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Determination of Some Biological Properties of *Paracentrotus lividus* (Lamarck, 1816) in Antalya Gulf Shores

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Abstract

The research was carried out at three stations to determine some biological and ecological properties of *Paracentrotus lividus* in Antalya Gulf. A total of 396 specimens were caught between September 2001 – August 2002. The sex, test diameter and dry weight distributions and the length of sexual maturity were determined. The test diameter and dry weight of *P. lividus* samples varied from 4.21 cm and 23.48 g respectively. The populations was composed of 48.23 % females, 42.93 % males and 8.48 % were immatures. The gonad index of *P. lividus* was shown that maximum gonad growth occured in March. The highest gonad index was found in I station (Konyaalti). It was coincided with the period of decreasing sea temperatures, and gonad growth exhibits reserve relationship with temperature. Sexual maturation length belong to this species are found as 2.8 cm. In sampling were found mean 11.5 ind./m^2 species at I. station, 7.1 ind./m^2 species at II. station and 5.8 ind./m^2 species at III. station. *P. lividus* in Gulf of Antalya generally is similar with other region of Aegean Sea and Mediterranean.

Key words: *Paracentrotus lividus,* Antalya Gulf, Echiniodea

INTRODUCTION

Echinoideae are important not only due to their main tasks in the ecosystem, but also economically to the fact that their gonads, called as "Uni" in many countries, are consumed in raw form. They are represented with approximately 800 species in world seas, and only 17 of them are present in our country. Edible species are about 20, and three of them (*P. lividus,* (Lamarck, 1816), *Psammechinus miliaris* (Gmelin, 1778), *Sphaerechinus granularis* (Lamarck, 1816))are consumed in France [1].

The members of Echinodermata are generally live in salt water. They have only few members which can live in waters with less salt as Black Sea. Sea Urchins (echinoidea) cant be found in freshwater and in the shores of Black Sea (Özaydın vd, 1995; Öztürk, 1999). In spite of this we can find *Paracentrotus lividus* ve *Arbacia lixula* (Linnaeus, 1758) in our all seas except Black Sea. The population of these species are decreased morever disappaered in some places because of pollution and extremely hunting.

This study aims to determine some biological properties such as test diameter and weight distribution, sex ratio, seasonal distribution, density and spawning season of *P. lividus,* one of echinoidea being scattered in three marked stations at Antalya Gulf shores.

MATERIALS and METHODS

Field of study

This study was conducted out at three determined stations at Antalya Gulf shores (Figure1). Station I: The starting point of rock cliffs at Konyaalti region, coordinates 36° 51' N; 30° 37'E. Station II: Shores open to waves at Side (lighthouse), coordinates 36°46' N; 31°21'E. Station III: Shores close to waves at Side, coordinates 36° 45' N; 21° 28'E.

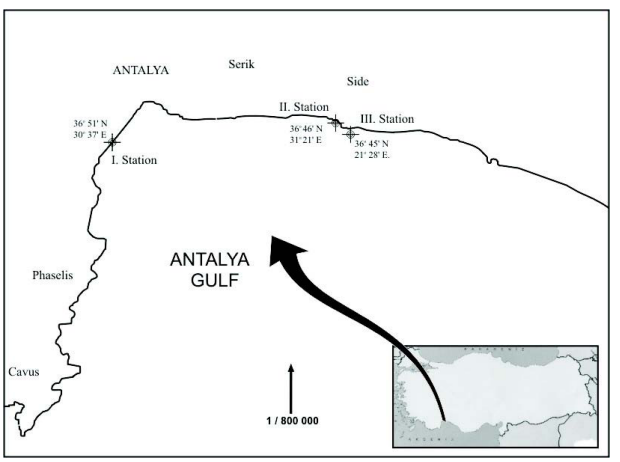

Figure 1. Field of study and sampling stations

Collection and evaluation of samples

In this study *P. lividus* samples were collected at every stations approximately 350 m^2 area with seasonal samplings, by free diving method from 0-10 m depth. The samples for autumn was collected on 11.11.2001, winter samples was taken on 02.03.2002, samples for spring was obtained on 05.18.2002, and summer samples were added on 08.20.2002.

To determine densities of sampled materials, sampling was performed triplicate at abundant areas of these creatures, on a 2 x 5 m minial area (10 m^2), and then average values were calculated [2].The test diameters of individuals belonging to *P. lividus* were measured with a calliper, while body and gonad weights were recorded by an digital weighing device with 0.01 g precision. Dissected samples, sexual organs and egg diameters were determined by microscope.

Gonad index was used to determine the reproduction period of *P. lividus*. The formula used was gonad index = (gonad weight / body weight) x 100 [3]. The test diameter – body weight relationship was analyzed with the formula Log W = Log a + b x Log TD Where, TD: test diameter, W: weight. The t test and χ^2 test was applied to evaluate statistical analyses.

RESULTS

Observations at the stations

I. Station (Konyaalti)

During the study, it was observed that freshwater diffused among the cliffs, and formed a cold-type layer over marine water. In this station, it was determined that the creatures settled on rather spongy rocks and lived inside cavities to protect against waves. Their habitat was in the infralittoral area up to 10 m depth. In the station, dense populations of reddish calcareous algae, namely *Peyssonneila* Decaisne and *Galaxaura oblangata* (Ellis et Solander) Lamourox species were observed. This station contained average 11.6 *P. lividus* individuals per m^2.

II. Station (Shores open to waves at Side)

This station is composed of rocky areas of table shapes emerging from sea surface. The ground other than rocky areas are completely of a sandy structure. Echinoideae were found in only rocky areas with 0-8 m depth and 7.1 per m^2. There were dense distributions of *Pocidonia oceanica* (L) Delile in sandy parts and *Peyssonneila* in rocky areas.

III. Station (Shores close to waves at Side)

This region was a huge amount of tourism activities in all seasons. Underwater had many waste origin of tourism. Echinoideae were counted as 5.8 per m^2 at depths of 0-6 m. In the station, it was observed that *Dasycladus clavaeformis* (Roth) C. Agarth species of Chlorophyta were abundant in all seasons, while *Liagora* Lamour, *Galaxaura oblangata* species of Rhodophyta were densely distributed in summer and autumn. In addition, *Cymodocea nodosa* and *Posidonia oceanica* species belonging to fanerogams were density present in the station.

Results about *P. lividus*

Test diameter (lenght) and weight properties

Lengths of *P. lividus* species varied in the range of 2.7 – 5.6 cm. In all stations, individuals of 4.3 cm length were predominant (Figure 2). Species weights were variable in 7.27-57.15 g range and the highest average value was reached at station III (Table 1).

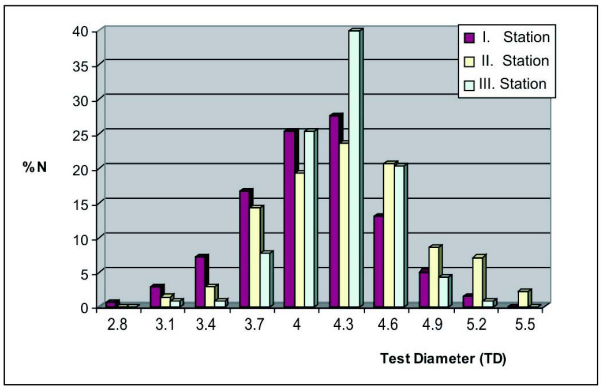

Figure 2. The lenghts (Test diameter) distribution of *P. lividus* in stations

Table 1. Lenght (Test Diameter) and weight values of *P. lividus* in stations

	I. Station	II. Station	III . Station	All Stations
N (Number)	138	118	140	396
Lenghts (cm)	4.08 ± 0.44 (2.7 – 5.3)	4.25 ± 0.32 (3.2 – 5.3)	4.31 ± 0.50 (3 – 5.6)	4.21 ± 0.42 (2.7 – 5.6)
Weights (g)	20.98 ± 5.18 (7.27 – 36.18)	23.54 ± 4.66 (10.91 – 36.4)	28.92 ± 8.38 (10.70 – 57.15)	23.48 ± 6.14 (7.27 – 57.15)

Sex ratio

Sex ratios of *P. lividus* according to the stations were listed (Table 2). Female and male ratios were close to each other and there was no statistical significance of this difference in II. and III. stations, (P>0.05). *P. lividus* individuals at Antalya Gulf were 48.23 % females, 42.93 % males and 8.48 % were immature.

Table 2. Sex ratio of *P. lividus*

	Female		Male		Immature		Total
	N	%N	N	%N	N	%N	N
I. Station	74	53.62	47	34.06	17	12.32	138
II. Station	55	46.61	54	45.76	9	7.63	118
III . Station	62	44.29	69	49.29	9	6.42	140
All Stations		48.23		42.93		8.83	

Gonad Index

Gonad index of *P. lividus* individuals were in 0.11 – 14.60 range. The change of gonad index according to stations and sexes were listed in the table 3. The maximum values of gonad index were 5.88 for station I (Konyaalti) and 6.51 in spring.

Table 3. The Gonad index of *P. lividus* in season

	I. Station	II. Station	III . Station A	verage
Autumn 5	.03	4.52 4	.84	4.79
Winter 5	.59	2.74 5	.23	4.52
Spring	6.13 6	.20	7.20 6	.51
Summer 7	.01	6.02 3	.85	5.62
All Seasons	5.88 4	.86	5,29	

Diameter of sexual maturity

The sexual maturity of females were in I. station 2.8 cm, in II. Station and in III. station were 3,1 cm diameter respectively. For males were in I. station 3.1 cm, in II. station 3.7 cm and in III. station 3,4 cm (Table 4a,b,c).

Table 4a. Sexual maturity diameter of *P. lividus* at I. station

Test Diameter (cm)	Female		Male		Immature		Total (N)	Ratio(%)
	N	%N	N	%N	N	%N		
2.8	1	100.00	—		—		1	0.72
3.1	2	50.00	1	25.00	1	25.00	4	2.89
3.4	4	40.00	5	50.00	1	10.00	10	7.24
3.7	10	43.48	6	26.08	7	30.44	23	16.67
4.0	15	42.85	15	42.85	5	14.28	35	25.36
4.3	23	60.53	14	36.84	1	2.63	38	27.54
4.6	12	66.67	4	22.22	2	11.12	18	13.04
4.9	5	71.43	2	28.57	-	--	7	5.07
5.2	2	100.00	-	--	-	--	2	1.45

Table 4b. Sexual maturity diameter of *P. lividus* at II. station

Test Diameter (cm)	Female		Male		Immature		Total (N)	Ratio(%)
	N	%N	N	%N	N	%N		
3.1	1	100.00	-	0.00	-	0.00	1	0.85
3.4	1	100.00	-	0.00	-	0.00	1	0.85
3.7	4	44.44		44.44	1	11.12	9	7.62
3.8	16	53.33	12	0.00	2	6.67	30	25.42
4.1	21	44.68	24	51.06	2	4.25	47	39.83
4.6	11	45.83	10	41.67	3	12.50	24	20.33
4.9	2	0.40	3	0.60	-	--	5	4.24
5.2	-	--		100	-	--	1	0.85

Table 4c. Sexual maturity diameter of *P. lividus* at III. station

Test Diameter (cm)	Female		Male		Immature		Total (N)	Ratio(%)
	N	%N	N	%N	N	%N		
3.1	1	50.00			1	50.00	2	1.43
3.4	3	75.00	1	25.00	3	15.00	4	2.85
3.7	9	45.00	8	40.00	2	7.41	20	14.29
4.0	9	33.33	16	59.26	1	3.03	27	19.28
4.3	13	39.39		14	-	--	33	23.57
4.6		15		7		1	29	20.71
4.9		4		4		1	12	08.57
5.2		5	-	--	-	--	10	7.14
5.5		3	-	--	-	--	3	2.14

Test diameter – weight relationship

Test diameter magnitude of *P. lividus* at the stations was in the range of 2.7–5.6 cm. There was a relationship between test diameter and weight, and these were expressed as regression curves in station (Figure 3a,b,c).

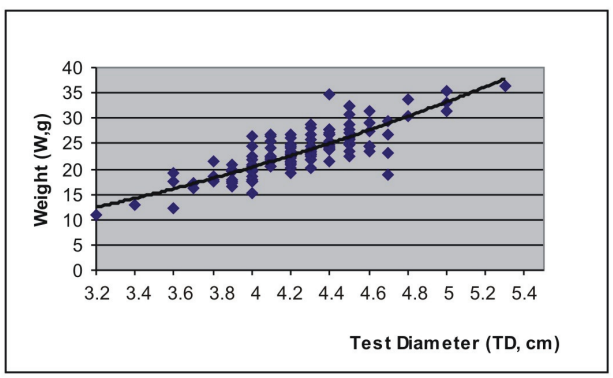

Figure 3a. Test diameter – weight relationship of *P. lividus* at I. station

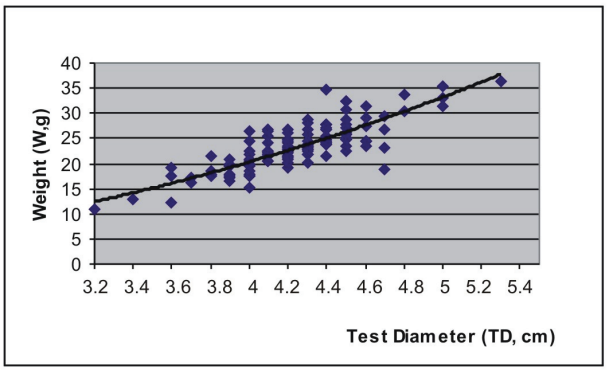

Figure 3b. Test diameter – weight relationship of *P. lividus* at II. Station

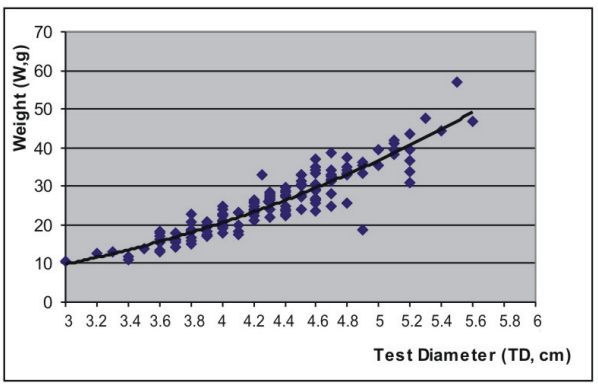

Figure 3c. Test diameter – weight relationship of *P. lividus* at II. Station

I. Station : LogW = -0,017 +2,2008 x Log TD (r = 0,829), II. Station : LogW = -0,238 + 2,5803 x Log TD (r = 0,926), III. Station : LogW = -0,0871 + 2,006 x Log TD (r =0,868).

Density

There were variable densities of *P. lividus* individuals at all stations (Table 5). With fourtlicate sampling, stations I, II, and III contained 11.6, 7.11 and 5.8 individuals per m^2 as average, respectively. The highest density was reached 10.3 individuals / m^2 in summer season as average, while station I had the highest density of 12.7 per m^2.

	I. Station	II. Station	III . Station	Average
Autumn	12.3	5.3	5.0	7.5
Winter	10.3	5.3	4.0	6.5
Spring	11.0	7.7	6.3	8.3
Summer	12.7	10.3	8.0	10.3
Average	11.6	7.1	5.8	

Table 5. Density of *P. lividus* in stations (m^2)

RESULTS and DISCUSSION

In this study, it was aimed to determine some biological properties of *P. lividus* species (Echinoideae) in Antalya Gulf at 3 pre-defined stations. It is clear that *P. lividus* was consistent with other species reported by several authors.

The average values of test diameter and weight of *P. lividus* individuals were 4.21 cm and 23.48 g, respectively. In Urla region, however, these values were 4.49 cm and 38.84 g, respectively [4].

The sex ratios at Antalya Gulf were 48.23% female, 42.93% male, 8.83% immature, and at Urla region, the corresponding values were 71.68% female, 23.99% male, 4.33% immature, respectively [4]. This difference might be due to less sample number or narrow sampling period.

Gonad index values of *P. lividus* showed that I station had a higher value than the others. This is possibly because of the presence of a freshwater source at Konyaalti station, and therefore, of the lower water temperature. Gonad developments of individuals at Konyaalti stations were, as expected, faster. King, [3] investigated the procreation feature of an echinoideae species (*Centrostephanus rodgersi*) in a change of gonad index per month basis, and suggested that the maximum gonad index value was present between April – June. With the completion of eggs, the gonad index values were at highest rate. A survey of gonad index (GI) change according to season showed that in autumn, I. station, II. station, and III. station had GI values of 5.03, 4.52 and 4.84, respectively. The maximum gonad growth of *P. lividus* became in March. Bryne [1] pointed out that the gonad growth was high in October- March. However, an inversely proportional relationship exists between gonad growth and water temperature. Ballynahown station (close to waves) had a GI value of 3.2 and marine temperature of 13.8 °C, while Glinsk station (open to waves) had a GI value of 5.4 and marine temperature of 10.7 °C.

Test diameter composition values of all stations indicated that the most frequently encountered test diameter was in the range of 2.8 – 5.2 cm for 396 specimens examined. This value was reported to be 4.25 cm for Urla region [4], and in Bosphorus (Istanbul) and island shores consisted species, the largest of which had a body diameter of 5 cm [7]. This led the authors to consider that the decrease of test diameter, observed for *P. lividus* individuals from Marmara Sea to Mediterranean, may be attributed to the consumption regime. This is because of the fact that Mediterranean shows an oligotrophic feature, while the nutritive elements increase towards the Marmara Sea [6]. Sexual maturity diameter for *P. lividus* at Antalya Gulf was found to be 2.8 cm. In Urla region, this value was reported to be in the range of 2.25 – 2.75 cm [4].

Test diameter - weight relationship of the *P. lividus* at Antalya Gulf was investigated according to the stations, and the highest correlation coefficient was found in station III ($r = 0.903$). In Urla region, the relationship was given as an exponential expression of $W = 0.817\ D^{2.526}$, with $r = 0.97$ [4].

Previous study [4] showed that *P. lividus* was present along with macrobentic brown, red algae and *P. oceanica* and consumed this species as food. Merki [4] reported that algae constituted 75 % part of this species' consumption, and Morrisson [5] pointed out that calcareous algae was their favorite food. Their affinity to calcareous algae can be explained if the spacious skeleton of these creatures are considered to be made of $CaCO_3$.

The fact that I. station contained more *P. lividus* species than the other stations (11.6 per m^2). This is possibly due to the vast presence of red calcareous algae in this station. It was determined that II. station (Side; the region open to waves) intensely contained *P. oceanica*, and *P. lividus* in this region were less than the other stations (7.1 per m^2). This can be explained with the food preference of the species. III. Station contained green algae in rocky regions, as well as brown algae of *Cystoseria* and *Padina povania*, and red algae of *Corallina* species, all of which were predominant. Merki [4] and Kocataş [6] suggested that *P. lividus* were densely present in the regions with the species mentioned above, and prefentially consumed these species for food. Since *P. lividus* were present in a rich place with both plant and animal organisms at a wave-safe region, it is predictable that echinoideae population density should be higher than the other stations. The second possibility is that marine saltiness decreased due to seasonal conditions and that water exchange is low in these regions.

The authors believe that the results of this study will guide the forthcoming studies and will be helpful in determining the suitable collecting season for gonad consumption of these species.

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