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RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

Preliminary results of spat collection of Rayed pearl oyster *(Pinctada radiata)* in Turkey

Işınlı inci istiridyesi (*Pinctada radiata*) spatlarının toplanması üzerine Türkiye'deki ilk sonuçlar

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Abstract: This research was carried out in Karantina Island to find pearl oyster (*Pinctada radiata* Leach, 1814) spat collection efficiency of bag and shell collector types. Environmental limits such as temperature, salinity, chlorophyll-a, and total particulate matter (TPM) were monitored during the study period. The abundance of *P.radiata* spat were found on the bag collector as 11.66±2.08 ind./0.91m^2 at the first time in August. At the same month the highest temperature and salinity were recorded as 27 ºC and 36.5‰, respectively. G2 (group 2/deployed on June 25) performed the highest spat collection for the bag collectors while G4 (deployed on August 29) for the shell collector was more successful during the research. A total of 172±34.39 *P. radiata* spat were collected during the study. 119±22.60 (69.18%) individuals (ind) were harvested from bag collector and 53±11.78 (30.82%) from shell collector. While the avarege abundance of *P. radiata* spat were 7.26 ind./m^2 on bag collectors, it was 3.23 ind./m^2 on the shell collectors. A significant difference was determined in the total abundance of *P. radiata* between the collector groups ($p<0.05$). The length range of Pinctada spat on the bag collectors was between 4.47- 33.9 mm while it was 4.66-18 mm on the shell collectors. Fouling organisms (barnacles, polychaete, bryozoa) and predators (crabs, gastropods) of pearl oyster were also found on the collector groups. Results of the study established that bag collectors were more effective to collect the pearl oyster spat than the shell collectors.

Keywords: *Pinctada radiata, rayed pearl oyster, spat collector, Karantina Island*

Öz: Bu çalışma torba ve kabuk kolektör tipleriyle ışınlı inci istiridyesi (*Pinctada radiata*, Leach 1814) spatlarının toplama verimliliğini bulmak için Karantina Adası'nda gerçekleştirildi. Kolektörler altı grup olarak hazırlandı ve uzun halat sistemi üzerine yerleştirildi. Sıcaklık, tuzluluk, klorofil-a ve toplam partikül madde miktarı gibi çevresel parametreler çalışma periyodu boyunca izlendi. *P. radiata* spatı ilk olarak Ağustos ayında torba kolektörlerde 11,66±2,08 birey/0,91 m^2, kabuk kolektörlerde ise 2,33±1,52 birey/0,91 m^2 olarak tespit edildi. Aynı ayda en yüksek sıcaklık ve tuzluluk değerleri sırasıyla 27 °C ve ‰ 36,5 olarak kayıt edildi. Çalışma boyunca, torba kolektörlerde en iyi spat toplama performansını Grup 2 (G2-25 Haziran'da yerleştirildi) gösterirken, kabuk kolektörde G4 (29 Ağustos'ta yerleştirildi) daha başarılı olmuştur. Toplamda 172±34,39 spat toplandı. 119±22,60 (69.18%) spat torba kolektörlerle toplanırken, 53±11.78 (30.82%) spat kabuk kolektörlerle toplandı. Ortlama 7,26 birey/m^2 Pinctada spatı torba kolektörlerde, 3,23 birey/m^2 kabuk kolektörde belirlenmiştir. Kolektör grupları arasında toplam spat bulunma farkının önemli derecede anlamlı çıktığı görülmüştür ($p<0,05$). Torba kolektörler üzerinde bulunan Pinctada spatlarının boy aralığı 4,47-33,9 mm arasında değişirken, kabuk kolektörler üzerinde bulunan spatların boy aralığı 4,66-18 mm arasında değişim gösterdi. Fouling organizmalar (Balanus, Poliket, Bryozoa) ve predatör türler de (yengeç ve gastropod) kolektör gruplarında bulundu. Çalışma sonucunda torba kolektörlerin kabuk kolektörlere oranla daha verimli olduğu belirlenmiştir.

Anahtar kelimeler: *Pinctada radiata, Işınlı İnci İstiridyesi, spat toplama, Karantina Adası*

INTRODUCTION

Pinctada radiata (Leach, 1814), known as the rayed pearl oyster, is distributed of the north-western Indian Ocean and the Red Sea (Al-saadi, 2013), Mediterranean (Göksu et al., 2002) and Aegean coasts (Yiğitkurt, 2011). Culturing pearl oyster can supply to economic and social benefits and its techniques does not depend on using big capital (Lodeiros et al., 2002). Pearl culture facilities create employee and correspondingly a business outcome because of its marine protein and shells with nacre. By these features it comes to be proper species for investment (Baqueiro and Castagna, 1988; Gervis and Sims, 1992).

Pearl production consists of four principal stages; spat collection or larval production, growth, nucleus implant, and harvesting (Chellam et al., 1991). Spat collection is the first stage of bivalve culture (Beer and Southgate, 2000). This step is economical in comparision to larval culture procedures; hence; various types of collector materials are being used for a long time (Friedman and Bell, 1996). Collector materials should be long-suffering, cheap, and easy to access besides ideal substrate for bivalve spat (Vakily, 1989). Various materials were used for spat collection of pearl oyster. Some of those are cedar springs, mollusk shells, old fishing nets for *P. martensii* in Japan (Alagarswami, 1991); oyster baskets, nylon mesh, nylon frills for *P. fucata* (=*P. radiata*, *P. imbricata*) in India (Nayar et al., 1978; Victor et al., 1987); neutron tube, shade mesh, *Pemphis acidula* sprigs for *P. margaritifera* in French Polynesia (Coeroli et al., 1983); wooden boards, split bamboo for *P. margaritifera* in Sudan (Rahma and Newkirk, 1987); nylon gill net in mesh bags for *P. mazatlanica* and *Pteria sterna* in Mexico (Monteforte and Garcia-Gasca, 1994); shade mesh sheet/strips and plastic sheet/strips for *P. margaritifera* in Solomon Islands (Friedman et al. 1998); shade cloths in mesh bags for *Pinctada spp.* and *Pteria spp.* in Australia (Beer and Southgate, 2000); onion bags for *P. imbricata* (Urban, 2000).

Efficiency of spat collection is affected by currents, depth, biological and chemical changes in water parameters, and hydrodynamics as well as the collector material types (Acarli et al., 2011; Coeroli et al., 1983; Monteforte and Garcia-Gasca, 1994; Knuckey, 1995; Friedman et al., 1998). Deployment timing of collector is critical for spat acquisition because bad timing triggers settlement of non-target species (Lok et al., 2006). Wild spat procurement from marine environment must be continuous and reliable for a sustainable bivalve aquaculture; in addition, success of this process depends on survival of new settled spat (Burke et al. 2008). The easily accessible and enduring settlement media (mesh bags) used for spat collection has proven effective for collection of many pearl oyster species (Beer and Southgate, 2006).

There has not been commercial enterprise for pearl culture in our country yet. Abundance of the pearl oyster spat on two different collector types, efficiency of collector materials, and the effect of environmental conditions on spat collecting were examined in this research. This study aims to determine the effect of collector types and water conditions on spat collection. It was also aimed to find out the best timing for spat attachment. This research is a fundemantally important work and considered leading the further studies about pearl culture.

MATERIALS AND METHODS

Spat collectors were deployed on a long line system in Karantina Island (38°22''44N, 26°47''12E) in the west of Izmir Bay between May, 2003 and June, 2004 (Figure 1). The water depth was nearly 10 meter with muddy and sandy sediment.

During the study, seawater parameters such as temperature, salinity, total particulate matter (TPM), and chlorophyll-*a* were followed. A mercury-in-glass thermometer with a range of -10 to 100±0.5 °C was used to measure the monthly temperature and a hand refractometer was used for salinity (ppt) measurements. TPM and chlorophyll-a were determined by filtering with GF/C filters (Strickland and Persons, 1972).

Figure 1. Study area at Urla Karantina Island

Two different models of collector were perapered for the study. Bag collectors which were originally used as "polyethylene bags" (size: 26x35 cm, 0.91 m^2, mesh size: 3x3 mm) were put inside the polyethylene bodies for protection (Fig.2a). Shell collectors were consisted of mussel shells. For this purpose, fifteen mussel shells (average mussel shell size: 60.27±7.26 mm) were fixed into a polyethylene bag (26x35 cm) in a regular basis for each. Both collector types as one collector group were deployed on a long line at 1 meter below the surface in triplicate (Fig. 2b).

Six collector groups were installed in the following dates: group (G)1 on May 23rd, G2 on June 25th, G3 on July 21st, G4 on August 29th, G5 on September 29th, and G6 on November 07th. Three samples of each collector were removed from groups to observe the collection efficiency of pearl oyster spat at every deployment month. Spat shell length was measured from dorso-ventral axis. Fouling organisms (barnacles, polychaeta, bryozoa) and predators (crabs, gastropods) for Pinctada was recorded within the collectors. A scale was created for the counted fouling and predator species: 0-none; 1- few (1-19); 2-a few (20-39); 3- some (40-59); 4-many (60-79); 5-most (80-99).

Obtained data for each group of collectors were analyzed by using Mann Whitney U test. Monthly differences of recruitment were evaluated with Kruskal-Wallis. Statistical tests were performed using SPSS 15 software. Differences were considered significant when $p<0.05$.

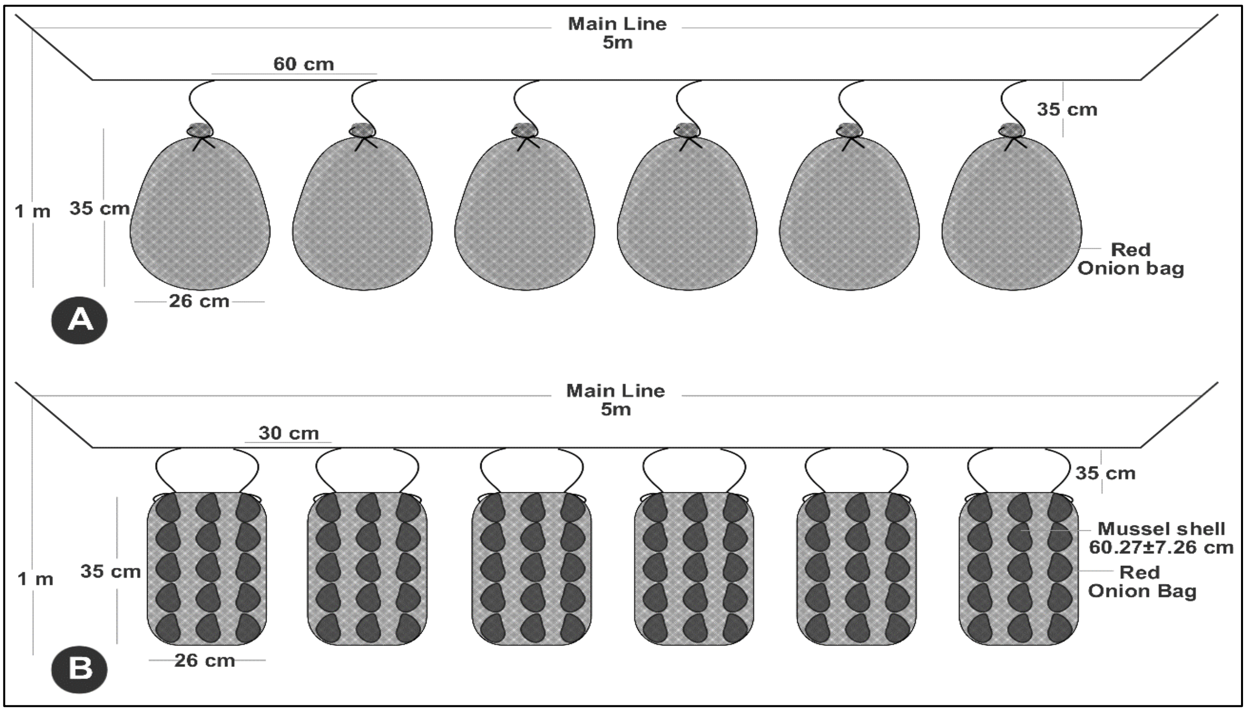

Figure 2. -(A) Bag and (B) shell collector design

RESULTS

During the study, temperature ranged between 12.5 ºC and 27 ºC in the seawater. The highest was measured in August, 2003 while the lowest was recorded in December, 2003. Average salinity was ‰ 36.21±0.15 (Fig. 3).

The highest TPM and chlorophyll-a were recorded as 33 mg/l in August and 6.2 µg/l in September while the lowest values were observed 13 mg/l in July and 0.7 µg/l in January, respectively (Fig. 3b). From June to November, these data varied similarly and later on, TPM increased while chlorophyll-a decreased until January.

A total of 172±34.39 *P. radiata* spat were obtained from both collector types during the study. Bag type collected 69.18% of pearl oyster spat while shell collectors did 30.82%.

Significant difference was found between collector types ($p<0.05$). Length range of spat on bag collectors was 4.47-33.9 mm and 4.66-18 mm on shell collectors. For bag collectors in G2, G3, and G4, average spat lenghts were 15.69±7.29, 20.49±11.42 and 8.20±1.99 mm and they were 12.69±4.32, 11.96±4.59 and 9.08±4.54 mm for shell collectors respectively.

P. radiata spat were not detected on G1, G5, and G6. Collector bags which belongs to G1 got lost on September 29th. Collector bags of G5 and G6 were excessively damaged on June, 29th. Therefore, collector bags on G1, G5, and G6 couldn't be examined.

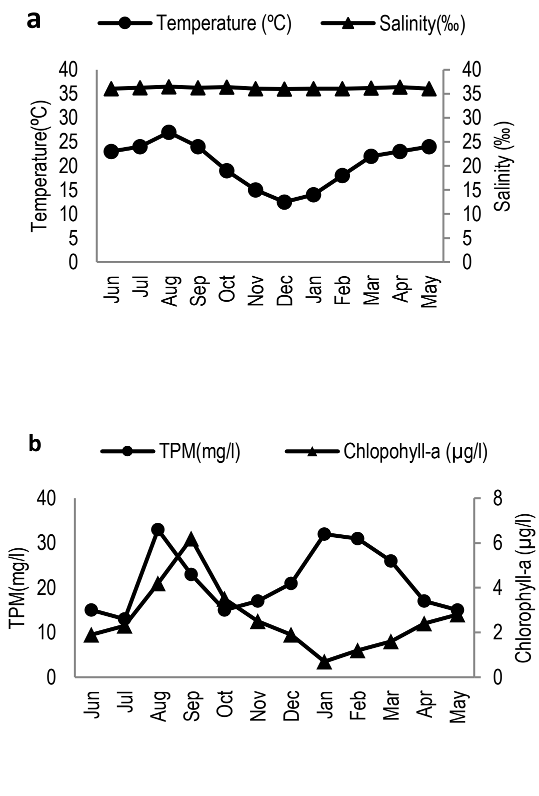

Figure 3. (a)Temperature (°C) and salinity (‰), (b) TPM and chlorophyll-a in study area

First spat settlement on both collector types was observed at G2 on August, 29th. An abundance of 11.66±2.08 individual (ind)/0.91 m^2 pearl oyster spat were collected from bag collectors while shell collectors accumulated 2.33±1.52 ind./0.91 m^2 in August (Table 1). Spat settlement on bag collectors was significantly higher than that of shell collectors ($p < 0.05$). It was defined that 100% of newly settled spat on G2 in August 29th were smaller than 10mm on bag collectors (Table 1). Finally, 15 ind./0.91 m^2 were collected by bag collectors and 9 ind./0.91 m^2 by shell collectors on G2.

More spat were collected with G3; 17 ind./0.91 m^2 on bag and 13 ind./0.91 m^2 on shell collector in September 29th. Total number of spat on G3 was determined to 29 ind./0.91 m^2 on bag collectors and 28 ind./0.91 m^2 on shell.

Whereas there were no *P. radiata* spat during first samplings in September 29th on G4, 34 ind./0.91 m^2 and 22 ind./0.91 m^2 were collected by bag and shell collectors respectively in the samplings of the other months. It was observed that spat within the collectors were continously growing with the extended underwater time. For example, in G2 on August 29th, 100% of the spat were under 10 mm length, but in June 26th 44.4% spat were over 20 mm length in the last sampling of same group.

Table 1. Mean number and size distrubution (%) of settled pearl oyster *P. radiata* spat on bag and shell collector types

			Spat/Bag Collectors (%)				Spat/Shell Collectors (%)		
	Sampling Date	***Spat/Bag collector***	***<10 mm***	***10-20 mm***	***>20 mm***	***Spat/Shell collector***	***<10 mm***	***10-20 mm***	***>20 mm***
G2 (Jun 25)	**Jul 21**	-	-	-	-	-	-	-	-
	Aug 29	11.66±2.08	100.00	-	-	2.33±1.52	50.00	50.00	-
	Sep 29	5.33±1.52	-	40.00	60.00	2.33±1.52	-	100.00	-
	Nov 07	12.33±1.52	41.66	33.33	25.00	-	-	-	-
	Dec 29	13.66±2.08	7.69	30.76	61.53	1.66±1.15	-	100.00	-
	Jan 26	9.33±1.52	11.11	44.44	44.44	4.33±1.52	50.00	25.00	25.00
G3 (Jul 21)	**Aug 29**	2.33±1.52	100.00	-	-	4.33±1.52	100.00	-	-
	Sep 29	17.33±1.52	64.70	29.41	5.88	13.33±1.52	61.53	30.76	7.69
	Nov 07	3.33±1.52	33.33	-	66.66	-	-	-	-
	Dec 29	2.33±1.52	-	-	100.00	1.66±1.15	-	100.00	-
	Jan 26	3.33±1.52	-	-	100.00	5.33±1.52	20.00	40.00	40.00
	Mar 02	2.33±1.52	-	-	100.00	5.33±1.52	20.00	40.00	40.00
G4 (Aug 29)	**Sep 29**	-	-	-	-	-	-	-	-
	Nov 07	9.33±1.52	100.00	-	-	-	-	-	-
	Dec 29	9.33±1.52	77.77	22.22	-	7.33±1.52	57.14	42.85	
	Jan 26	8.33±1.52	87.50	12.50	-	3.33±1.52	100.00	-	-
	Mar 02	2.33±1.52	100.00	-	-	12.33±1.52	8.33	91.66	
	May 14	6.33±1.52	50.00	50.00	-	-	-	-	-

During the study 1147 macro organisms were observed on bag collectors except fouling and predators, and 2008 organisms were found on shell collectors. Some important species in the collectors are shown in Table 2.

Total number of collected bivalve species were 1022 and 1109 for bag and shell collectors, respectively. The larvae of predators also settled to spat collectors and grew rapidly so that large numbers of predators including crabs (*Pilimnus hirtellus* Linnaeus 1761, *Psidia longimana* Risso 1816) and Cymatium gastropods were found on the collectors (Table 3). The number of crab and cymatium gastropod was considerably higher on the bag collectors. It was found that fouling organisms (barnacles, polychaete, bryozoa) settled on shell collector in high numbers throughout the study. Bag collectors held less fouling organisms than shell collectors used during this study. Especially abundance of barnacle individuals on G1 and G4 shell collectors were more dominant. Almost every month barnacles and polychaets were observed on both type of collectors.

Table 2. Abundance of species on bag and shell collectors (1. *Pinctada radiata*, 2. *Ostrea edulis*, 3. *Mytilus galloprovincialis*, 4. *Chlamys glabra*, 5. *Chlamys varia*, 6. *Pinna nobilis*, 7. *Modiolus barbatus*, 8. *Cardium tuberculatum*, 9. *Arca noea*, 10. *Lima lima*, 11. *Anomia ephippium*, 12. *Paracentrotus lividus*)(L-Lost/D-Damaged/B-Bag/S-Shell)

Groups	Abundance of Species in Bag and Shell Collectors																						
G1	**1B**	**1S**	**2B**	**2S**	**3B**	**3S**	**4B**	**4S**	**5B**	**5S**	**6B**	**6S**	**7B**	**7S**	**8B**	**8S**	**9B**	**9S**	**10B**	**10S**	**11B**	**11S**	**12B**	**12S**
Jun 25	-	-	-	4	-	4	11	5	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-
Jul 21	-	-	-	10	1	10	23	1	-	-	-	-	-	-	-	-	18	-	-	-	-	18	-	-
Aug 29	-	-	-	13	-	13	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-
Sep 29	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Nov 07	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Dec 29	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
G2																								
Jul 21	-	-	-	21	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Aug 29	11	2	-	91	-	91	-	3	-	-	-	1	-	-	-	-	-	-	-	-	-	24	-	-
Sep 29	5	2	-	74	-	74	3	-	-	-	-	-	-	-	-	-	20	-	16	-	-	20	-	-
Nov 07	12	-	-	34	-	34	7	2	-	-	2	-	-	3	-	-	1	6	2	-	-	11	-	-
Dec 29	13	1	-	25	-	25	6	-	-	-	-	-	2	12	-	-	-	1	4	-	-	21	-	-
Jan 26	9	4	-	62	-	62	2	-	-	2	1	-	1	9	-	1	1	6	1	-	-	38	2	11
G3																								
Aug 29	2	4	-	15	-	15	4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-
Sep 29	17	13	-	28	2	28	23	1	-	-	11	-	-	-	-	-	-	-	3	-	-	19	-	-
Nov 07	3	-	3	11	-	11	4	-	-	-	1	-	2	1	-	-	33	-	5	-	-	18	-	-
Dec 29	2	1	-	15	1	15	-	-	-	-	-	-	8	-	2	-	21	-	3	-	-	22	-	-
Jan 26	3	5	-	13	2	13	1	-	-	1	-	1	4	-	-	-	34	1	2	-	-	19	1	5
Mar 02	2	5	1	-	1	-	-	-	-	1	-	-	5	2	-	-	45	2	5	-	-	-	-	1
G4																								
Sep 29	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-
Nov 07	9	-	-	7	-	7	37	-	-	-	-	-	-	-	-	-	8	-	5	-	-	6	-	-
Dec 29	9	7	-	15	1	15	26	-	-	1	-	-	-	-	-	-	4	3	5	-	-	32	2	-
Jan 26	8	3	-	8	-	8	52	1	-	2	-	-	-	-	1	-	2	6	27	-	-	55	9	1
Mar 02	2	12	-	-	-	-	21	-	-	1	-	1	-	1	-	-	16	4	33	-	-	-	-	1
May 14	6	-	-	1	-	1	33	1	-	-	-	-	-	-	-	-	8	-	53	-	-	-	-	-
G5																								
Nov 07	-	-	-	4	-	4	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	96	-	-
Dec 29	-	-	-	-	-	-	5	1	1	-	-	-	-	-	-	-	-	-	-	-	1	61	-	-
Jan 26	-	-	-	-	-	-	30	-	1	-	-	-	-	-	-	-	3	-	4	-	1	83	4	-
Mar 02	-	-	-	1	-	1	9	-	2	-	-	-	1	-	-	-	-	-	14	-	2	79	11	-
May 14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	51	4	-
Jun 29	D	D*	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
G6																								
Dec 29	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	25	-	-
Jan 26	-	-	-	13	8	13	17	2	33	10	-	-	-	-	-	-	-	-	-	-	33	54	-	-
Mar 02	-	-	-	-	-	-	8	-	48	-	-	-	-	-	-	-	2	-	-	-	48	79	-	-
May 14	-	-	-	-	-	-	1	-	20	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-
Jun 29	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D

Table 3. Density of fouling organism on bag and shell collectors. (*A. Barnacles, B. Polychaete, C. Bryozoa, D.Crabs, E. Cymatium*) [1-few (1-19), 2-a few(20-39), 3-some(40-59), 4- many(60-79), 5- most(80-99)] (L-Lost/D-Damaged)

Groups	Sampling date	Bag Collector					Shell Collector				
		A	B	C	D	E	A	B	C	D	E
	Jun 25	1	1	1	0	0	4	1	1	0	0
	Jul 21	1	1	1	0	0	2	3	1	0	1
	Aug 29	1	1	1	1	1	2	3	1	1	1
	Sep 29	L	L	L	L	L	L	L	L	L	L
	Nov 07	L	L	L	L	L	L	L	L	L	L
G1	Dec 29	L	L	L	L	L	L	L	L	L	L
	Jul 21	1	1	1	0	0	2	1	2	0	0
	Aug 29	1	1	1	0	0	1	3	1	0	0
	Sep 29	1	1	1	1	0	2	5	1	0	1
	Nov 07	1	1	1	1	1	1	3	1	0	1
	Dec 29	1	1	1	1	1	2	2	1	1	1
G2	Jan 26	1	1	1	1	1	3	4	1	1	1
	Aug 29	1	1	0	0	0	1	2	0	0	0
	Sep 29	1	1	1	0	0	2	3	1	0	1
	Nov 07	1	1	1	1	1	2	3	1	1	1
	Dec 29	1	1	0	1	1	2	2	0	1	1
	Jan 26	1	1	1	1	1	2	4	1	1	1
G3	Mar 02	1	1	1	1	1	2	3	1	1	1
	Sep 29	1	1	0	0	0	5	1	0	0	1
	Nov 07	1	1	0	0	0	4	1	1	0	0
	Dec 29	1	1	1	0	0	4	2	1	0	0
	Jan 26	1	1	0	1	1	4	1	0	0	0
	Mar 02	1	1	1	1	1	3	2	1	1	1
G4	May 14	1	1	0	1	1	2	1	0	1	1
	Nov 07	1	1	1	0	0	1	2	1	0	0
	Dec 29	1	1	1	1	1	1	2	1	0	0
	Jan 26	1	1	1	1	1	1	2	1	0	0
	Mar 02	1	1	1	1	1	3	1	1	1	0
	May 14	1	1	1	1	1	2	1	1	1	1
G5	Jun 29	D	D	D	D	D	D	D	D	D	D
	Dec 29	1	1	0	0	0	1	2	0	0	0
	Jan 26	1	1	1	0	0	1	2	1	0	0
	Mar 02	1	1	1	1	1	1	1	1	1	1
	May 14	1	1	1	1	1	1	2	1	1	0
G6	Jun 29	D	D	D	D	D	D	D	D	D	D

DISCUSSION

The collectors should be deployed a few weeks before spawning of target species; thus, primary bio-film layer occurs on the collector materials (Su et al., 2007). The collector systems that are deployed much earlier than regenerative phase will collect none target species and fouling life forms which compete with the target species (Yigitkurt, 2011). If collector systems are deployed after estimated larval settlement time, the spat collection capability of collector decreases and that can cause infrequency of pearl oyster spat (Ruzzante and Zaixso, 1985). Pearl oyster spat could not be found on both collector types in G1,G4, and G5. Absence of spat in G1 is relevant with too early deployment corresponding to pre-reproductive activity and G4 and G5 is considered to be outdated of the breeding season.

Temperature is a critical ecological agent in the regulation of oyster reproduction (Sastry, 1979). Spawning of bivalves is usually triggered by variation in sea water, such as increase and decrease in temperature or saltiness (Gervis and Sims, 1992). Pearl oyster spat were first observed in August, 2003, both on bag and shell collectors when the sea water temperature and salinity were the highest during the study. It is estimated that first reproductive activity began in late July or early August according to duration of metamorphosis. Reproductive activity was observed in a long period of the year, especially in July and August, considering newly settled individuals under 10 mm length which were determined on collectors. According to many studies, reproduction occurs by an increase in water temperature (Behzadi et al., 1997, Saucedo and Monteforte, 1997). Researchers noted that there is a positive corelation between recruited spat numbers and water temperature (Robinson et al., 1991) while studies revealed that there is no relationship between temperature and spat numbers (Harvey et al., 1995). No correlation was detected between temperature and spat collection in our study.

Environmental parameters, like chlorophyll-a and TPM, affect the growth and settlement of bivalves (MacDonald and Thompson, 1985; Gervis and Sims, 1992), which varies with site and depth (Lodeiros et al., 1998) of the water. In addition Wada, et al., (1995) reported that elements could affect regenerative cycle such as food availability and particulate matter. The largest number of pearl oyster spat were found on G3 in September which had the highest chlorophyll-a values. It was found that number of settled spat decreased by months when chlorophyll-a values were lower. For a successful oyster culture and pearl production nutrient-reach areas should be determined (Tomaru et al., 2002). Study region is suggested to be an appropriate location considering chlorophyll-a and TPM values during the study.

An average of 7.26 ind./m² *P.radiata* spat were detected on bag collectors while it was 3.23 ind./m² on shell collectors. Urban (2000) obtained 83 ind./m² and Núñez, et al., (2006) found 67 ind./m² for *P. imbricata* spat. Another study which is conducted in La Paz Bay in Mexico, 22 ind./m² of *P. mazatlantica* spat were observed on collectors (Gaytan-Mondragon et al., 1993). In comparision with the other studies, a number of pearl oyster spat were less in this study. In the study area it can be declared that there were very few mature pinctada individuals when the number of obtained spat were taken into consideration.

Predation is an important cause for mortality of pearl oyster spat (Govan, 1995; Friedman and Bell, 1996; Friedman et al., 1998). Various predator species for bivalves settle on collectors during the planktonic phase and then grow with the other species (Friedman et al., 1998). In this research, the larvae of predators settled to collectors and grew so reached up to large numbers including crabs and gastropods on the collectors. However, broken shells of bivalve such as fan mussel and clam, which is thought to be consumed by these predator species. Furthermore, no serious damage was observed on *P. radiata* spat. Fouling organisms (barnacles, polychaeta, bryozoa) were also represented with high numbers on the shell collectors throughout the study. Detection in large quantities of fouling species on shell collectors is more attiributable to low abundance of spat in the area than the collector material.

The bag collector was more effective than shell collector to collect pearl oyster spat in the present study. Shell collector, containing hard surface structures, was more successful to collect edible oyster (*O. edulis*) spat (Lok and Acarli, 2006) which is in accordance with the other similar research in the world. During a study about *Pinna nobilis* spat collection, 183 *P. radiata* spat were collected by mesh bag collectors at the same site in 2007-2008 (Acarlı et al., 2011). In this study 119 ±22.60 spat of *P. radiata* were collected although this study carried out four years before Acarlı's study. Yiğitkurt (2011) reported 2059 pearl oyster spat; 1401 from surface waters and 658 from deeper waters around Urla Karantina Island. Significant differences on spat numbers between the mentioned studies are very engrossing in studies that carried out close years.

This is the first study of spat collection with two different collector materials for *P. radiata* in Turkey. This research is a fundemantally important work for commercial enterprises and similar researches. Subjects like reproductive activity, growth, and pearl production are required to get information about the biology of this species.

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