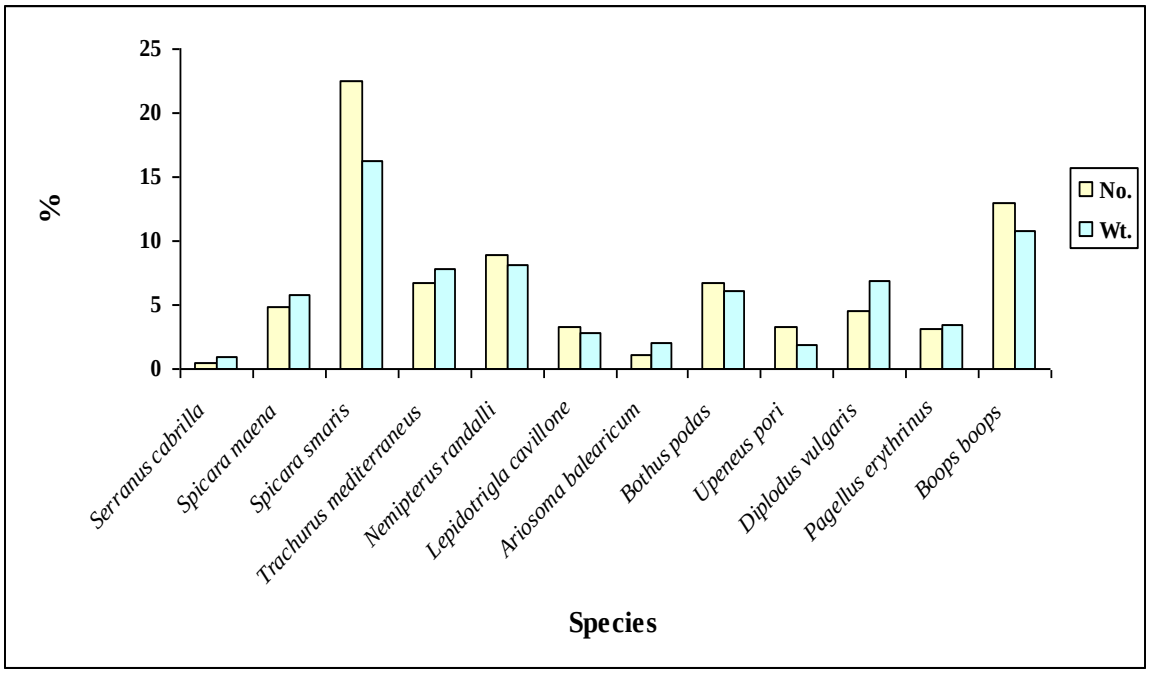

Fig.3. Number and weight percentages of dominant by- catch fish species off Alexandria 2018-2019.

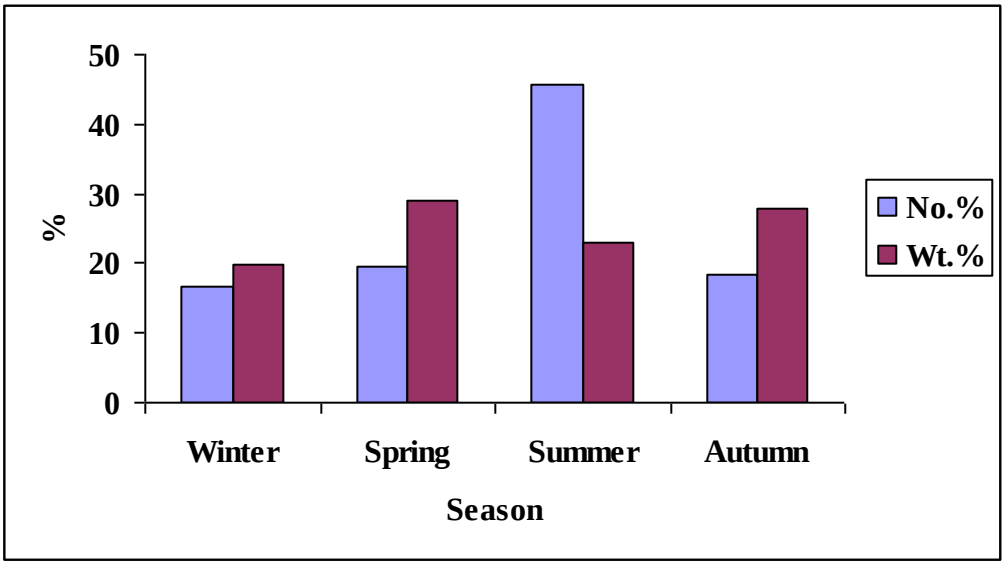

Fig. 4. Seasonal number and weight percentages of by- catch off Alexandria 2018-2019.

Table 4. Seasonal percentage of occurrence for the by- catch from Alexandria during 2018-2019.

Species	No.	Winter	Spring	Summer	Autumn
		%	%	%	%
Raja miraletus	3	--	--	--	100
Ariosoma balearicum	95	9.47	1.05	51.58	37.89
Conger conger	3	--	--	--	100
Ophichthus rufus	1	100	--	--	--
Atherinomorus lacunosus	1	--	--	100	--
Saurida lessepsenianus	4	--	50	50	--
Synodus saurus	19	5.88	2.94	--	91.17
Synodus synodus	32	--	100	---	---
Sargocentron rubrum	13	23.08	--	76.92	--
Sardinella aurita	7	--	--	100	--
Sardinella maderensis	3	--	--	100	--
Dussumieria elopsoides	3	--	--	100	--
Etrumeus golanii	11	--	100	--	--
Engraulis encrasicolus	7	--	15	75	10
Merluccius merluccius	2	--	100	--	---
Liza aurata	32	--	---	100	--
Ophidion barbatum	2	50	--	--	50
Apogon imberbis	10	20	--	80	--
Apogonichthyoides pharaonis	4	---	50	50	--
Apogonichthyoides taeniatus	23	95.65	---	4.348	--
Ostorhinchus fasciatus	36	--	--	100	--
Jaydia smithi	27	--	7.41	88.89	3.70
Parablennius tentacularis	1	--	--	100	--
Callionymus filamentosus	77	92.21	2.59	3.89	1.98
Synchiropus sechellensis	445	99.33	--	0.449	0.225
Alepes djedaba	1	--	--	100	--
Seriola fasciata	15	--	--	100	--
Trachurus mediterraneus	613	--	1.468	46.493	52.04
Trachurus trachurus	17	11.765	88.235	--	--
Centracanthus cirrus	10	90	10	--	--
Spicara flexuosa	79	--	--	--	100
Spicara maena	445	1.348	98.202	0.449	--
Spicara smaris	2065	3.341	62.179	--	34.479
Cepola macrophthalma	1	--	--	--	100
Gobius paganellus	2	--	--	100	--
Gobius niger	18	--	--	100	--
Pomadasys incisus	37	--	--	97.297	2.703
Coris julis	5	40	--	60	--
Xyrichtys novacula	6	16.667	66.667	16.667	--
Equulites klunzingeri	7	--	--	100	--
Dicentrarchus punctatus	2	--	--	--	100
Mullus barbatus barbatus	165	0.606	--	98.182	1.212
Parupeneus forsskali	4	100	--	--	--
Mullus surmuletus	36	--	--	97.222	2.777
Upeneus moluccensis	54	11.111	--	12.963	75.926
Upeneus pori	295	8.474	8.813	0.678	0.82
Nemipterus japonicus	21	--	--	--	100
Nemipterus randalli	818	5.379	82.396	12.224	--
Chromis chromis	20	100	--	--	--

Sparisoma cretense	4	--	--	100	--
Argyrosomus regius	48	--	--	100	--
Umbrina cirrosa	31	--	--	100	--
Scomber japonicus	3	--	100	--	--
Scomberomorus tritor	12	--	--	100	--
Serranus cabrilla	38	42.103	7.895	47.368	2.632
Serranus hepatus	47	61.702	27.569	6.383	4.255
Siganus rivulatus	5	--	--	100	--
Boops boops	1182	53.145	10.561	1.184	34.179
Diplodus cervinus	5	--	--	100	--
Diplodus puntazzo	12	--	--	100	--
Diplodus sargus sargus	4	--	100	--	--
Diplodus vulgaris	412	3.398	0.486	58.009	38.107
Pagellus acarne	7	14.287	28.571	--	57.143
Pagellus erythrinus	292	9.589	9.589	18.151	62.671
Pagrus pagrus	20	--	5	35	60
Sparus aurata	2	--	100	--	--
Spondyliosoma cantharus	18	--	83.333	--	16.667
Sphyraena chrysotaenia	18	5.556	--	94.444	--
Sphyraena sphyraena	1	--	--	--	100
Terapon puta	113	--	--	100	--
Trichiurus lepturus	10	--	--	100	--
Uranoscopus scaber	2	--	--	100	--
Bothus podas	617	96.758	1.134	0.643	1.459
Citharus linguatula	79	1.265	5.063	7.595	86.076
Microchirus ocellatus	16	31.250	43.750	--	25.00
Microchirus variegatus	1	100	--	--	--
Solea aegyptiaca	77	--	--	100	--
Pegusa impar	2	--	--	100	--
Solea solea	1	--	--	--	100
Synapturichthys kleinii	1	--	--	100	--
Dactylopterus volitans	1	--	--	--	100
Scorpaena notata	1	--	--	--	100
Scorpaena scrofa	1	100	--	--	--
Chelidonichthys lucerna	14	--	7.143	92..857	--
Lepidotrigla cavillone	303	52.145	10.561	--	37.294
Trigla lyra	1	--	100	--	--
Trigloporus lastoviza	5	40.00	--	20.00	40.00
Macroramphosus scolopax	1	--	100	--	--
Fistularia commersonii	2	--	--	50	50
Stephanolepis diaspros	84	7.143	--	92.857	--
Stephanolepis hispidus	2	--	--	--	100
Lagocephalus sceleratus	3	66.665	--	--	33.334
Lagocephalus suezensis	33	100	--	--	--
Torquigener flavimaculosus	16	100	--	--	--
Zeus faber	3	--	--	--	100

3. **Biological Studies**:

Table (5) shows the computed length weight relations and condition factor (K) for the most dominant species of by catch during the period of investigation. The corresponding calculated weights were presented in figures (5- a and 5 – b). The same table shows the length weight relationship parameters, regression coefficient and condition factor for the most dominant species.

Table 5. Length weight relationship parameters, regression coefficient and condition factor for the most by-catch dominant species from Alexandria 2018-2019.

Species	No.	Length range (cm)	a	b	R^2	K ± S. D.
Spicara maena	445	8-17	0.7057	0.2595	0.990	0.758 ± 0.026
Lepidotrigla cavillone	303	7-11	0.5032	0.3196	0.9155	1.310 ± .074
Upeneus pori	295	7-14	0.820	0.2495	0.9573	0.586 ± 0.253
Nemipterus randalli	818	6-16	0.5760	0.2983	0.9587	1.150 ± 0.152
Serranus cabrilla	38	9-19	0.8822	0.2532	0.9635	1.200 ± 0.102
Trachurus mediterraneus	613	7-20	0.6357	0.247	0.9852	0.335 ±0.246
Ariosoma balearicum	95	10-56	3.2525	0.0794	0.6824	0.198 ± 0.114
Bothus podas	617	7-14	0.3348	0.3464	0.9764	0.885 ± 0.012
Diplodus vulgaris	412	5-14	0.6170	0.2992	0.9658	1.049 ± 0.156
Pagellus erythrinus	292	6-14	0.6671	0.2931	0.9626	1.262 ± 0.241
Boops boops	1182	8-16	0.5795	0.2630	0.9805	0.676 ± 0.125
Spicara smaris	2065	5-17	0.6964	0.2469	0.9760	0.631 ± 0.043

Table (6) reveals the estimated lengths at each year of life for the most dominant species of by- catch. It is obvious that three species with one year of life (*Spicara maena; Lepidotrigla cavillone and Upeneus pori*). Eight species acquired two years of life (*Nemipterus randalli; Serranus cabrilla; Trachurus mediterraneus; Ariosoma balearicum; Bothus podas; Diplodus vulgaris; Pagellus erythrinus and Boops boops*). One species was found belonging to age group three (*Spicara smaris*).

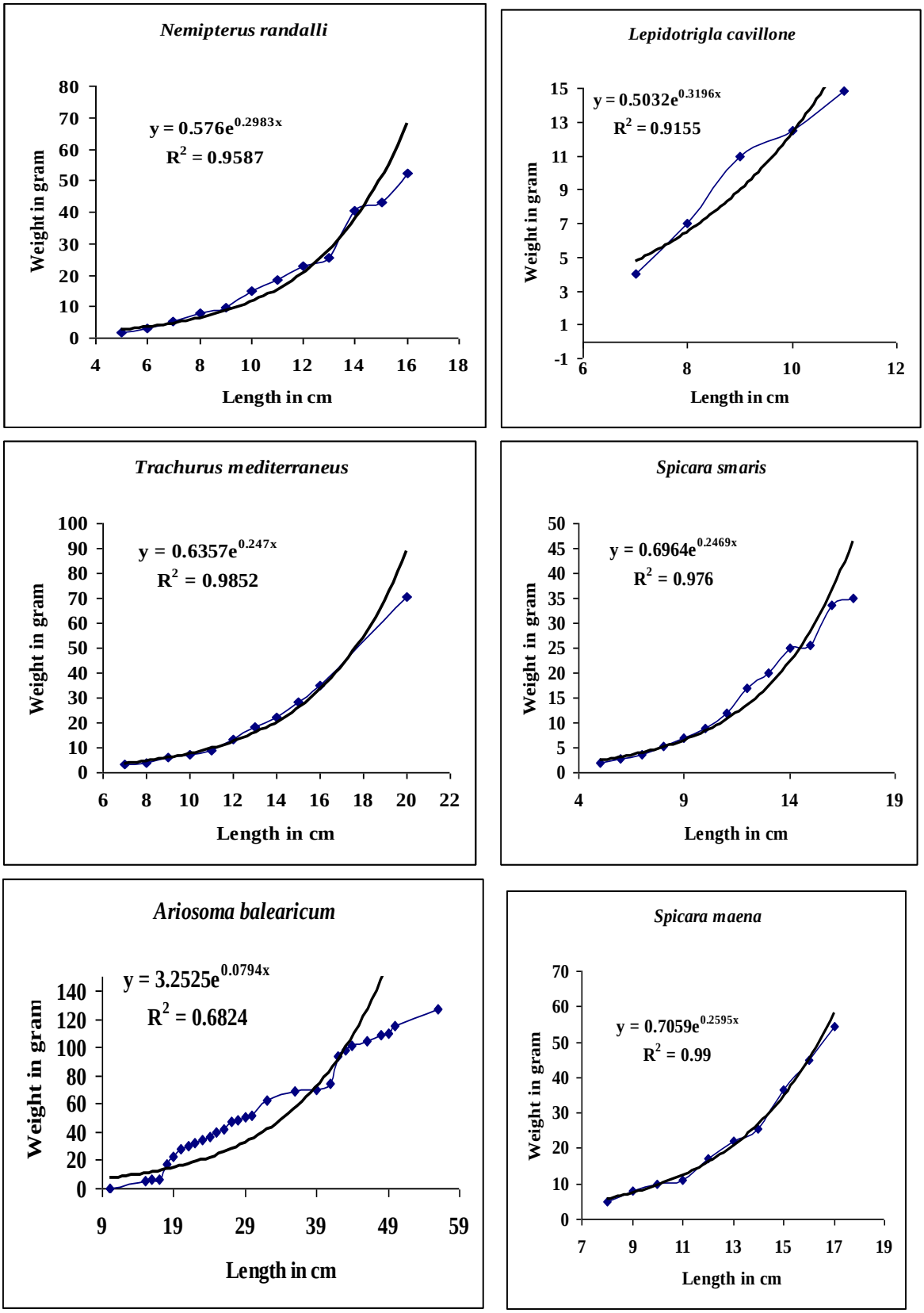

Fig. 5- a. Length weight relationship for the most dominant species from the by- catch obtained by the bottom trawler off Alexandria, during 2018-2019.

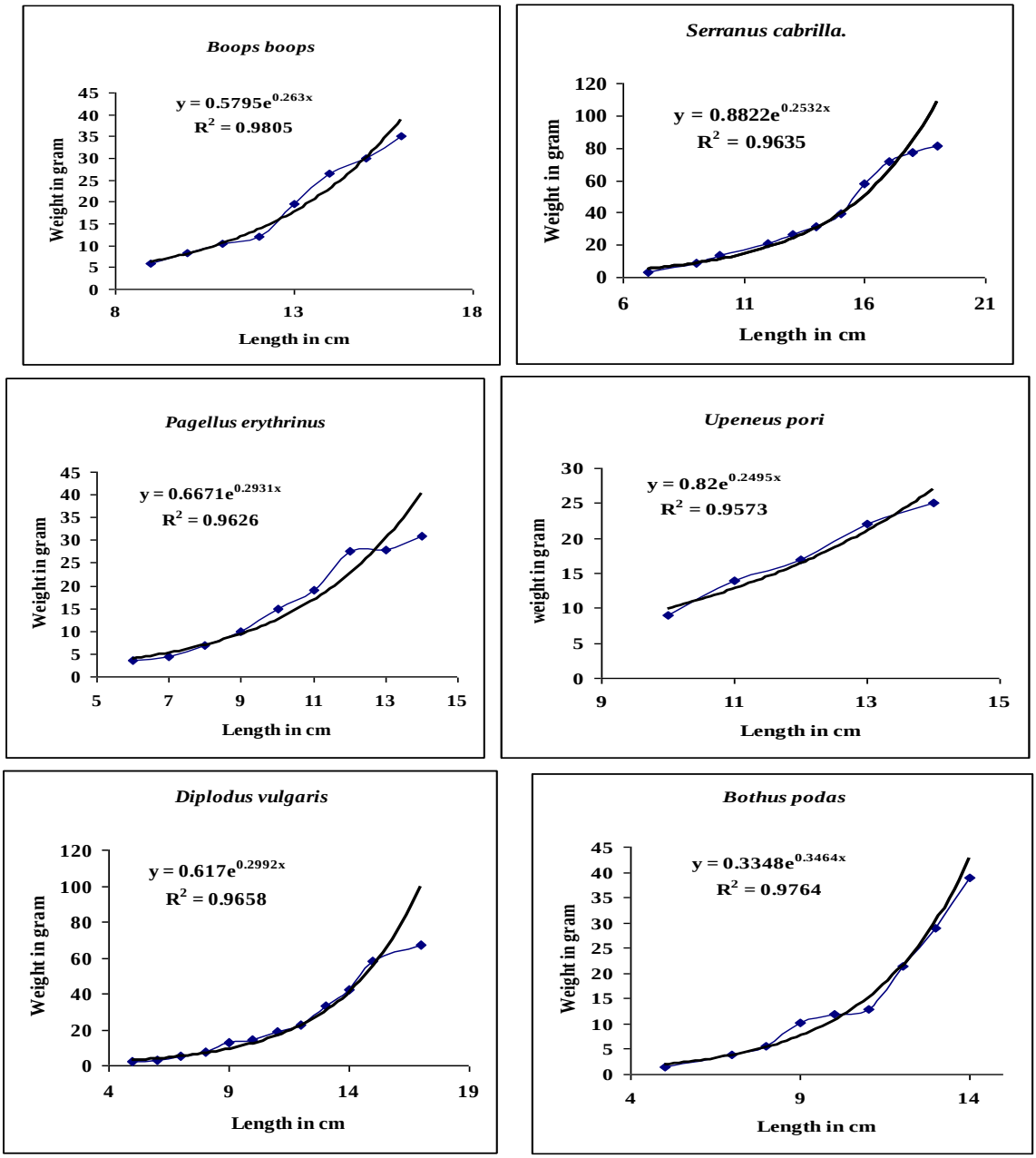

Fig. 5- b. Length weight relationship for the most dominant species from the by catch obtained by the bottom trawler off Alexandria, during 2018-2019.

Table 6. Length at each year of life using length frequency distribution for the most dominant by- catch species caught from Alexandria during 2018-2019.

Species	**No.**	Length and standard deviation at each year of life		
		Age group I	Age group II	Age group III
Spicara maena	445	12.81 ± 0.57		
Lepidotrigla cavillone	303	10.25 ± 1.29		
Upeneus pori	295	10.5 ± 0.69		
Nemipterus randalli	818	7.64 ± 0.50	11.66 ± 0.68	
Serranus cabrilla	38	10.96 ± 1.16	15.54 ± 0.91	
Trachurus mediterraneus	613	10.46 ± 0.71	13.70 ± 1.36	
Ariosoma balearicum	95	22.25 ± 1.90	29.05 ± 0.81	
Bothus podas	617	8 ± 0.39	12.33 ± 0.77	
Diplodus vulgaris	412	8.37 ± 0.62	12.15 ± 0.1.47	
Pagellus erythrinus	292	7.89 ± 0.86	10.70 ± 0.1.18	
Boops boops	1182	10.52± 0.87	14.63± 0.65	
Spicara smaris	2065	6.92 ± 0.91	10.12 ± 0.65	15.91± 0.51

DISCUSSION

The trawl net is the most destructive type of the mobile fishing gears, as it is dragged on the sea bottom gathering a wide array of organisms as by-catch. The non-target catch have become a component of target catch of generic trawl effort **Alverson *et al*. (1994)**. The multi-species trawlers have a poor selectivity resulting in the capture of a huge amount of non-target species. Furthermore, they have both direct and indirect impacts on the marine ecosystem and biodiversity as well as mechanically disturbing the sea bottom **Watling and Norse (1998).** According to **Alverson *et al*. (1994)**; **Hall *et al*. (2000); Machias *et al*. (2001); Rochet and Trenkel (2005) and Rizkalla *et al*. (2016)**, considerable elements may affect the by catch extent such as fishing method practiced, fishing gear, fishing depth, fishing season, duration and number of hauls and the marketing. Taking into account that **Charbonnier and Caddy (1986)** declared that the mesh size of the cod end of the Egyptian

trawlers (not exceed than 25 mm) has no regulation as compared with those given in other areas of the eastern Mediterranean (stretched mesh size in Cyprus 34 mm, Greece 28 mm, Israel 48 rnm and Turkey 40 mm). High seas trawling in Italy applied cod end mesh size of 40 mm, as a result the Mullidae fisheries increased. The same regulation took place in Israel and Turkey **FAO (1993, Fisheries Technical Paper, No. 335). Alsayes *et al.* (2009)** reported that in the Egyptian Mediterranean waters, the most common fishing gear is the Italian trawl net whereas, about 1200 trawlers operate at this area.

Table (7) showed the weight percentages of most dominant economic and non – economic species for previous studies in comparison with the present investigation that used the whole by catch species data. The higher values of weight percentages of economic species were recorded in the present study followed by **Rizkalla (1995); Faltas *et al*. (1998) and Rizkalla *et al*. (2016)** : (76.28 %); (63.17%); 33.35 % and (42.22%) respectively. The higher values of weight percentages of non economic species were found by **Rizkalla *et al*. (2016)** followed by **Faltas *et al*. (1998)**; Present study; and **Rizkalla (1995)**: 37.74 %; 31.74 %; 23.72 % and 14.44 % respectively. From the same table, the higher number of individuals was recorded in the present work (56 economic and 39 non – economic species) while the smallest value was given by **Rizkalla (1995)** (36 economic and 26 non economic species). It is perspicuous that there are differences in the biodiversity and abundance in numbers and weights percentages. These differences may be ascribed to many aspects as: fishing area, fishing season, continuation of fishing operations, number of trips, depth of trawling and the fishing gear used. As the majority of economic species in the by catch were caught before reaching their first sexual maturity. This will evidently lead to future production decrease of economic fishes obtained from the Egyptian Mediterranean waters and accordingly the amount of economic species will be progressively decreased due to the continuous loss of the future stock. The Suez Canal, a corridor unique to the Mediterranean Sea is responsible for the increased introduction of new thermophilic non-indigenous species (NIS) into the worming sea **Galil *et al*.(2014)** and **Halim and Rizkalla (2011**). **Rizkalla and Akel (2015)** recorded 45 immigrant species in the Egyptian Mediterranean waters. From Table (2), the results declared the presence of 44 immigrant species of which one fish species of Atlantic Ocean origin; 36 fish species of Red Sea origin and 7 invertebrates.

Table 7. Comparison between number and weight percentages of economic and non – economic species for the present study with reference to previous studies given by other authors in the Egyptian Mediterranean waters.

	Economic species		Non – economic species	
	No.	Wt % (most dominant species)	No.	Wt % (most dominant species)
Rizkalla, 1995 Off Alexandria	36	63.17	26	14.44
Faltas *et al*. 1998 Abu – Qir Bay	30	33.35	33	31.74
Rizkalla *et al*. 2016 Off Alexandria	44	42.22	45	37.78
Present study, 2018-2019. West of Alexandria. (The whole by catch species)	56	76.28	39	23.72

CONCLUSION

In conclusion, it is endorsed to increase the cod end mesh size from 2.5 cm to 4.0 cm at least as it would help in reducing the high fishing mortalities. Furthermore, sustainable yield of economic taxa of the future stock as well as conservation of biodiversity are profoundly recommended.

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