Mar. Sci. Tech. Bull. (2021) 10(4): 416-425
e–ISSN: 2147–9666
info@masteb.com

dergipark.org.tr/en/pub/masteb
www.masteb.com
DOI: 10.33714/masteb.993252

Marine Science and Technology Bulletin

RESEARCH ARTICLE

Spatial and temporal distribution of *Liocarcinus depurator* (Crustacea: Decapod) caught by beam trawl in the southeastern Black Sea

Hatice Onay[1*] • Sabri Bilgin[2]

[1] *Recep Tayyip Erdogan University, Faculty of Fisheries, Department of Fishing Technology, Rize, Turkey*
[2] *Sinop University, Faculty of Fisheries, Department of Fishing Technology, Sinop, Turkey*

ARTICLE INFO

Article History:
Received: 09.09.2021
Received in revised form: 05.11.2021
Accepted: 10.11.2021
Available online: 27.12.2021

Keywords:
Portunidae
CPUE
Biomass
Abundance
Crab

ABSTRACT

This study was carried out to determine the temporal and spatial distribution of *Liocarcinus depurator* (Crustacea: Decapod) caught by beam trawl in the southeast Black Sea between December 2012 and November 2013. Sampling was executed at depths from shoreline to deeper 30 m by using a 2 m wide beam trawl from İyidere, Merkez and Çayeli stations. *L. depurator* was determined most intensely (1000 m^2) at 0-5 m depth at Çayeli station and during the summer season. *L. depurator* started to migrate from shallow to deeper in autumn and left the coast completely in winter. It approached the shore again in the spring and spread at all depths in the summer season. In addition, while it was distributed in three different habitats according to CPUE values, the highest CPUE value was calculated at Çayeli station, which has a macroalgae structure.

Please cite this paper as follows:

Onay, H., & Bilgin, S. (2021). Spatial and temporal distribution of Liocarcinus depurator (Crustacea: Decapod) caught by beam trawl in the southeastern Black Sea. *Marine Science and Technology Bulletin*, *10*(4), 416-425. https://doi.org/10.33714/masteb.993252

Introduction

Blue-leg swimcrab *Liocarcinus depurator* is distributed in the North Sea, Atlantic Ocean, Mediterranean Sea and Black Sea (Horton & Lilley, 2008). It is a wide species of bathymetry, temperature and habitat (Zariquiey-Álvarez, 1968, Minervini et al., 1982; Pérès & Picard, 1965; Christiansen, 1982). It is found in a variety of substrates, although it is most commonly found in mud, coastal-littoral mud and both mid-shore and cullet-filled sands (Schembri & Lanfranco, 1984). It was reported that *L. depurator* is the main food source for Crustacea, Mollusca, Polychaete, Ophiuroid and other fish (Freire, 1996). Decapod crustaceans are important ecological components of the marine ecosystem and play a vital role in the intermediate trophic level (Farina et al.,1997). Studies on crab species in the Black Sea are generally on taxonomy and records (Anosov, 2000; Bilgin &

* Corresponding author
E-mail address: hatice.bal@erdogan.edu.tr (H. Onay)

Çelik, 2004; Ateş et al., 2010; Micu et al., 2011; Bilgin, 2019; Demirbas et al, 2021). There are also studies on the distribution of the species (Holthuis, 1961; Zariquiey Alvarez, 1968; Kattoulas & Koukouras, 1975; García Raso, 1984; D'Udekem d'Acoz, 1993; Manjón-Cabeza & García Raso, 1998; Abelló et al., 2002; Rufino et al., 2005). However, apart from the studies on the biology of the species in the Black Sea (Aydın et al., 2013; Aydın, 2018), there is no study on the distribution abundance and ecological aspects of the species in the Black Sea. The aim of this study is to characterize the seasonal, bathymetric, and spatial distribution sympatry of *L. depurator*, the benthic crab community in the southern Black Sea. This study is the first to determine the temporal and spatial distribution of this species in the Black Sea.

Materials and Methods

This study was carried out monthly between December 2012 and November 2013 by using a 2 m width and 15 mm mesh opening beam trawl, from 3 stations (İyidere, Merkez and Çayeli) at 4 different depth groups, on the coast of Rize, Turkey (Figure 1).

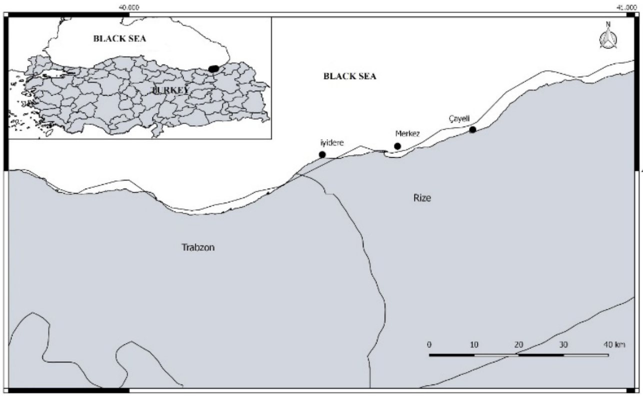

Figure 1. Study area

The amount of catch per unit effort (CPUE) was calculated according to the formula below for the *L. depurator* species.

$$CPUE = \frac{N_i}{t_i} \quad (1)$$

Here, *CPUE*=catch per unit effort, N_i=*i*. number of individuals in the tow, t_i=*i*. tow time (hour).

CPUE and abundance analyses according to location, depth and season groups were performed according to One-way analysis of similarity (ANOSIM) (Clarke & Warwick, 1994). It was made according to the similarity percentage analysis (similarity percentages: SIMPER) of the groups that make up the difference between the groups (depth, season, station) (Clark, 1993). Multiple statistical analyses (multivar) were performed using the PAST program v. 2.14 (Hammer et al., 2001).

Results

As a result of the beam trawling the bottom structure of the stations were determined as follow: *Iyidere station***,** the bottom structure was generally formed as sandy, crust and small rock debris. Sandy and rocky areas were dominant. This station generally consists of sand, gravel and shell structure in terms of bottom structure. *Merkez station***,** the bottom structure was generally consisted crust and small rock debris covered with macroalgae (*Zostera* sp., *Ulva* sp.). Sandy areas were dominant. *Çayeli station***,** the bottom structure of this station was partially covered with sandy and macroalgae (*Zostera* sp., *Ulva* sp. and *Cystoseira* sp.).

During the research, a total of 146 tow were taken from İyidere, Merkez and Çayeli stations using a 2 m wide beam trawler (Beam trawl). The differences in the amount of abundance between the depth groups were found to be statistically significant (Kruskal-wallis test, $p<0.05$). Number of individuals in 1000 m^2 (±standard error) area was calculated as 15697.4±2260.55 ind. in the 0-5 m depth group, 13050.3±5894.50 ind. in the 5-10 m depth group, 3900.7±1373.69 ind. in the 10-20 m depth group and 4362.5±1626.79 ind. in the 20-30+ m depth group, respectively (Figure 2).

The differences in intensity between the seasons were found to be insignificant between the following seasons: Spring-Winter ($P=0.595$) and Autumn-Summer ($P=0.3195$). *L. depurator* individuals were found in the highest abundance (ind./1000*m^2) in Summer, Autumn, Spring and Winter seasons, respectively. Number of individuals in 1000 m^2 area was calculated as 8123.7±4997.92 ind. in the spring, 4259.8±1586.10 ind. in the winter, 11514.3±2569.65 ind. in the autumn, and 12297.5±1981.91 ind. in the summer (Figure 3). The average number of *L. depurator* individuals in an area of 1000 m^2 in the research area was calculated as 9380.4±1637.47 ind. The highest density of *L. depurator* was recorded in Çayeli (Figure 4), although statistically significant differences (Kruskal-Wallis test, $P<0.05$) were observed among the stations. The differences between seasons in terms of abundance were found to be statistically significant and they were listed as: (Kruskal-wallis test) Spring-Autumn ($P=0.002279$), Spring-Summer ($P=8.543E06$), Winter-Autumn ($P=0.01825$) and Winter-Summer ($P=0.0001551$).

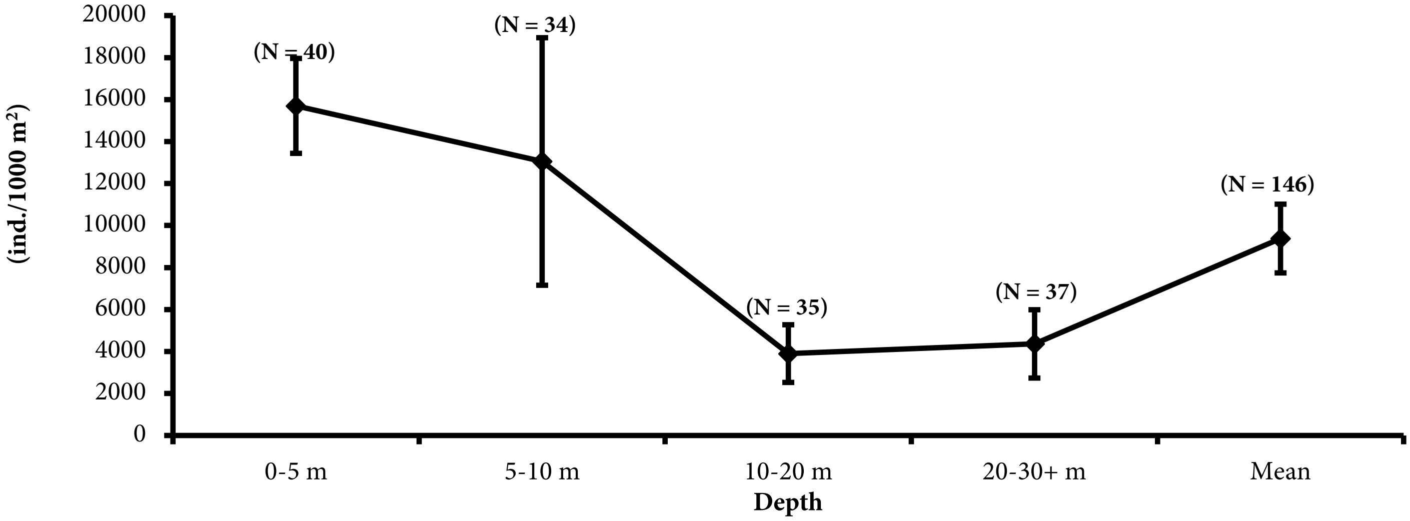

Figure 2. Average abundance of *L. depurator* by depth groups (ind./1000 m^2). The values in parentheses indicate the number of towing, middle point average and the bars indicate the standard error.

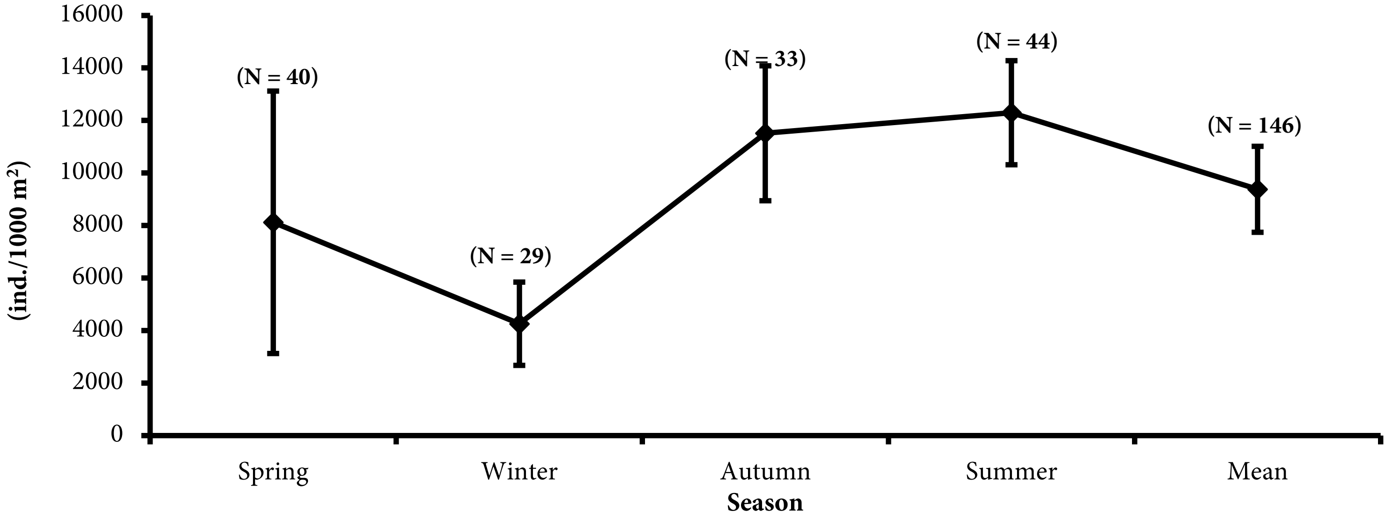

Figure 3. Average abundance of *L. depurator* according to seasons (ind./1000 m^2). The values in parentheses indicate the number of tows, middle point average and the bars indicate the standard error.

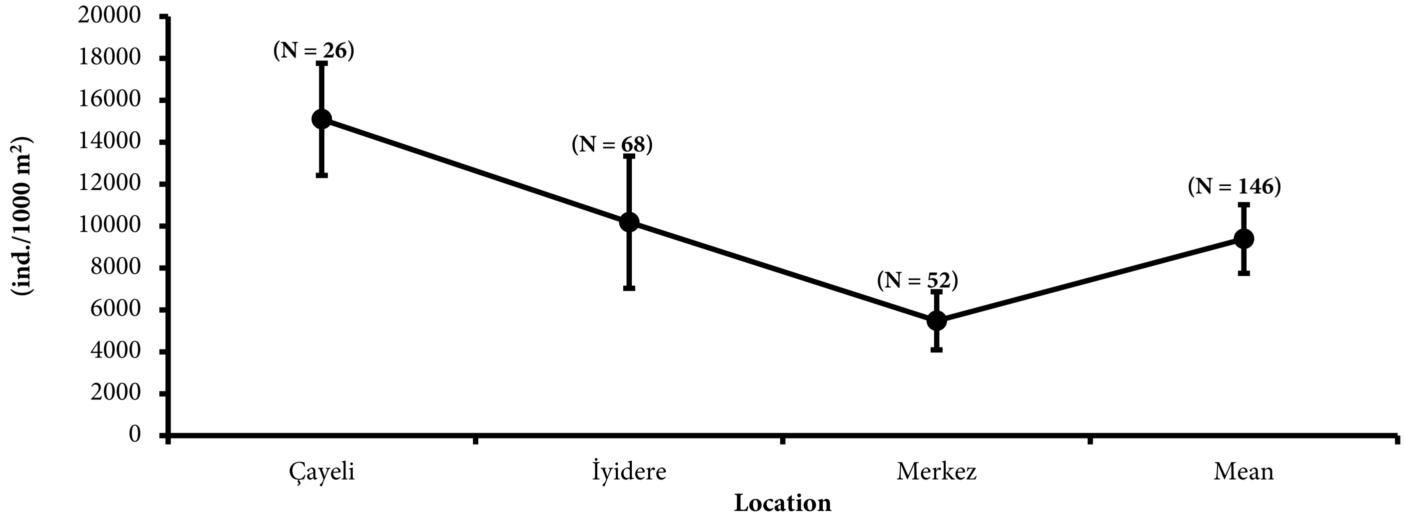

Figure 4. Average abundance of *L. depurator* species according to location (habitat) groups (ind./1000 m^2). The values in parentheses indicate the number of tows, middle point average and the bars indicate the standard error.

Spatial and Temporal Distribution of CPUE Values of L. depurator

The difference between the seasons in terms of catch amount in unit effort (CPUE: individuals/hour) was statistically significant and it is as follows: (Kruskal-wallis test) Spring-Autumn (P=0.004293), Spring-Summer (P=1.077E-05), Winter-Autumn (P=0.01152) and Winter-Summer (P=7.708E-05). The difference in the catch amount of CPUE between the seasons was insignificant between Spring and Winter (P=0.7084) and Autumn and Summer (P=0.2101) (Figure 5). *L. depurator* individuals were found in the highest abundance (individuals/hour) in Summer, Autumn, Spring and Winter seasons, respectively. The difference detected in terms of CPUE was similar to the difference between seasons in terms of intensity. *L. depurator* individuals were found in the highest abundance (individuals/hour) in Çayeli, Iyidere and Merkez stations, respectively (Figure 6). *L. depurator* individuals are at the highest abundance (individuals/hour) at the depth of 0-5 m, 5-10 m, 20-30 m, and 10-20 m, respectively (Figure 7).

One-way similarity analysis (one-way ANOSIM) was performed to determine whether the CPUE values of *L. depurator* species differ between seasons according to depth groups or not, and according to this analysis, the difference was found to be statistically significant (Global R=0.3225; P < 0.0001). According to the similarity percentage (SIMPER) test results, the first distinguishing depth group is 5-10 m, and the second distinguishing depth group is 0-5 m, between spring and winter. Among the other seasons (Spring-Autumn, Spring-Summer, Winter-Autumn, Winter-Summer and Autumn-Summer), the first depth group that distinguishes in terms of abundance of *L. depurator* is the 0-5 m depth group (Table 1).

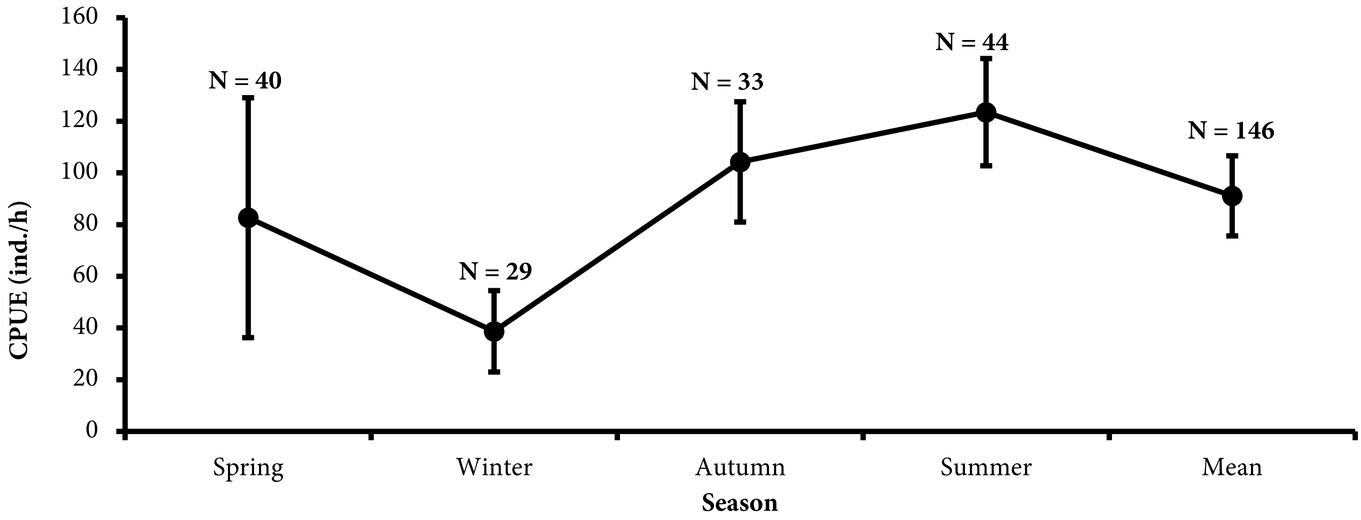

Figure 5. Average CPUE (ind./hour) values of *L. depurator* species by season. The bars represent the standard error, middle point average and the numbers represent the number of tows.

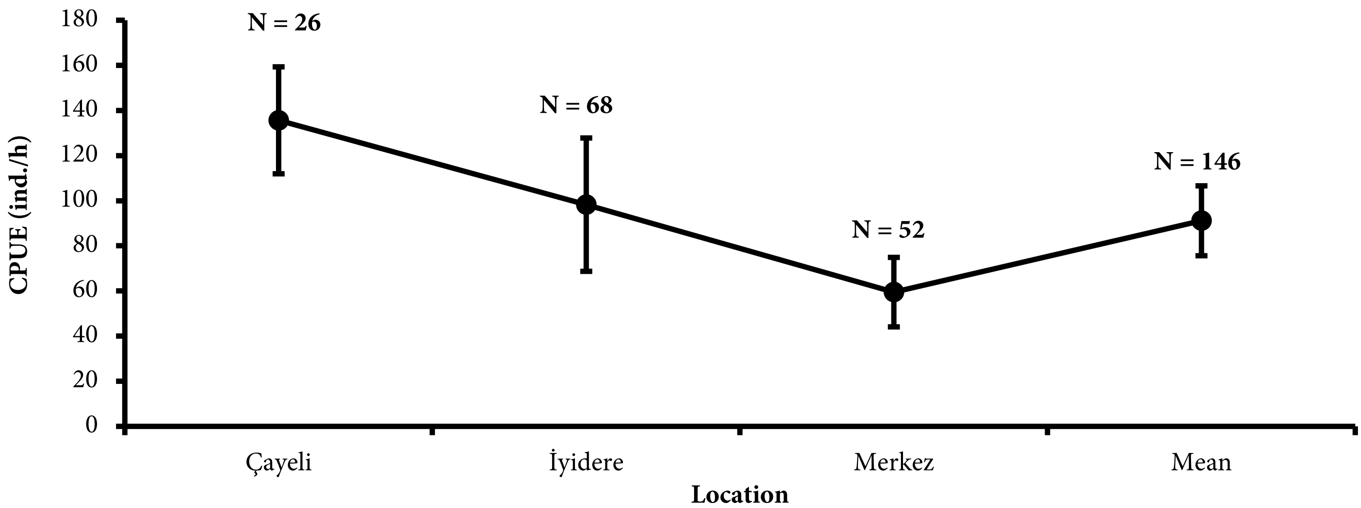

Figure 6. Average CPUE (ind./hour) values of *L. depurator* species by location. The bars represent the standard error, middle point average and the numbers represent the number of tows.

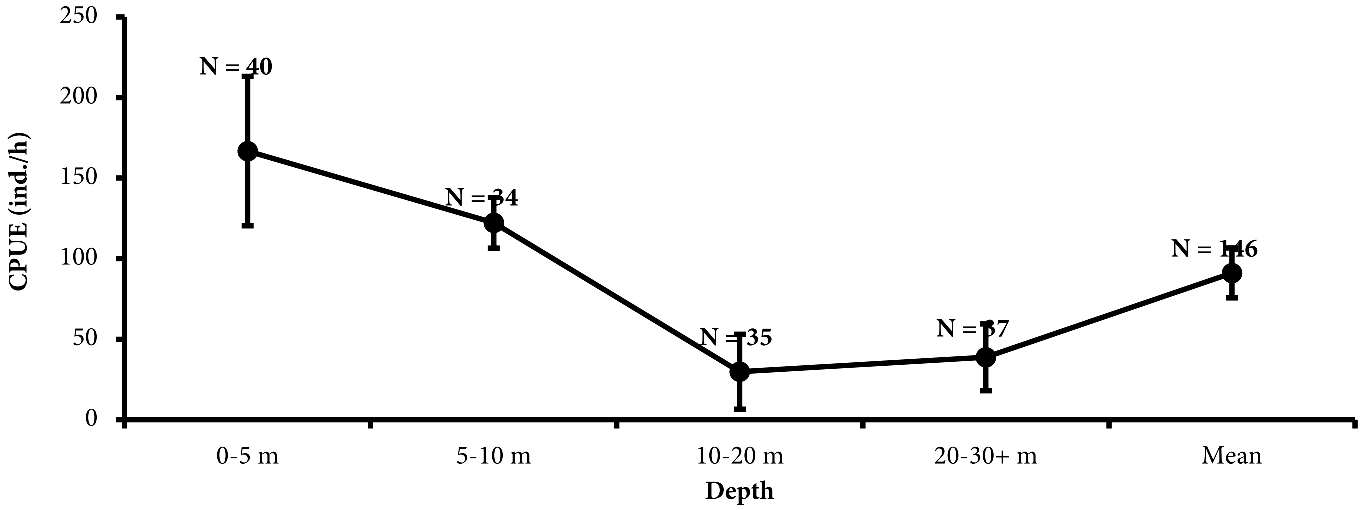

Figure 7. Average CPUE (ind./hour) values by depth groups of *L. depurator* species. The bars represent the standard error, middle point average and the numbers represent the number of tows.

Table 1. Similarity analysis of CPUE values between seasons according to depth groups (one-way ANOSIM) and similarity rates (SIMPER). Global R = 0.3225; P<0.0001.

Groups	ANOSIM		SIMPER				
	R	***P***	***Average dissimilarity***	***Distinctive depth group 1***	***Contrib%***	***Distinctive depth group 2***	***Contrib%***
Spring -Winter	0.1012	0.0576	84.45	5-10 m	37.03	0-5 m	29.22
Spring-Autumn	0.0275	0.2594	80.28	0-5 m	39.25	5-10 m	30.06
Spring-Summer	0.3389	0.0001	81.51	0-5 m	52.53	5-10 m	19.36
Winter-Autumn	0.2652	0.0061	89.57	0-5 m	40.74	5-10 m	27.76
Winter-Summer	0.7552	0.0001	96.69	0-5 m	60.75	20-30^{+} m	15.56
Autumn-Summer	0.0872	0.1511	67.89	0-5 m	34.24	5-10 m	19.69

Table 2. Similarity analysis of CPUE values between locations according to depth groups (one-way ANOSIM) and similarity rates (SIMPER). Global R=0.1142; P<0.0133.

Groups	ANOSIM		SIMPER				
	R	***P***	***Average dissimilarity***	***Distinctive depth group 1***	***Contrib%***	***Distinctive depth group 2***	***Contrib%***
İyidere-Merkez	0.1744	0.0033	78.93	0-5 m	37.26	5-10 m	22.93
İyidere-Çayeli	0.0945	0.0900	72.70	0-5 m	36.59	5-10 m	18.95
Merkez-Çayeli	0.0313	0.2478	63.76	0-5 m	37.40	5-10 m	14.05

Table 3. Similarity analysis of CPUE values between seasons according to locality groups (one-way ANOSIM) and similarity rates (SIMPER). Global R=0.1494; P<0.0002.

Groups	ANOSIM		SIMPER				
	R	***P***	***Average dissimilarity***	***Distinctive locality group 1***	***Contrib%***	***Distinctive locality group 2***	***Contrib%***
Spring-Winter	0.0037	0.3838	73.58	İyidere	55.53	Merkez	17.95
Spring-Autumn	0.0445	0.1336	85.11	İyidere	41.43	Çayeli	30.23
Spring-Summer	0.2388	0.0007	90.46	Çayeli	32.91	Merkez	30.63
Winter-Autumn	0.144	0.0136	82.06	İyidere	42.09	Çayeli	32.25
Winter-Summer	0.4292	0.0001	92.61	Çayeli	35.09	Merkez	32
Autumn-Summer	-0.0037	0.3838	73.58	İyidere	55.53	Merkez	17.95

One-way similarity analysis (one-way ANOSIM) was performed to determine whether the CPUE values of *L. depurator* species differ between locations according to depth groups or not, and according to this analysis, the difference was found to be statistically significant (Global R = 0.1142; P<0.0133). According to the percent of similarity (SIMPER) test results, the first distinguishing depth group among the locations is 0-5 m, and the second distinguishing depth group is 5-10 m (Table 2). One-way similarity analysis (one-way ANOSIM) was performed to determine whether the CPUE values of *L. depurator* differ between seasons according to location groups or not, and according to this analysis, the difference was found to be statistically significant (Global R=0.1494; P<0.0002). According to the percent of similarity (SIMPER) test results, the first location group that distinguishes between the seasons is Iyidere, and the second distinguishing location group is the Merkez, regarding the seasons are Spring-Winter and Autumn-Summer seasons. The first location group that distinguishes between the seasons is Iyidere and the second distinguishing location group is Çayeli, regarding the seasons are Spring-Autumn and Winter-Autumn. The first location group distinguishing between the seasons is Çayeli, and the second distinguishing location group is the Merkez, regarding the seasons are Spring-Summer and Winter-Summer (Table 3).

In the spring, *L. depurator* was found more abundant between 0 and 10 m depth, while it was found less abundant between 10 and 30+ m depth. In winter, *L. depurator* was determined in the least abundant at 0-5 m depth. In the summer, *L. depurator* was determined at all depths (Figure 8). CPUE values of *L. depurator* were determined at the lowest rate in Çayeli station in summer and winter seasons. In the other two stations, *L. depurator* was encountered in all seasons (Figure 9). *L. depurator* was found at all depths at three stations. The CPUE value decreased from 0-5 m depth to 20-30$^+$m depth at Iyidere and Çayeli stations. At the Merkez station, the lowest CPUE value was determined at a depth of 10-20 m (Figure 10). It was determined that the *L. depurator* started to migrate from shallow to deeper in autumn and left the coast completely in winter. It was observed that it approached the shore again in the spring and spread at all depths in the summer season. In addition, while it was distributed in three different habitats according to CPUE values, the highest CPUE value was calculated at Çayeli station, which has a macroalgae structure.

Discussion

L. depurator is a resistant species that can tolerate temperature changes (Christian, 1982; Peres & Picard, 1995) and can live in various habitats at different depths (Abello & Valladares, 1988; Minervi et al., 1982; Zariquiey-Alvarez, 1968). In this study, *L. depurator* individuals were determined as a result of shootings between 0 and 30$^+$ m. The depth in which individuals are detected most abundance in an area of 1000 m^2 is the depth group of 0-5 m, whereas the depth group with the lowest abundance is the depth group of 20-30$^+$ m. Researchers working at similar depths (0-40 m) reported a high number of individuals in shallow waters which is consistent with this study, while they determined less number of individuals in deeper waters with increasing depth (Manjón-Cabeza & García Raso, 1998; García-Raso & Majón-Cabeza, 2002; González-Gordillo et al., 1990; Ramsay et al., 1998; González-Gurriarán et al., 1990; Freire et al., 1993; González-Gurriarán et al., 1991). Researchers working in deeper waters (between 50 and 800 m) reported *L. depurator* species more abundance compared to increasing depth at depths between 50 and 100 m, while they found a decrease in the number of individuals with increasing depth (Sarda et al., 1982; Ellis et al., 2000; Farina et al., 1997). The Black Sea, in which this study was conducted, is a semi-enclosed inland sea. In the southwest, it has connections with the world's seas as much as the Turkish Straits System allows. This restricted water exchange contains oxygen only from the surface to a depth of 150 m (15% of the total volume). In addition, at a deeper level it leads to the formation of an almost completely oxygen-free environment containing hydrogen sulphide (Ross et al., 1974). This feature of the Black Sea prevents the *L. depurator*, which was detected at much deeper depths (800 m) (Rufino et al., 2005), from living much deeper in the Black Sea. The differences in the number of individuals at different depths in the studies may be due to the fishing method (fishing equipment and features) used by the researchers, and the number and duration of shooting in the operations. Our results showed that *L. depurator* migrates from shallow waters to deeper waters in winter, while it migrates from deep waters to shallow waters during summer and spring. This is due to the water temperature, but may be related to the prolongation of daylight and reproductive behaviour. *L. depurator* has been detected in various habitats (sand, mud and shell) as well as having a wide distribution in depth. In this study, the highest amount of *L. depurator* individuals was detected in Çayeli, Iyidere and Merkez stations, respectively. In studies, *L. depurator* was commonly detected in muddy habitats (d'Udekem d'Acoz, 1992; Abelló, 1993; Relini et al., 1986; Pastore et al., 1998; Falciai, 1997). Secondly, their common

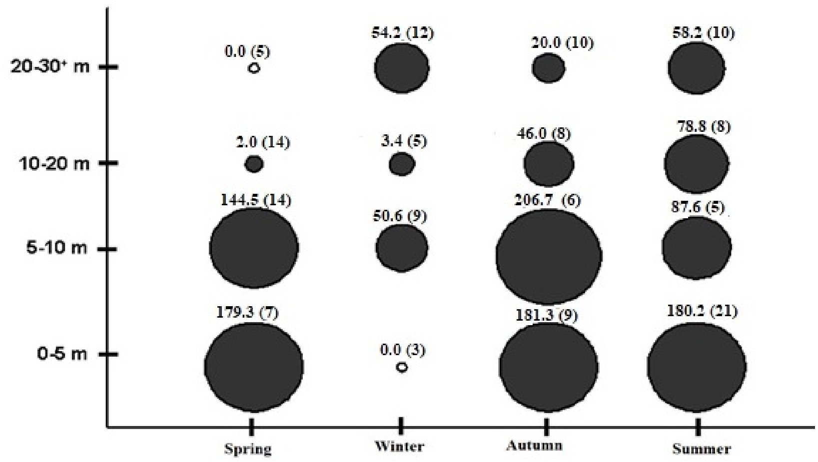

Figure 8. Average CPUE (ind./hour) values of *L. depurator* species by depth groups and seasons. The numbers in parentheses represent the number of tows.

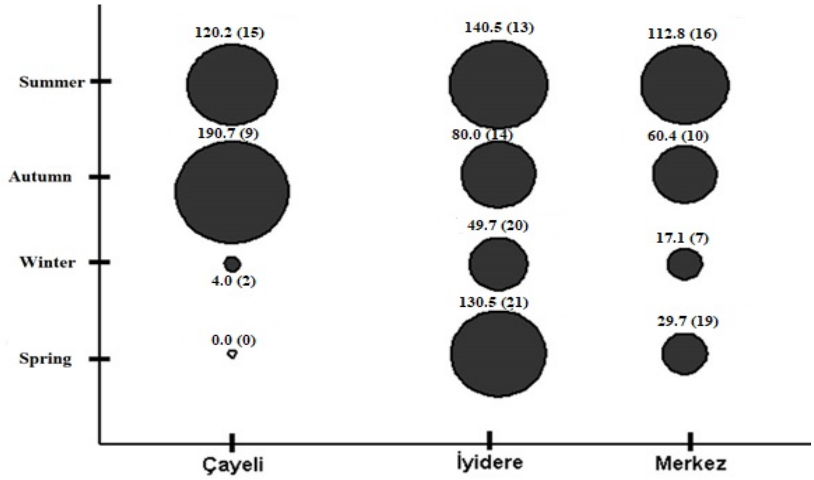

Figure 9. Average CPUE (ind./hour) values of *L. depurator* by location and seasons. The numbers in parentheses represent the number of tows.

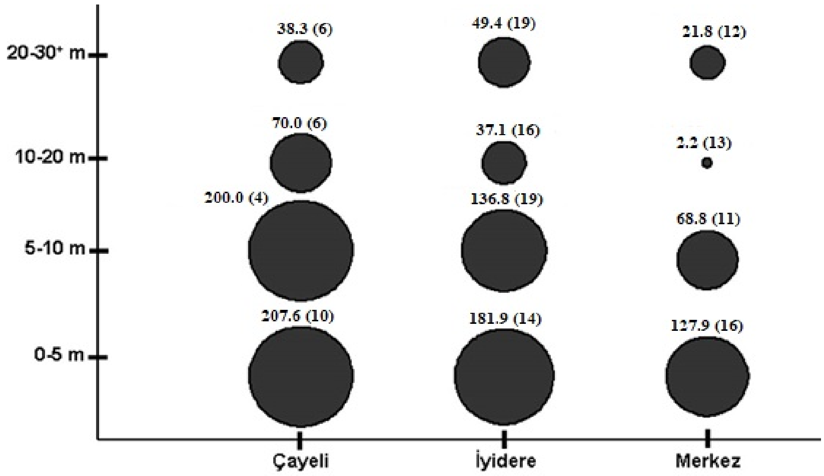

Figure 10. Average CPUE (ind./hour) values for *L. depurator* species by depth groups and locations. The numbers in parentheses represent the number of tows.

habitat is sand, gravel and shell (Stevic, 1979). In the algae habitat, Bilgin et al. (2007) determined the crab species living in the *Zostera marina* species in their studies in Sinop coasts, in the Black Sea. They found *Liocarcinus vernalis* in the first place in terms of abundance, while *L. depurator* was the second most intense and sampled along 12 months.

The detection of *L. depurator* in different habitats may be due to the fact that the researchers used different depths and fishing methods. As a matter of fact, *L. depurator* is more concentrated in shallow (mud-sand) waters and found less frequently in deeper waters (Minervini et al., 1982). This is an indication that the availability and abundance of *L. depurator* is under the influence of depth-habitat. Our findings showed that *L. depurator* density change with seasons, depth and habitat characteristics. However, considering the reproductive biology and fecundity characteristics of the species, it will be more useful to understand the role of *L. depurator* in the ecosystem.

Conclusion

L. depurator was distributed at all depths between 0-30$^+$ m in autumn and summer seasons. However, with the decrease in temperature in the winter season, the *L. depurator* migrated from the coast to the deeper areas, while in the spring it migrated towards the coast with the increase in temperature. For an ecosystem-based fisheries management, revealing other bio-ecological characteristics of *L. depurator* will contribute to the literature and fisheries management. As a result, crabs have an important place in the benthic ecosystem as they form the food of other demersal creatures. In the light of these data, it shows that the place of crabs in the ecosystem is undeniably important.

Acknowledgements

This study was supported by the Scientific Research Projects unit of Recep Tayyip Erdoğan University with the project numbered 2013.103.03.1. We would like to thank RTEU and related units for their support. This study was produced from Hatice Onay's master's thesis.

Compliance With Ethical Standards

Authors' Contributions

Author SB designed the study, HO wrote the first draft of the manuscript, performed and managed statistical analyses. Both authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

References

Abelló, P. (1993). Pautes de distribucío de les espècies de la família Portunidae (Crustacea: Brachyura) als fons de substrat tou de la Mediterránia nord-occidental. *Butlletín de la In-stitucío Catalana d`Història Natural*, *61*, 59-68.

Abelló, P., & Valladares, J. (1988). Bathyal decapod crustaceans of the Catalan Sea (northwestern Mediterranean). *Butlletín de la In-stitucío Catalana d`Història Natural*, *48*, 97-102.

Abello, P., Carbonell A., & Torres, P. (2002). Biogeography of epibenthic crustaceans on the shelf and upper slope off the Iberian Peninsula Mediterranean coast: implications for the establishment of natural management areas. *Scientia Marine*, *66*, 183-198.

Anosov, S. E. (2000). Keys to identification of Brachyuran larvae of the Black Sea. *Crustaceana*, *73*(10), 1239-1246.

Ateş, A. S., Kocataş, A., Katağan, T., & Özcan, T. (2010). An updated list of Decapod Crustaceans on the Turkish coast with a new record of the Mediterranean shrimp, *Processa acutirostris* Nouvel and Holthuis 1957 (*Caridea, Processidae*). *North-Western Journal of Zoology*, *6*(2), 209-217.

Aydın, M. (2018). Length-weight relationships and condition factors of five crab species (Decapoda) in the Black Sea. *Pakistan Journal of Zoology*, *50*(4), 1519-1524.

Aydın, M., Karadurmuş, U., & Erbay, M. (2012). Length-weight relationships and reproduction characteristics of *Liocarcinus navigator* (Herbst, 1794). *Ege Journal of Fisheries and Aquatic Sciences*, *29*(4), 193-197.

Bilgin, S. (2019). Review: An update list of crab species (Crustacea: Decapoda: Brachyura) with exotic crabs in the Black Sea fauna. *Journal of Anatolian Environmental and Animal Sciences*, 4(2), 211-215. https://doi.org/10.35229/jaes.566520

Bilgin, S., & Çelik, E. Ş. (2004). *Karadeniz'in Sinop kıyıları (Türkiye) yengeçleri* [The crabs of the Sinop coasts of the Black Sea (Turkey)]. *Fırat Üniversitesi Fen ve Mühendislik Dergisi*, *16*(2), 337-345.

Bilgin, S., Ateş, A. S., & Çelik, E. Ş. (2007). The Brachyura (Decapoda) community of *Zostera marina* meadows in the coastal area of the southern Black Sea (Sinop Peninsula, Turkey). *Crustaceana*, *80*(67), 17-730.

Christiansen, M. E. (1982). A review of Crustacea Decapoda Brachyura in the northeast Atlantic. *Quaderni del Laboratorio di Tecnologia della Pesca*, *3*(2-5), 347-354.

Clarke, K. R. (1993). Non parametric multivariate analyses of changes in community structure. *Australian Journal of Ecology*, *18*, 117-143.

Clarke, K. R., & Warwick, R. M. (1994). *Change in marine communities: An approach to statistical analysis and interpretation* (2nd ed.). PRIMER-E Ltd.

D'Udekem D'Acoz, C. (1992). Contribution à la connaissance des crustacés décapodes helléniques I: Brachyura. *Bios*, *1*(2), 9-47.

D'Udekem D'Acoz, C. (1993). Contribution á la Connaissance des Crustacés Décapodes Helléniques I: Brachyura. *Bios*,

Demirbaş, A., Gözler, A. M., Baytaşoğlu, H., & Kaya, C. (2021). Heavy metal concentration levels and biometric analysis of *Liocarcinus depurator* from different locations on the western Black Sea coast of Turkey. *Environmental Monitoring and Assessment*, *193*(6), 346-352. https://doi.org/10.1007/s10661-021-09113-y

Ellis, J. R., Rogers, S. I., & Freeman, S. M. (2000). Demersal assemblages in the Irish Sea, St George's Channel and Bristol Channel. *Estuarine, Coastal and Shelf Science*, *51*(3), 299-315. https://doi.org/10.1006/ecss.2000.0677

Falciai, L. (1997). Decapod crustaceans of the trawlable sea bed around the island of Lampedusa (Central Mediterranean). *Crustaceana*, *70*, 239-251.

Fariña, A. C., Freire, J., & González-Gurriarán, E. (1997). Megabenthic decapod crustacean assemblages on the Galician continental shelf and upper slope (north-west Spain). *Marine Biology*, *127*(3), 419-434. https://doi.org/10.1007/s002270050029

Freire, J., Fernández, L., Muiño, R., & González-Gurriarán, E. (1993). Análisis geoestadístico de la distribucíon espacial de las poblaciones de crustáceos y peces megabentónicos en la Ría de Ferrol (Galicia NO España). *Publicaciones Especiales del Instituto Español de Oceo-nografia*, *11*, 259-267.

Garcia Raso, J. E. (1984). Brachyura of the coast of Southern Spain. *Spixiana*, *7*(2), 105-113.

García-Raso, J. E., & Majón-Cabeza, M. E. (2002). An infralittoral decapod crustacean community of southern Spain affected by anthropogenic disturbances. *Journal of Crustacean Biology*, *22*(1), 83-90.

González-Gordillo, J. I., Cuesta Mariscal, J. A., & Pablos, F. (1990). Adiciones al conocimiento de los crustáceos decápodos de las zonas mediolitoral e infralitoral de las costas suratlánticas andaluzas (Suroeste España). I Brachyura. *Cahiers de Biologie Marine*, *31*, 417-429.

González-Gurriarán, E., Fernández, L., Freire, J., Muiño, R., & Rodriguez-Solorzano, M. (1991). Estructura de la comunidad megabentónica (crustáceos decápodos-Brachyura-y peces demersales) de la Ría de Ferrol (Galicia, NW España). *Boletín del Instituto Español de Oceanografía*, *7*(2), 89-99.

Hammer, Ø., Harper, D. A. T., & Ryan, P. D. (2001). PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica*, *4*, 9.

Holthuis, L. B. (1961). Report on a collection of Crustacea Decapoda and Stomatopoda from Turkey and the Balkans. *Zoologische Verhandelingen*, *47*, 1-67.

Horton, A., & Lilley, J. (2008). *Crabs of the seashore of the British Isles*. British Marine Life Study Society.

Kattoulas, M., & Koukouras, A. (1975). Benthic fauna of the Evvoia coast and Evvoia Gulf. VI. Brachyura (Crustacea, Decapoda). *Scientific Annals Faculty of Physics and Mathematics, University of Thessaloniki*, *15*, 291-312.

Manjón-Cabeza, M. E., & García Raso, J. E. (1998). A structure and evolution of a decapod crustacean community from the coastal detritic bottoms of Babate (Cádiz, Southern Spain). *Journal of Natural History*, *32*, 1619-1630.

Micu, D., Niţă, V., & Todorova, V. (2011). First record of Say's mud crab *Dyspanopeus sayi* (Brachyura: Xanthoidea: Panopeidae) from the Black Sea. *Marine Biodiversity Records*, *3*, 36.

Minervini, R., Giannotta, M., & Falciai, L. (1982). A preliminary report on the decapod crustaceans in the estuarine area of the Tiber. *Quaderni del Laboratorio di Tecnologia della Pesca*, *3*(2-5), 305-318.

Pastore, M., Maiorano, P., & Latorre, F. (1998). Distribution of Brachyuran crabs in the North- Western Ionian Sea. *Journal of Natural History*, *32*, 10-11.

Pérès, J. M., & Picard, J. (1965). Nouveau manuel de bionomie benthique de la mer Méditterranée. *Recueil del Travaux de la Station on Marine d`Endoume*, *31*(47), 1-137.

Ramsay, K., Kaiser, M. J., & Hughes, R. N. (1998). Responses of benthic scavengers to fishing disturbance by towed gears in different habitats. *Journal of Experimental Marine Biology and Ecology*, *224*(1), 73-89.

Relini, G., Peirano, A., & Tunesi, L. (1986). Osservazioni sulle comunità dei fondi strascicabili del Mar Ligure Centro-Orientale. *Bollettino dei Musei e degli Istituti Biologici dell'Università di Genova*, *52*, 139-161.

Ross, D. A., Uchupi, E., Prada, K. E., & Macilaine, J. C. (1974). Bathymetry and Microtopography of the Black Sea (pp. 1-10). In Degens, T. & Ross, A. (Eds.), *The Black Sea geology, chemistry and biology*. American Association of Petroleum Geologists.

Rufino, M. M., Abelló, P., Yule, A. B., & Torres, P. (2005). Geographic, bathymetric and inter-annual variability in the distribution of *Liocarcinus depurator* (Brachyura: Portunide) along the Mediterranean coast of the Iberian Peninsula. *Sciente Marina*, *69*(4), 503-518.

Sardà, F., Valladares, F. J., & Abelló, P. (1982). Crustáceos decápodos y estomatópodos capturados durante la campaña Golfo de Cádiz 81. *Investigacion Pesquera*, *10*, 89-100.

Schembri, P. J., & Lanfranco, E. (1984). Marine Brachyura (Crustacea: Decapoda: Brachyura) from the Maltese Islands and Surrounding Waters (Central Mediterranean). *CENTRO*, *1*, 21- 39.

Števcic, Z. (1979). Cruises of the research vessel "Villa Velebita" in the Kvarner region of the Adriatic Sea XIX. Crustacea, Decapoda. *Thalassia Jugoslavica*, *15*, 279-287.

Zariquiey Alvarez, R. (1968). Crustáceos Decápodos Ibéricos. Investigación Pesquera, 32, Barcelona.