Distribution and Population Structure of Greater Weever, *Trachinus draco* (Linnaeus, 1758.), in the Northern and Central Adriatic Sea

Rasprostranjenost i struktura populacije pauka bijelca, Trachinus draco (Linnaeus, 1758.) u sjevernom i srednjem dijelu Jadranskog mora

Selma Čustović
Sveučilišta u Splitu
Prirodoslovno-matematički fakultet

Nedo Vrgoč
Institut za oceanografiju i ribarstvo
Split

Igor Isajlović
Institut za oceanografiju i ribarstvo
Split
e-mail: igor@izor.hr

Svjetlana Krstulović Šifner
Sveučilišni Odjel za studije mora Sveučilišta u Splitu, Hrvatska

Corrado Piccinetti
Laboratorio di Biologia Marina e Pesca, Italy

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Summary

This study describes the distribution patterns and population structure of greater weever in the Adriatic Sea. Biological data were obtained during MEDITS surveys in the spring-summer period. The aim of this study is to provide recent data for better understanding of species biology and to create basis for fisheries management based on ecological approach.

KEY WORDS
greater weever
Trachinus draco
distribution
population density
population structure
the Adriatic Sea

Sažetak

Ova studija opisuje uzorke rasprostranjenosti i populacijsku strukturu pauka bijelca u Jadranu. Biološki podatci dobiveni su za vrijeme MEDITS istraživanja u proljetno-ljetnom razdoblju. Cilj ove studije je prikazati recentne podatke za bolje razumijevanje biologije vrste te stvoriti bazu za održivo upravljanje u ribarstvu temeljenog na ekološkom pristupu.

KLJUČNE RIJEČI
pauk bijelac
Trachinus draco
distribucija
gustoća populacije
struktura populacije
Jadransko more

INTRODUCTION / *Uvod*

The greater weever (*Trachinus draco* Linnaeus, 1758) is demersal marine fish widely distributed across the Mediterranean, Black Sea and Eastern Atlantic [1], [2] and notoriously known by its venomous spines which can inflict serious human injuries by accidental sting. The main toxin is single peptide protein called dracotoxin with hemolytic and membrane depolarizing activities [3]. Because of that, it is usually classified as one of the most venomous fish in the Mediterranean [4]. In the Adriatic it is mostly distributed in the channel areas preferring muddy and sandy sediments where usually rests on the bottom or buried in the sediment exposing eyes and first dorsal fins [5]. Although greater weever is widely distributed in the Mediterranean area, population density is not so high compared to the total catch of other commercially important demersal species and therefore has a minor commercial importance [6]. However, its venom glands makes greater weever protected from the most predators giving it the possibility to freely inhabit the area and preying other organisms. These biological and behavioral characteristics, from the the ecological point of view, raised this smaller body sized species higher in the trophic levels [7] and gives it a significant role in marine demersal ecosystem. Because of its minor commercial importance greater weever usually hasn't been considered as a priority in fisheries biology. The lack of more detailed data in recent scientific literature about distribution patterns, population structure, dynamics and trends, especially for the Adriatic Sea, is evident. The aim of this article is to provide new data which could be used as an input in more complex fisheries management process, based on ecological approach, in order to maintain responsible exploitation of demersal resources.

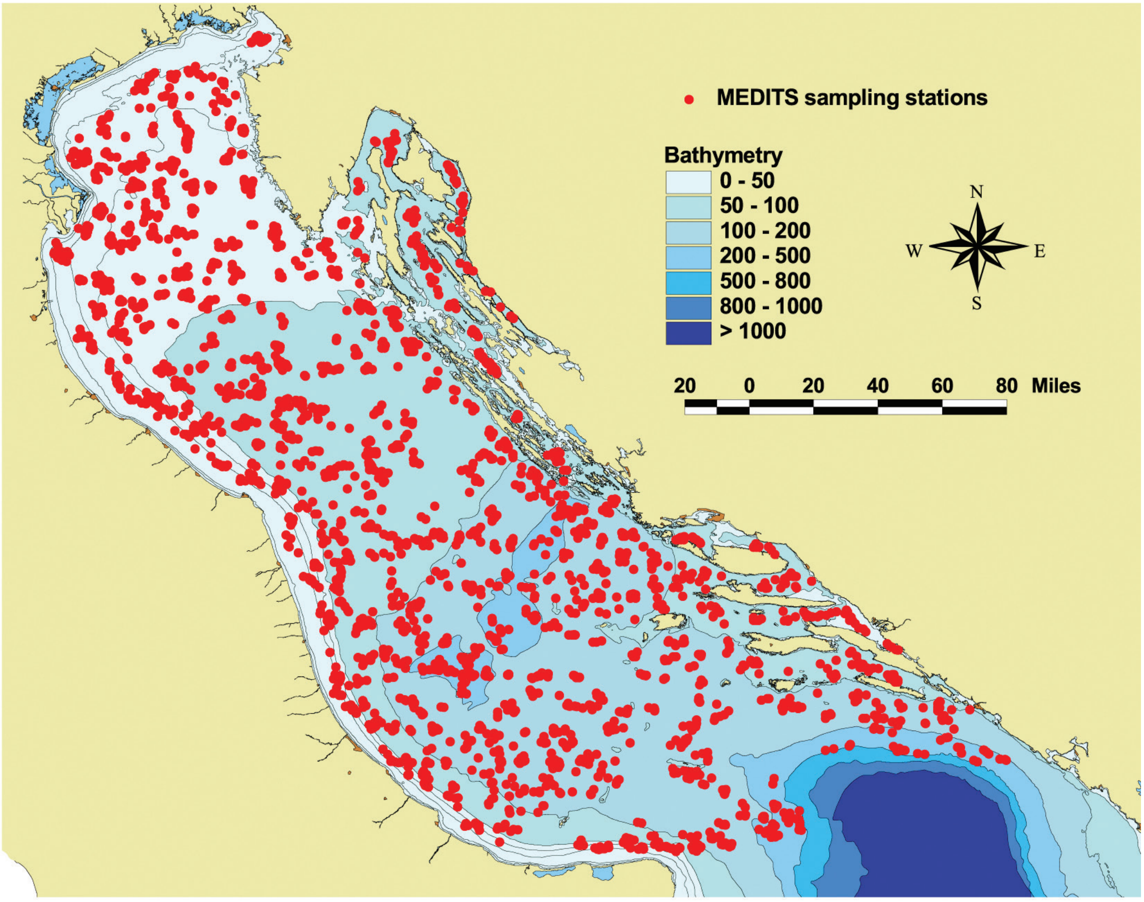

Figure 1 Sampling stations of MEDITS bottom trawl surveys in the Northern and Central Adriatic Sea (GSA 17) from 1996 to 2013.
Slika 1. Postaje uzorkovanja u sklopu MEDITS istraživanja u sjevernom i srednjem Jadranu (GSA 17) od 1996. do 2013.

MATERIALS AND METHODS / *Materijali i metode*

The samples of greater weever from the Northern and Central Adriatic Sea were obtained during MEDITS Program ("Mediterranean International Trawl Survey") which were held in spring - summer period from 1996 to 2013 Samples were collected, based on MEDITS protocol [8] using specially designed bottom trawl net GOC 73. Sampling stations were randomly distributed according to the depth strata (10-50; 50-100; 100-200; 200-500; 500-800 m) and the number of stations was proportional to the surface of each stratum (Figure 1). The duration of tow in the area shallower than 200 m was 30 min, while in the area deeper than 200 m was 60 min. The population density was expressed as indices of abundance (Nkm^{-2}) and biomass ($kgkm^{-2}$) per square kilometer calculated according to Souplet (1996) [9]. Ordinary kriging interpolation method was used for modeling spatial distribution based on population density as input variable [10]. In order to evaluate spatial homogeneity of greater weaver data, the semi-variance was calculated, as a measure of the degree of spatial dependence between samples. Laboratory analysis was performed on 509 specimens, mostly collected from the eastern side of the Adriatic Sea. A total length was measured for all specimens to the nearest mm in length, and weighed to the nearest 0.01 g of wet mass. Sex and maturity were determined by macroscopic examination of gonads following MEDITS protocol. The hypothetical isometric growth and statistical differences between mean lengths of females and males were tested using Student's t test and differences between their distributions by x^2 test. The length-weight relationship was determined using the power function $W=aLt^b$, where W is the somatic fish weight in g, Lt is total length of specimen in cm, *a* is a proportionality constant and b a regression coefficient [11].

RESULTS AND DISCUSSION / *Rezultati i diskusija*
DISTRIBUTION / *Rasprostranjenost*

The data obtained during MEDITS surveys (1996 – 2013) in the Central and Northern Adriatic Sea during spring-summer period shows that *T.* draco has stratified spatial distribution by the area and depth (Figure 2). The average population density of 15.75 Nkm^{-2} and 1.27 $kgkm^{-2}$ for a total surveyed area varies between 31.02 Nkm^{-2} and 2.58 $kgkm^{-2}$ on the eastern side (Croatian territorial waters) to 7.31 Nkm^{-2} and 0.37 $kgkm^{-2}$ on the western side (Italian territorial waters), while in the extraterritorial waters population density was 10.57 Nkm^{-2} and 0.91 $kgkm^{-2}$ (Table 1). Distribution patterns and population density shows that this species is more abundant in the eastern side of the Adriatic, mainly in the channel area and in the northern part along eastern coast. It is scarcely distributed on the western side, mostly in a shallower area of the Central Adriatic. The vertical distribution also differs between eastern and western side, but generally greater weever prefers area shallower than 100 m (Table 1). Decreasing of population density by the bathymetric gradient follows general rule of depth related differences in distribution for demersal species due to the changes of environmental factors [12], [13], [14]. Greater weever has a higher population density on fine-grained sand and silty sand sediments (Table 1) Detailed analysis of greater weever's distribution showed strong variation in population density between different

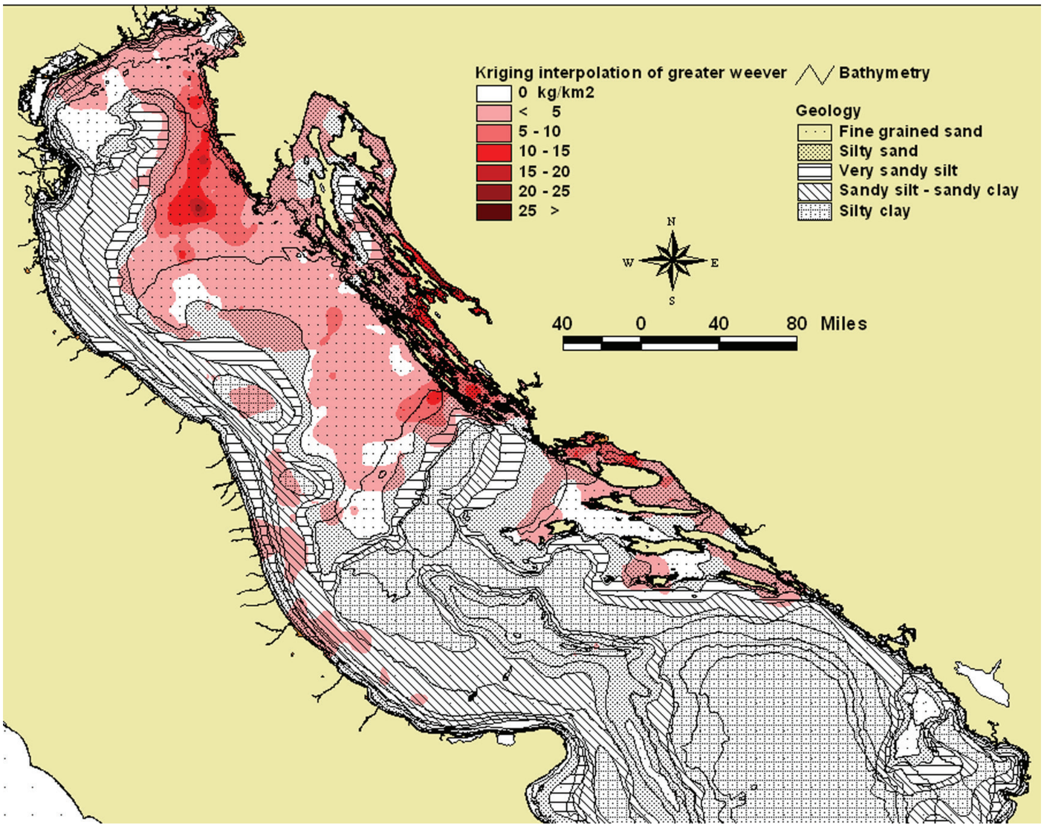

Figure 2 Distribution of greater weever (Trachinus draco) in the Northern and Central Adriatic Sea (GSA 17) during MEDITS 1996 – 2013 surveys

Slika 2. Rasprostranjenost pauka bijelca (Trachinus draco) u sjevernom i srednjem Jadranu (GSA 17) za vrijeme MEDITS istraživanja od 1996. do 2013.

parts of the Adriatic covered by the same sediment inside the same depth strata. The Kruskal - Wallis test could not confirm significant differences in the distribution of greater weever, according to the bottom sediments. Some authors confirmed that greater weever is more abundant in shallower area, where sandy sediments dominate [12], [15], [16]. Contrary to that, Gaertner et al., (1999) [17] found that distribution of greater weever is not so strongly associated with sediment type. Also, Bagge (2004) [15] furthermore describes seasonal migration of this species between areas with different sediment type. Moreover, if distribution of greater weever in the Northern and Central Adriatic is compared with the distribution of benthic biocenosis which were previously described [18], [19], it could be noticed that the area with a highest density of greater

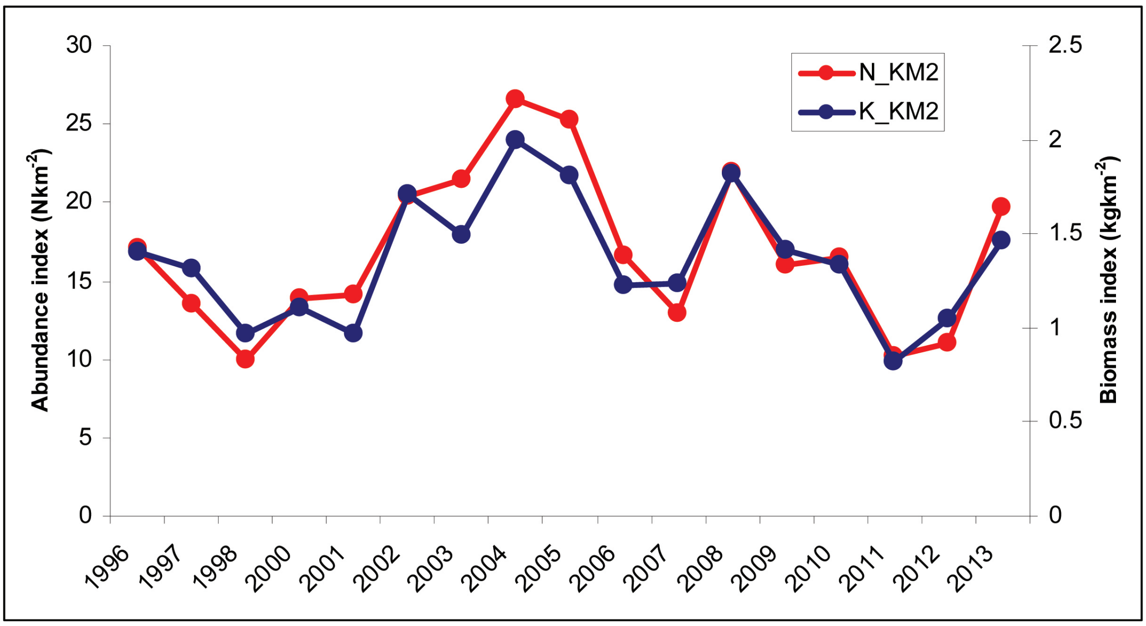

Figure 3 Population density trends of greater weever (Trachinus draco) during MEDITS 1996 – 2013 surveys

Slika 3. Trendovi gustoće populacije pauka bijelca (Trachinus draco) za vrijeme MEDITS istraživanja od 1996. do 2013.

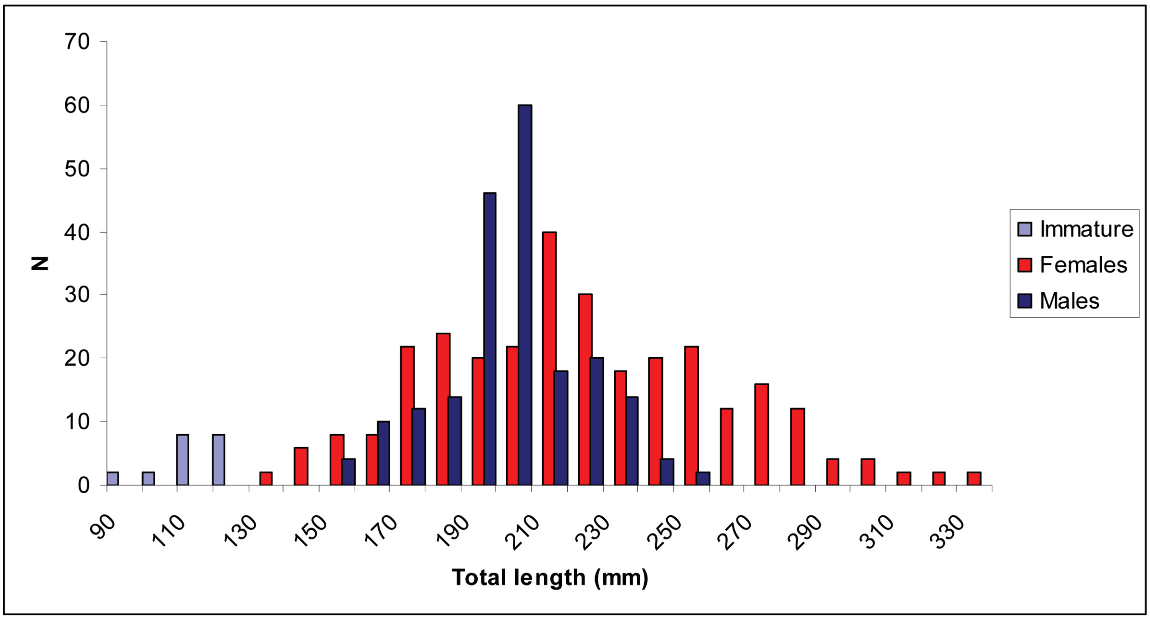

Figure 4 Length frequency distribution of greater weever (Trachinus draco) in the Northern and Central Adriatic Sea (GSA 17) during MEDITS 2009 – 2013 surveys

Slika 4. Dužinska struktura populacije pauka bijelca (Trachinus draco) u sjevernom i srednjem Jadranu (GSA 17) za vrijeme MEDITS istraživanja od 2009. do 2013.

weever's population overlaps with the areas where biocenosis of detritic bottoms prevails. Therefore, it is more likely that distribution pattern of greater weever is driven by complex association between specific bottom communities, together with combination of abiotic (temperature, salinity, etc.) and biotic factors (mostly intra and inter species relationship, food availability, etc). Similar species relationship between abiotic factors, demersal communities and trophic food weeb has been described for the Mediterranean [20], [13], [14] and Eastern Atlantic [15].

POPULATION DENSITY TRENDS / *Trendovi gustoće populacije*

The average values of population density fluctuated during the period from 1996 to 2013, but generally negative trend exists since 2008 with some evidence of recovery in 2013 (Figure 3). Demersal organisms in the Adriatic Sea are mainly exploited by bottom trawlers and it is well known that intense fishing effort can lead to negative changes in distribution and demographic structure of demersal species, especially those ones which are on the higher trophic level. This situation has already been described in the Adriatic for a large fish like *Zeus faber* [21] and *Raja clavata* [22]. Observed negative trend of greater weever population and fluctuation of population density between years are probably not mainly caused by intensive fishing effort of bottom trawlers because this species, characterized as a smaller body sized predator which spent most of the time buried in the sediment, has a better survival rate than other demersal fish. Also a significant part of its population is not so exploited, because the channel areas of the eastern side of the Adriatic area

Table 1 Population density of greater weever (Trachinus draco) in the Northern and Central Adriatic during MEDITS 1996 – 2013 surveys

Tablica 1. Gustoća populacije pauka bijelca (Trachinus draco) u sjevernom i srednjem Jadranu za vrijeme MEDITS istraživanja od 1996. do 2013.

	STRATUM									
	10-50		50-100		100-200		200-500		TOTAL	
AREA	Nkm^{-2}	$kgkm^{-2}$	Nkm^{-2}	$kgkm^{-2}$	Nkm^{-2}	$kgkm^{-2}$	Nkm^{-2}	$kgkm^{-2}$	Nkm^{-2}	$kgkm^{-2}$
TOTAL area	20.35	1.62	23.25	1.87	2.88	0.27	0.00	0.00	15.75	1.27
CTW	60.52	5.29	34.60	2.71	4.20	0.42	0.00	0.00	31.02	2.58
ITW	7.45	0.36	10.66	0.61	0.44	0.04	0.00	0.00	7.31	0.37
ETW	17.95	1.51	16.18	1.41	1.74	0.14	0.00	0.00	10.57	0.91
SEDIMENT	Fine-grained sand		Silty sand		Very sandy silt		Sandy silt-sandy clay		Silty clay	
	35.58	3.11	25.14	1.90	3.57	0.30	6.37	0.33	2.30	0.15

(CTW - Croatian territorial waters; ITW – Italian territorial waters; ETW – Extra territorial waters)

(CTW - hrvatske teritorijalne vode, ITW - talijanske teritorijalne vode, ETW – izvan teritorijalne vode) under strict fisheries regulation measures which significantly reduce fishing effort of bottom trawlers. Changes in a population dynamics of greater weever are probably more affected by climatic and hydrographic regime shifts of the Adriatic Sea rather then fisheries effort. Following these regimes shifts, which are closely correlated with changes of primary production described in several studies for the open Central Adriatic [23], [24], [25], it can be observed that positive trends of greater weever follow the positive trends of primary production and vice versa.

POPULATION STRUCTURE / *Struktura populacije*

Total length of greater weever ranged between 95 and 333 mm with the mean of 207.54 ±36.57 mm and modal value located at 210 mm. The western Mediterranean population of greater weever shows similar length distribution [27], but with slightly lower modal value at 170 mm. The higher ratio of adult individuals in the Adriatic is more likely the result of fisheries regulation measures for bottom trawlers. For males, total length ranged from 115 to 298 mm with mean value of 198.11 ±27.55 mm while for females total length ranged from 115 to 333 mm with mean of 219.63 ±38,95 mm (Figure 4). Student's *t* test showed statistically a significant difference between mean values ($t = 3.98$; $p<0.05$). Sex was determined for 493 specimens; 269 females (55%) and 224 males (45%). The ratio between males and females was significantly different from expected 1:1 ratio ($x^2 = 4.11$; $p<0.05$). Most of the mature females (48.7 %) were in spawning phase confirming that spawning period mainly occurred during spring-summer period [2], [5]. The length–weight relationship for total sample (N= 509) was $W = 0.006\ Lt^{3.0383}$ ($r^2 = 0.965$), and the isometric growth of total sample was confirmed by Student's t test ($p<0.05$). When calculated for each sex, *L–W* relationship for females was $W = 0.0048\ Lt^{3.1172}$ ($r^2 = 0.9617$) with the positive allometry, while for males it was $W = 0.0104\ Lt^{2.844}$ ($r^2 = 0.9445$) showing the negative allometry. The value of the parameter *b* in the length-weight relationship was statistically different from 3 both for females (N=269, t=3.082, P>0.05) and males (N=224, t=3.382, P>0.05). Obtained value for parameter b in this study is slightly higher from previous result described in the Adriatic Sea [26]. These differences are probably associated with inter-annual changes in the nutritional condition of the organisms, the different size composition of samples included in the analysis, small number of individuals in certain studies and different sampling season.

CONCLUSION / *Zaključak*

Although greater weever is not abundant species in the Adriatic Sea, it is nevertheless widely distributed and it can be found in all depth strata, except the deepest parts. Generally, it prefers the area shallower than 100 m depth. The population density is mostly stable, taking into consideration some negative trends in the last years, which have been observed in the most commercially important stocks. The population structure shows normal distribution without the indication of overexploitation both for juveniles and spawners.

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REFERENCES / *Literatura*

[1] Roux, C., (1990) Trachinidae, in J. C. Quero, J. C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.), Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). UNESCO, Paris, 2: 893-895.

[2] Tortonese, E., (1986), Trachinidae, in P. J. P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.), Fishes of the north-eastern Atlantic and the Mediterranean. UNESCO, Paris, 2: 951-954.

[3] Chhatwal, I. & Dreyer, F. (1992), Isolation and characterization of dracotoxin from the venom of the greater weever fish Trachinus draco.Toxicon, 30, (1): 87–93.

[4] Maretić, A. (1986), Otrovno bilje i životinje naših krajeva. Stvarnost, Zagreb.

[5] Jardas, I. (1996), Jadranska ihtiofauna. Školska knjiga, Zagreb, 317-318.

[6] FAO (2012), The State of World Fisheries and Aquaculture 2012. Food and Agriculture Organization of UN, Roma

[7] Froese, R. & Pauly, D. Editors, (2014), FishBase. World Wide Web electronic publication. www.fishbase.org, version (08/2014)

[8] MEDITS Working Group, (2013), International bottom trawl survey in the Mediterranean, MEDITS Handbook. Version 7.

[9] Souplet, A. (1996), Calculation of abundance indices and length frequencies in the MEDITS survey, in: J. Bertrand (ed.), Campagne internationale de chalutage demersal en Mediterranee (MEDITS). Campagne 1995. Raport final 1, 21-26.

[10] Shepard, D. (1968), A two-dimensional interpolation function for irregularly-spaced data, Proceedings of 23rd National Conference ACM. ACM, 517-524

[11] Pauly, D. (1984), Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM, Manila, 325.

[12] Demestre, M., Sanchez, P. & Abello, P. (2000), Demersal fish assemblages and habitat characteristics on the continental shelf and upper slope of the north-western Mediterranean. Journal of Marine Biology Association of the United Kingdom, 80: 981-988.

[13] Kallianotis, A., Sophronodis, K., Vidoris, P. & Tselepides, A. (2000). Demersal fish and megafaunal assemblages on the Cretan continental shelf and slope (NE Mediterranean): seasonal variation in species density, biomass and diversity. Progress in Oceanography, 46: 429-455.

[14] Moranta, J., Quetglas. A., Massutí, E., Guijarro, B., Hidalgo, M. & Diaz, P. (2008), Spatio-temporal variations in deep-sea demersal communities of the Balearic Islands (western Mediterranean). Journal of Marine Systems, 71: 346–366.

[15] Bagge, O. (2004), The biology of the greater weever (Trachinus draco) in the commercial fishery of the Kattegat. ICES Journal of Marine Science, 61: 933-943.

[16] Damalas, D., Maravelias, C. D., Katsanevakis, S., Karageorgis, A. P. & Papaconstantinou, C. (2010), Seasonal abundance of non-commercial demersal fish in the eastern Mediterranean Sea in relation to hydrographic and sediment characteristics. Estuarine, Coastal and Shelf Science, 89: 107-118.

[17] Gaertner, J. C., Mazouni, N., Sabatier, R. & Millet, B. (1999), Spatial structure and habitat associations of demersal assemblages in the Gulf of Lions: a multicompartmental approach. Marine Biology, 135: 199-208.

[18] Vatova, A. (1949), La fauna bentonica dell'Alto e Medio Adriatico. Nova Thalassia, 1 - 110.

[19] Pérès, J. M. & Gamulin-Brida, H. (1973), Biološka oceanografija. Školska Knjiga, Zagreb

[20] Moranta, J., Stefanescu, C., Massutí, E., Morales-Nin, B. & Lloris, D. (1998), Fish community structure and depth-related trends on the continental slope of the Balearic Islands (Algerian Basin, Western Mediterranean). Marine Ecology Progress Series, 171: 247-259.

[21] Vrgoč, N. Krstulović Šifner, S., Dadić, V. & Jukić-Peladić, S. (2006), Demographic structure and distribution of John Dory, Zeus faber L. 1758, in Adriatic Sea. Journal of applied ichthyology, 22, (3): 205 - 208.

[22] Krstulović Šifner, S., Vrgoč, N., Dadić, V., Isajlović, I., Peharda, M. & Piccinetti, C. (2009), Long-term changes in distribution and demographic composition of Thornback ray, Raja clavata, in the northern and central Adriatic Sea. Journal of Applied Ichthyology, 25: 40-

[23] Grbec, B., Morovic, M., Beg Paklar, G.,Kušpilic, G., Matijevic, S., Matić, F. & Ninčević – Gladan, Ž. (2009), The relationship between the atmospheric variability and productivity in theAdriatic Sea area. Journal of the Marine Biological Association of the United Kingdom, 1 -10.

[24] Matić, F., Grbec, B. & Morović, M. (2011), Indications of Climate Regime shifts in the Middle Adriatic Sea. Acta Adriatica,52,(2): 235–246.

[25] Vilibić, I., Matijević, S. & Šepić, J. (2012), Changes in the Adriatic oceanographic properties induced by the Eastern Mediterranean Transient. Biogeosciences Discuss, 9: 927–956.

[26] Dulčić, J. & Kraljević, M. (1996), Weight-length relationships for 40 fish species inthe eastern Adriatic (Croatian waters). Fisheries Research, 28: 243– 251

[27] Ordines, F., Farriols. M. T., Lleonart, J., Guijarro, B., Quetglas, A. & Massutí, E. (2014), Biology and population dynamics of by-catch fish species of the bottom trawl fishery in the western Mediterranean. Mediterranean Marine Science, 15, (3): 613-625