www.trjfas.org
ISSN 1303-2712
Turkish Journal of Fisheries and Aquatic Sciences 11: 385-391 (2011) DOI: 10.4194/trjfas.2011.0307

Determining Density of *Caulerpa racemosa* (Forsskål) J. Agardh and its Effects on Catch Compositions of Fishing Gears

Ali Ulaş[1,*], Faik Ozan Düzbastilar[1], Celalettin Aydın[1], Altan Lök[1], Cengiz Metin[1]

[1] Ege University, Fisheries Faculty, Dept. of Fishing and Processing Technology, 35100 Bornova, İzmir, Turkey..

* Corresponding Author: Tel.: +90.232 3757026; Fax: +90.232 3757026;
E-mail: ali.ulas@ege.edu.tr

Received 16 September 2009
Accepted 14 February 2011

Abstract

In this study, the variation of *Caulerpa racemosa* density depending on different depths and its effects on the diversity of some fish species in catch composition were investigated. The quadrate method was used by divers to determine the variation of density of *C. racemosa* depending on depth and its possible effects on fish species diversity was determined by visual census method and combined trammel nets. The study was conducted during the periods September 2005 and March 2007 from the Eastern Aegean coast. As a result of sampling dives, density of *C. racemosa* was found as 135.4, 146.5, 191.3, 385.7 and 635.1 g/m² at the depth ranges of 0-5, 6-10, 11-15, 16-20 and 21-25 m, respectively. 14 fishing operations were performed to sample fish species by using combined trammel nets. 293 individuals belonging to 13 species from the area covered by *C. racemosa* and 322 individuals belonging to 16 species from the control area were caught. Any variation was not found in terms of fish number sampled from those areas (P>0.01). 24 individuals belonging to 5 species and 32 individuals belonging to 5 species were censused from the area covered by *C. racemosa* and the control site, respectively. The differences between the number of fish sampled from those sites was found insignificant (P>0.01). Consequently this study contains the first results about invasion density of the invasive alga species seen in Turkish coasts and its effects of fish composition. It is very important to monitor this species in the invasion area and to observe its effects on other species for fishing management and the ecosystem.

Keywords: *Caulerpa racemosa*, quadrate, combined trammel net, fish species diversity, visual census technique.

Caulerpa racemosa (Forsskål) J. Agardh'nın Yoğunluk Tespiti ve Yoğunluğun, Balıkçılık Av Araçlarının Av Kompozisyonuna Etkisi

Özet

Bu çalışmada, *Caulerpa racemosa*'nın farklı derinliklere bağlı yoğunluk değişimi ve bu yoğunluk dağılımının, av kompozisyonunda balık tür çeşitliliğine olan etkisi araştırılmıştır. *C racemosa*'nın derinliğe bağlı yoğunluk değişimi, balıkadamlar tarafından Scuba dalış yapılarak quadrat yöntemiyle; balık tür çeşitliliğine olan etkisi, görsel sayım yöntemi ve kombine uzatma ağları avcılığıyla belirlenmiştir. Çalışma Eylül 2005-Mart 2007 tarihleri arasında Ege Denizi doğu kıyılarında yürütülmüştür. Örnekleme dalışları sonucunda *C. racemosa* yoğunluğu, 0-5, 6-10, 11-15, 16-20, 21-25 m derinlik konturlarında sırası ile 135,4, 146,5, 191,3, 385,7 ve 635,1 g/m² bulunmuştur. Balık türlerinin örneklenmesi amacıyla kombine uzatma ağları ile 14 av operasyonu gerçekleştirilmiştir. *C. racemosa* kaplı alanda 13 türe ait 293 birey yakalanırken kontrol bölgesinde, 16 türe ait 322 birey yakalanmıştır. Her iki alanda, yakalanan birey sayıları açısından fark bulunmamıştır (P>0,01). Görsel sayım yönteminde *C. racemosa* ile kaplı alanda 5 türe ait 24 birey tespit edilirken, kontrol bölgesinde 5 türe ait 32 birey tespit edilmiştir. Her iki alanda gözlenen birey sayıları açısından önemli bir fark bulunmamıştır (P>0,01). Sonuç olarak bu çalışma Türkiye kıyılarında gözlenen yayılımcı alg türünün yayılım yoğunluğu ve balıkçılık av kompozisyonuna etkileri konusunda ilk sonuçları içermektedir. Bu türün yayılım alanında izlenmesi ve diğer türler üzerinde etkilerinin gözlenmesi, balıkçılık yönetimi ve ekosistem açısından son derece önem arz etmektedir.

Anahtar Kelimeler: *Caulerpa racemosa*, quadrat, kombine uzatma ağı, balık tür çeşitliliği, görsel sayım tekniği.

Introduction

Caulerpa means in Latin the plant whose stem is grown horizontally and it is a genus of green algae. It has more than 70 species around the world (Verlaque *et al*., 2003). Cirik *et al*. (1998) reported that, there are two species of the genus *Caulerpa* is native to the Mediterranean. These are *Caulerpa prolifera* (Forsskål) J.V. Lamouroux, and *Caulerpa Olivieri* Dostal. In addition, *Caulerpa scalpelliformis* (Brown

ex Turner) C. Agardh and *Caulerpa racemosa* (Forsskål) J. Agardh were transported from Red Sea to the Mediterranean via the Suez Canal. These species distributed Levantine and Turkey's eastern Mediterranean coast. The invasive species of *Caulerpa taxifolia* (Vahl.) C. Agardh and *C. racemosa* attract attention due to their negative features among alga species (Verlaque *et al*., 2003). These two species are so fast-growing green alga that putting pressure on other sea creatures in a short time like 6 months, adapting themselves to various sea media, reproducing very rapidly and changing biotic and abiotic features of the habitat on which they are grown (Piazzi *et al*., 2001; Verlaque *et al*., 2004).

Researches were conducted on negative effects of *C. racemosa*, which is a warm sea originated exotic species, coming into Eastern Mediterranean Sea through the Suez Canal and *C. taxifolia* being introduced to Western Mediterranean Sea as a result of sea aquarium event on sea ecosystem (Gravez *et al*., 1999). It was reported that *C. racemosa*, which was observed in Cyprus in 1991 for the first time, spread out very rapidly in 9 years and put pressure on *Posidonia oceanica* population (Argyrou *et al*., 1999; Ceccherelli *et al*., 2000).

It was reported that *C. racemosa*, which is recorded in especially Eastern Mediterranean Countries, can spread out up to a depth of 50 m (Dumay *et al*., 2002; Piazzi *et al*., 2003). It was also reported that this species can settle rocky, sandy and muddy areas and they can be grow on leaves and roots of even dead sea-grass (Capiomont *et al*., 2005). This species can live in even polluted waters (inside harbors, bays) as well as within significantly variable temperature and depth contours and they can be moved to different areas as a result of activities of humans (anchoring, ballast tanks and fishing) (Carriglio *et al*., 2003; Ceccherelli and Piazzi, 2001; Smith and Walters 1999).

New variations of *C. racemosa* were determined adapting themselves to the hydrographic ecologic conditions in new invasion area. It was reported that these variations are grown faster compared with the types existing in the habitat (Panayotidis and Zuljevic 2001). It was reported that *C. racemosa* have been seen on the coasts of Bodrum, Marmaris, Çeşme and Ayvalık in Turkey and invasion has been continuing on the coast of Northern Aegean Sea (Cirik *et al*., 1998; Cirik *et al*., 2001).

The effects of *C. racemosa* on populations such as macrobentic fauna, crustaceans, malacofauna and zoobentic populations in the place in which it exists were studied but the studies on their effects on fish species and diversity are very few (Argyrou *et al*., 1999; Pandolfo and Chemello, 1995; Žuljevic *et al*., 2004; Casu *et al*., 2005; Tsirika *et al*., 2006).

169 literatures were examined by Klein about relating to invasion of *C. racemosa* in 2008 (Klein and Verlague, 2008); however, he could not see any study on the effects of this algae species on fish species diversity.

This study aims to reveal the consequences of the effects of density variation in *C. racemosa* on catch composition and catch efficiency of combined trammel net

Materials and Methods

The present study was conducted on coastal side of Gümüldür Region existing in northwest of Kuşadası Bay in the mid-Aegean Sea (Figure.1) because the area covered by *C. racemosa* and the control area are available on the coastal zone having same hydrographic features. The study was performed between September 2005 and March 2007 and at the depth ranging between 0 and 25 m.

Density variation in *Caulerpa racemosa* was determined by quadrate method (25x25 cm.). 10 quadrate sampling were performed for each 5 m depth contour up to a depth of 25 m and density values were

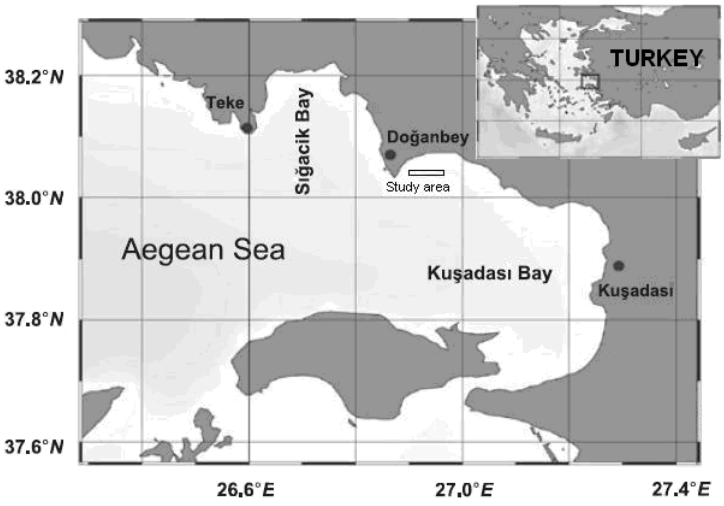

Figure 1. Study area.

calculated in g/m^2 based on average values of these samples.

The collected samples were measured under laboratory conditions and other species were separated. This procedure was completed in a tank filled with seawater because *Caulerpa* species may lose weight outside sea. Mud, stone and other algae species, which came into the bag during sampling, were eliminated. The samples were weighted with accuracy of 0.1 g.

Combined trammel nets were used for an efficient sampling in the areas covered by *C. racemosa* and also not covered area (control area). Combined trammel net consists of two parts. The upper part is 46 mm mesh size, a 50 mesh depth and thickness of 210 d/3 no. (Figure 2) intended for catching pelagic fishes. The lower size is for catching demersal and benthic fishes and consists of a 3 layer net. The net with 46 mm mesh size, a 50 mesh depth and thickness of 210 d/3 no was equipped with trammel nets with 280 mm mesh size, a 5 mesh depth and thickness of 210 d/6 no at both sides. Hanging ratio was used as 0.50 in the floating line, and the components and as 0.52 in the sinking line (Figure 2).

Two identical combined trammel nets were left in "S shape" in the area covered by *C. racemosa* and in the control area at sunset and settled the sea the next day before the sun rise. Total lengths of fish individuals, which are most efficiently caught in both areas, were measured with 1 cm accuracy. Kolmogorov-Smirnov (K-S) test was employed to examine whether any variation exists between groups of length of the species caught in both areas. Similarity of the numbers of individuals for the species caught in both areas was calculated with the Bray-Curtis Cluster analysis by using Bio Diversity Pro program. Chi-square (χ^2) test was applied to decide whether the variation between the numbers of individuals for the species caught in the area covered by *C. racemosa* and the control area is significant from the point of view of trammel nets and visual census method.

The base of the visual census method is that an observing skin diver records fishes and creatures that he sees while swimming at a constant speed just over the floor (Harmelin-Vivien *et al*., 1985; Borton and Kimmel, 1991; Bohnsack *et al*., 1994). The observations were completed between 12:00 and 13:00 that are the lightest hours during a day. The diving team including 2 people completed 15 experimental diving and transect visual census samplings with a deep time of 30 minutes.

Results

Density of *Caulerpa racemosa*

15 scuba dives were done up to a depth of 25 m with a total deep time of 15 hours and 40 minutes in the underwater studies intended for determining density of *C. racemosa*. The density of *C. racemosa* was determined as 135.4±0.3 g/m^2 between 0 and 5 m, as 146.5±0.6 g/m^2 between 6-10m, as 191.3±0.12 g/m^2 between 11 and 15m, as 385.7±0.6 g/m^2 between 16 and 20 m and as 635.1±0.9 g/m^2 between 21 and 25 m. The increase in weight depending on depth is shown in Figure 3.

Fish Species Diversity and Density

Combined Trammel Net

From the 14 combined trammel net operations; 293 individuals belonging to 13 species were caught in the field covered by *C. racemosa* and 322 individuals belonging to 16 species were sampled in the control field (Figure 4). *Scorpaena porcus* was the most caught species with the number of 82 in the area covered by *C. racemos*a and 112 in the control area. *Boops boops* followed this species with the number of 60 in both areas. Length-distribution graphics of these species are demonstrated on Figures 5 and 6. *S. porcus* caught in the area covered by *C. racemosa* are mostly in the length group of 14 cm while those

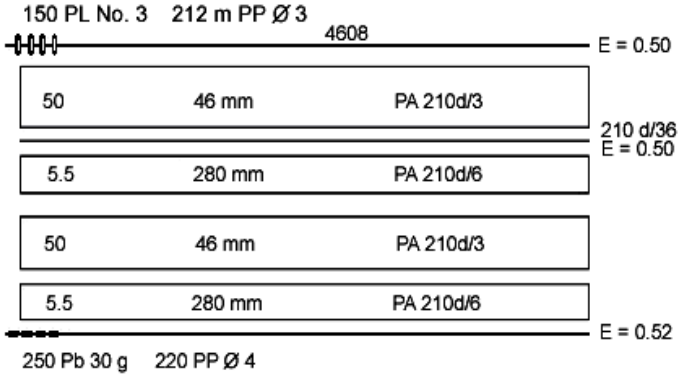

Figure 2. Technical plan of combined trammel net used in the experiment.

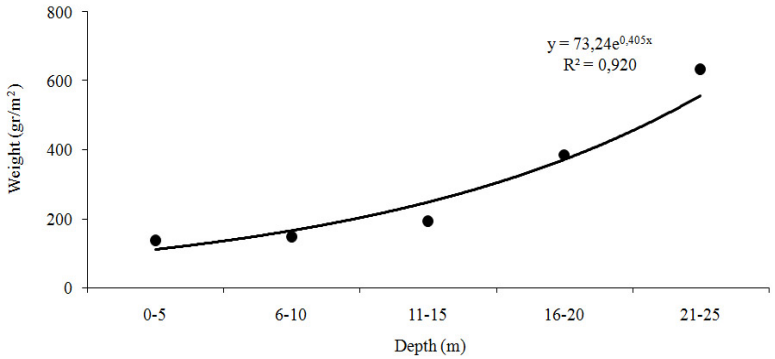

Figure 3. Variation in the weight of *C. racemosa* depending on depth.

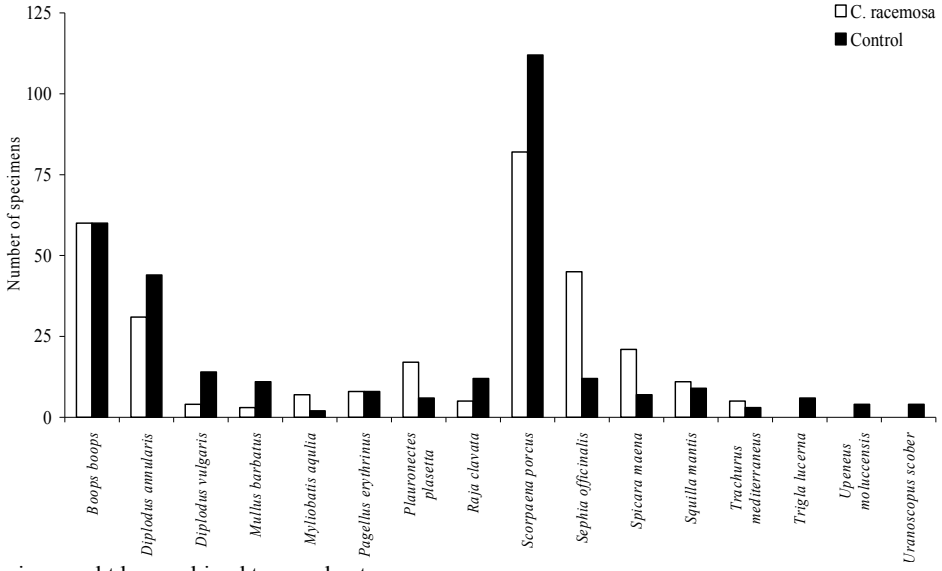

Figure 4. Species caught by combined trammel net.

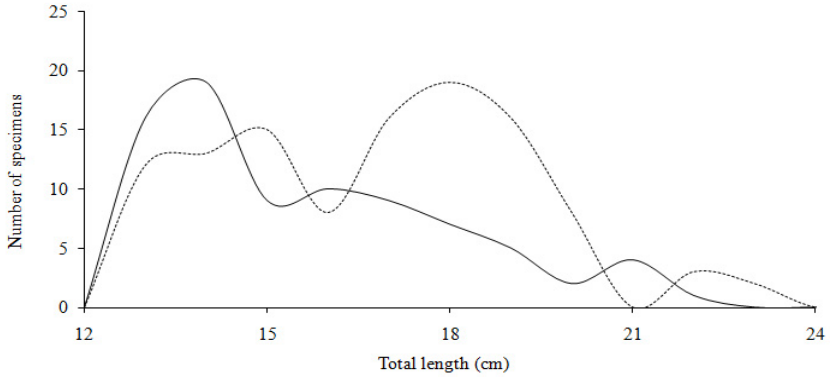

Figure 5. Length distribution for *S. porcus* caught by combined trammel net (Straight line: *C. racemosa*, dashed line: Control area).

caught in the control area are mostly in the length group of 18 cm. K-S test showed that a variation exists between the length groups of the individuals caught in both areas ($D_{observed}$: 0.2300, $D_{expected}$: 0,0021). *B. boops* caught mostly in both areas are 18 cm. Although *B. boops* caught in the area with *C. racemosa* and the control area show similar length-distribution graphic, K-S tests evidenced that, there is a difference between the individual caught in both areas ($D_{observed}$: 0.2167, $D_{expected}$: 0,0041).

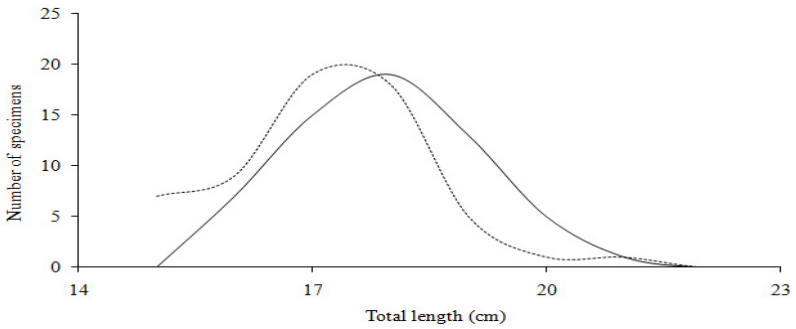

Figure 6. Length distribution for *B. boops* caught by combined trammel net (Straight line: *C. racemosa*, dashed line: Control area).

Visual Census

24 individuals belonging to 5 species were cencused in the field covered by *C. racemosa* and 32 individuals belonging to 5 species were recorded in the control field as a result of visual census method (Figure 7). *Serranus cabrilla* was mostly observed in the area of covered by C. racemosa, while *Gobius niger* and *Diplodus annularis* were seen also in the control area. Other species were seen in the area covered by *Caulerpa* are *Gobius niger, Gobius bucchichi, Mullus barbatus,* and *Octopus vulgaris* (Cephalopoda) and those are *Serranus cabrilla, Mullus barbatus,* and *Sephia officinalis* (Cephalopoda) in the control area.

Similarity ratio for the species observed by combined trammel nets and visual census method in the area covered by *C. racemosa* is 6%. However, this ratio is very low for the control area like 21% (Figure. 8). On the other hand, χ^2 test shows that the variation is not significant from the point of view of total numbers of individuals observed by combined trammel nets and visual census method in the area covered by *C. racemosa* and the control area ($P>0.05$).

Discussion

Caulerpa, which are defined as a foreign invasive algae genius, establishes a dominant structure in the environment and restricts living areas of other vegetative creatures (Cirik *et al*., 2001). The studies on these species are continuing for a long time (Tolay *et al*., 1998; Cirik *et al*., 1998; Carriglio *et al*., 2003) reported as a result of their study that, increase in phytobenthos affects macro-benthos. The researcher stated in his study that, decrease occurs in species of bivalves, echinoderm, gastropod and crustacean; however, more species are encountered in the medium due to the increase in polchaeta species Piazzi *et al*. (2003). Also, Piazzi *et al*. (2003) reported that, *C. racemosa* effects macroalgae positively in some species and negatively in the other species.

According to the fish species, Cirik *et al*. (2001) reported that, B. *boops* are frequently seen in the areas covered by *C. racemosa* and its pieces were seen in their stomach content. Ruitton *et al*. (2005) reported in his study on seasonal extension of *C racemosa*'s stolons that, herbivore *B. boops* and sarpa eat the extending stolons especially in falls and they are seen frequently in the area. Nizamuddin (1991) reported in his study executed in the Mediterranean Sea that, *B. boops, Sarpa salpa* and *Pagellus acarne* are fed in *C. racemosa* grasses. Sampling of *B. boops* by trammel nets in the area covered by *C. racemosa* in the study was seen as correlated with these results.

C. racemosa are grown differently in different bottom structures and depth. They are grown more intensively in shallow floors, which are lighted by sunlight (0-5 m), compared with stems and stolons. It is more intensive compared with pinnules of stems and stolans in muddy floors, which are deep and with less light (Şahin *et al*., 2000; Friedlander *et al*., 2006). In this study, the highest *C. racemosa* density was seen as 635.1±0.9 g/m^2 at the depths of 21-25 m with minimum light.

Combined trammel nets are commonly used commercially and in scientific researches. Catch efficiency of this fishing methods preferred for sampling demersal and pelagic species depends on mesh size, fish size and body shape. *S. porcus* and B. *boops* were caught at high ratios in both areas by combined trammel nets. This may be caused by the mesh size used because B. *boops* were mostly caught by the nets with full mesh size of 40-42 mm while S. *porcus* may be caught by many nets with various mesh sizes due to the pricks on its body (Ayaz *et al*., 2008). Trying Combined trammel nets specific to the species or alternative fishing methods (e.g. pot, longline) may improve performance in sampling in such studies.

Visual census method is one of the non-destructive sampling methods in sea studies (Borton and Kimmel, 1991). However, it is restricted by many factors such as fish recognition ability of the diver within a limited time and ability for guessing

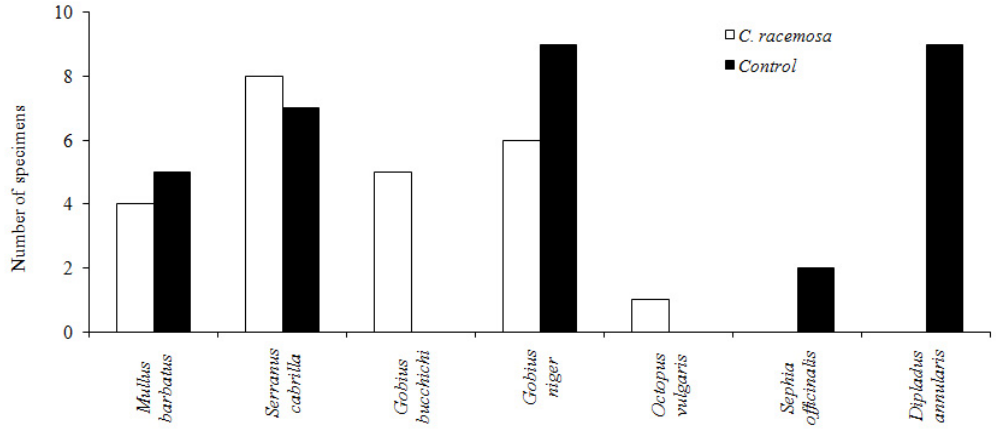

Figure 7. Distribution of the observed species in visual census method.

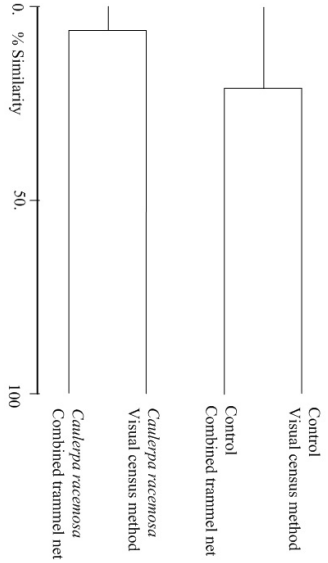

Figure 8. Similarity ratios for the species observed by combined trammel net and visual census method in the area covered by *C. racemosa* and the control area.

accurately individual number, visibility range and air bubbles scaring fishes (Ulaş *et al*., 2007). Any significant variation was not seen between the area covered by *C. racemosa* and the control area in the sampling by visual census method. Comparing the two sampling methods, the individual number found by visual census method is 11-fold lower than the number found by combined trammel nets. Divers should focus on the target species instead of all species for achieving more accurate results by visual census method in such studies.

Gravez *et al*. (1999) evidenced that, *C. taxifolia* decreased species and individual density at a ratio of 30-50% in the environment; however, any study was not seen for comparison for fish species and individual density in the *Caulerpa racemosa*'s invasion area.

In conclusion any significant variation was not found from the point of view of species and individual numbers between the area covered by *C. racemosa* and the control area by both of the sampling methods in this study. *C. racemosa* density determined in the study varies depending on the nature of the floor. However, it was evidenced that, this genus does not affect fish species and diversity.

References

Argyrou, M., Demetropoulous, M. and Hadjichristophorou, M. 1999. The impact of *Caulerpa racemosa* on the macrobenthic communities in the coastal waters of Cyprus. In: Proceedings of the Workshop on Invasive *Caulerpa* Species in the Mediterranean, Heraklion, Crete, Greece. MAP technical report series 125: 139–158.

Ayaz, A., İşmen, A., Altınağaç, U., Özekinci, U. and Ayyıldız, H. 2008. Technical specifications and stuructural differencies of trammel nets are used in Saroz Bay. Journal of Fisheries Siences, 2(3): 499-505.

Bohnsack, J.A., Harper, D.E., McCellan, D.B. and

Hulsbeck, M. 1994. Effects of reef size on colonization and assemblege structure of fishes at artificial reefs off southeastern Florida, U.S.A. Bulletin of Marine Science, 55(2-3): 796-823.

Borton, S.A., and Kimmel, J.J. 1991. Environmental assesment and monitoring of artificial reefs. In. W. Seaman Jr., L.M. Sprague (Eds.) Artificial Habitats for Maine and Freshwater Fisheries, Academic Pres Inc. New York: 177-236.

Capiomont, A., Breugnot, E., Martien, H. and Meinesz, A. 2005. Phenology of a deep-water population of *Caulerpa recemosa* var. *Cylindracea* in the Northwestern Mediterranean Sea. Botanica Marina, 48: 80-83.

Carriglio, D., Sandulli, R., Deastis, S., Gall D'Addabbo, M. and Grimaldi de Zio, S. 2003. *Caulerpa racemosa* spread effects on the meiofauna of the Gulf of Taranto, Biol. Mar. Medit., 10: 509–511.

Casu, D., Ceccherelli, G., Palomba, D., Curini-Gelletti, M. and Castelli, A. 2005. Effetto immediato della rimozione di *Caulerpa racemosa* sullo zoobenthos dell'infralittorale superficiale roccioso di Porto Torres (Nord Sardegna). In: XV Meeting of the Italian Society of Ecology, 1–3.

Ceccherelli, G., Piazzi, L. and Cinelli, F. 2000. Response of the non-indigeneous *Caulerpa racemosa* (Forsskål) J. Agardh to the native seagrass *Posidonia oseanica* (L.) Delile: effect of density of shoots and orientation of edges of meadows. Journal of Experimental Marine Biology and Ecology, 243: 227-240.

Ceccherelli, G and Piazzi.L., 2001. Dispersal of *Caulerpa racemosa* fragments in the Mediterranean: lack of detachmment time effects on establishment. Bot. Mar., 44: 209-213.

Cirik, Ş., Cihangir, B., Choukhi, A., Lök, A., Metin, C., Küçüksezgin, F., Demirkurt, E., Eronat, H., Tıraşın, E.M., Ünlüoğlu, A., Akçalı, B., Kavcıoğlu, R., Altay, O. and Kontaş, A. 2001. Research on *Caulerpa* species in Mediterranean. Final Report", no: DBTE 128, November 2001, İzmir.

Cirik, Ş., Tolay, M. and Evirgen, A. 1998. Observations of *C. racemosa* in The Agean Sea an Mediterranean of Turkish Region, Fourth International Workshop on Caulerpa taxifolia,1-2 February, Italia.

Dumay, O., Fernandez, C. and Pergent, G. 2002. Primary production and vegetative cycle in Posidonia oceanica Whwn in competition with the gren algae *Caulerpa taxifolia* and *Caulerpa racemosa*. J. Mar. Biol Assoc. UK. 82: 379-387.

Friedlander, M., Kosov, Y., Keret, G. and Dawes, C. 2006. Production of rhizoids by *Caulerpa prolifera* in culture. Aquatic Botany, 85(3): 263-266.

Gravez, V., Boudouresque, C.F., Meinesz, A. and Scabia, G. (Ed.) 1999. Fourht International Workshop on *Caulerpa taxifolia* (Abstract book), GIS Posidonie, Marseille, France.

Harmelin-Vivien, M., Harmelin, J.G., Chauvet, C., Duval, C., Galzin, R., Lejeune, P., Barnabe, G., Blanc, F., Chevalier, R., Duclerc, J. and Lasserre, G. 1985. Evaluation visuelle des peuplements et populations de poissons. Methodes et problemes. Revue d'Ecologie (Tere Vie), 40: 467-539.

Klein, J. and Verlaque, M. 2008. The *Caulerpa racemosa* invasion: A critical review. Marine Pollution Bulletin 56: 205-225.

Nizamuddin, M. 1991. The Green Marine Algae of Libya, Elga Publisher, Bern.

Panayotidis, P. and Zuljevic, A. 2001. Sexual reproduction of the invasive gren alg *Caulerpa racemosa* var. *Occidentalis* in the Mediterranean Sea. Oceanol. Acta., 24: 199-203

Pandolfo, A. and Chemello, R. 1995. Prime note sulla malacofauna associata a *Caulerpa racemosa* nella Baia di Santa Panagia (Sicilia Orientale), Biologia Marina Mediterranea, 2(2): 649–651.

Piazzi, L., Ceccherelli, G. and Cinelli, F. 2001. Threat to macroalgal diversity: effects of the introduced alga *Caulerpa racemosa* in the Mediterranean, Mar. Ecol. Prog. Ser., 210: 149–159.

Piazzi, L., Balata, D., Cecchi, E. and Cinelli, F. 2003, Co-occurrence of *Caulerpa taxifolia* and *C.* racemosa in the Mediterranean Sea: interspecific interactions and influence on native macroalgal assemblages., Crypt. Alg., 24: 233–243.

Ruitton, S., Verlaque, M. and Boudouresque, C.F. 2005. Seasonal changes of the introduced *Caulerpa racemosa* var. *cylindracea* (Caulerpales, Chlorophyta) at the northwest limit of its Mediterranean range. Aquatic Botany, 82(1): 55-70.

Şahin, E., Sezen, U., Bayınırlı, C. and Tuzcu, O. 2000. Invasion dynamic of *Caulerpa racemosa*, Underwater Science and Technology Symposium, 2000.

Smith, C.M. and Walters. L.J. 1999. Fragmentation and strategy for Caulerpa species: fates of fragments and implications for managements of an invasive weed. Mar. Ecol., 20: 307-319

Tolay. M., Cirik. Ş. and Evirgen. A. 1998. Observations of Caulerpa racemosa in Bodrum-Gökova Turkish Mediterranean Region, SECOTOX 98 International Conference on Exotoxicology and Environmental Safety,19-21 October, Antalya.

Tsirika, A., Patoucheas, D. and Haritonidis, S. 2006. Contribution to the knowledge of the benthic marine macroalgae from Mani region (Messiniakos Gulf, Greece). In: United Nations Environment Programme (Ed.), Proceedings of the Second Mediterranean Symposium on Marine Vegetation. Regional Activity Centre for Specially Protected Areas, Tunis, Tunisia, 245 pp.

Ulaş, A., Düzbastılar, F.O., Lök, A. and Metin, C. 2007. Pre-study on determination of efficiency of fish sampling methods on artificial reefs. Ege University Journal of Fisheries, 24(3-4): 287-293.

Verlaque, M., Verlaque, N., Durand, C., Huisman, J.M., Boudouresque, C.F. and Le Parco, Y. 2003. On the identity and origin of the Mediterranean invasive *Caulerpla racemosa* (Caulerpales, Chlorophyta), Eur. J. Phycol., 38: 325–339.

Verlaque, M., Afonso-Carrillo, J., Candelaria Gil-Rodríguez, M., Durand, C., Boudouresque, C.F. and Le Parco, Y. 2004. Blitzkrieg in a marine invasion: *Caulerpla racemosa* var *cylindracea* (Bryopsidales, Chlorophyta) reaches the Canary Islands, Biol. Inv., 6: 269–281.

Žuljević, A., Antolić, B., Despalatovic, M. and Onofri, V. 2004. The spread of the invasive variety of *Caulerpa racemosa* in the Adriatic Sea, Rapports de la Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée, 37: 466.