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Reproductive biology of *Ruditapes Decussatus* (Linnaeus,1758) in Çardak Lagoon, Dardanelles Strait

Çanakkale boğazı, Çardak lagünü'nde *Ruditapes decussatus* (Linnaeus,1758)' un üreme biyolojisi

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Abstract

This study was carried out in order to determine the reproductive period of the carpet clam (*Ruditapes decussatus* L. 1758). 43.32 % of the examined clams were the females, and 34.38 % were the males and the sex ratio was 1:1,23. Microscopical investigations indicated that the early spawners appeared in March-April. The gonad development started in March and spawning took place between July and October. Histological examinations revealed that gonad development started in March and terminated in October. The period between November and March was the resting stage of clam. The number of ripened individuals made a pike in June. Condition Index results were almost parallel with those of histological examinations. Determinations of temperature, salinity and chlorophyll-a revealed that *Ruditapes decussatus* spawned at 24 °C temperature and a salinity value between 20-26 ‰.

Keywords: *Ruditapes decussatus*, reproductive biology Çardak Lagoon, Dardanelles Strait,

Introduction

Clams are edible bivalves which are very common in the most part of the world (Gutierrez, 1991). *Ruditapes decussatus* have the highest commercial importance among other clam species in coasts of Turkey *Ruditapes decussatus* occurred in the Mediterranean, Aegean and Marmara Seas, and found on the sandy-muddy bottoms of the infralittoral zone (Tarkan, 1991; Oray and Tarkan, 1991; Tarkan and Oray, 1993). As in many European states, researches on *Ruditapes decussatus* are mainly focussed on its culture. However no researches have been carried out on the gonad development and spawning time of this species in Turkey.

As in other bivalves, temperature, salinity and nutrient concentrations of the sea water are important factors with respect to gonad development of clams (Devauchelle, 1990). Several methods are available for determining the gonad development and spawning time of the clams. The most avaible methods are the biopsy of gonads, the examination of biochemical changes in the gonads, the changes of condition index on annual base and the histological examination of gonad tissues (Devauchelle, 1990; Beninger and Lucas, 1984; Davenport and Chen, 1987).

The object of the present study is to determine the gonad development and spawning period of *R. decussatus* from Çardak lagoon .

Material and Methods

Clams were sampled by means of scooping between April 1995 and July 1996 at monthly interval from Çardak lagoon (Fig. 1). Depth of the sampling area varied between 0.5-1 m. The clams sampled were sieved in a sieve with a mesh opening of 2 mm.

Water temperature was determined by means of a mercury thermometer (Wirten). Salinity determinations were carried out by means of a salinometer (YSI 85). Chlorophyll-a determinations were carried out by means of a Shimandzu 120-01 spectrophotometre according to the method proposed by Parsons and Strickland (1963) and meter.

Monthly collections were subsampled for biometrical measuraments. Each subsamples contained 50 individuals. Live weights of the clams were determined, and the flesh was removed from the shells. Flesh and shells were separately weighed. The monthly arithmetical averages,

standard deviations, and minimum and maximum values of length, live weight, shell weight and flesh weight were determined.

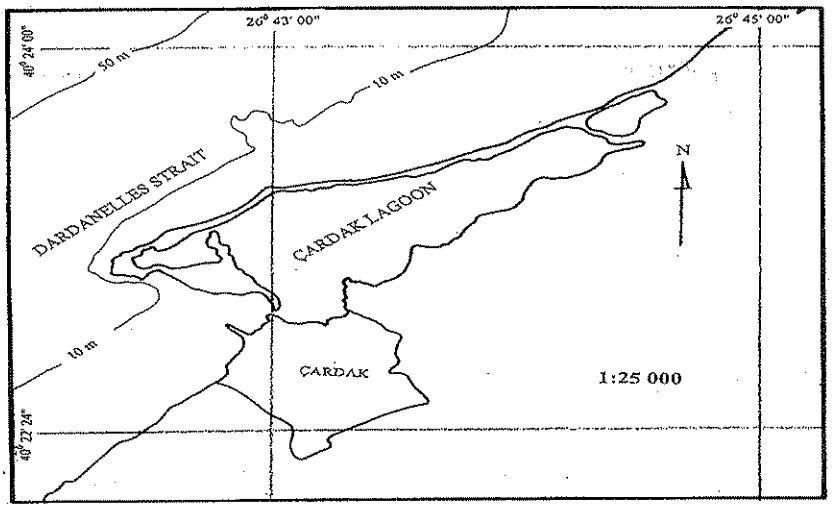

Figure 1. Sampling area

Figure 1. Sampling area

A small piece of gonad was examined under a light microscope (Magnification 600x) for determining the sexes and egg diameters. Sex ratio was calculated. Monthly condition index (C.I.) of the examined specimens were calculated according to the procedure of Davenport and Chen (1987). C.I.= wet flesh weight (g) x 100 / shell weight (g) Student's t-test was applied to see the statistical importance of the changes of condition index and average egg diameters.

For histological examinations a subsample of 20 individuals from monthly collections was taken. Histological examinations were carried out according to the procedure of Wilson and Hodgkin (1967); Luna (1960); Laurella *et al.* (1994); Corni *et al.* (1985). Shells and surrounding tissue of the gonad were removed. Gonad were fixed in Bouin's solution, embedded in paraffin and sectioned to a thickness of 7-10 µm by means of a sliding microtome sections were stained with hematoxilen and eosin. Sections were examined under a light microscope.
Development stages of gonads were determined according to the procedure by Renzoni (1960,1973); Valli (1979); Marano *et al.*(1981, 1982); Valli and Pineisch (1982); Sato (1994) and classified as follows:

1st stage: Resting phase. Sex determination was not possible. Gonad area was completely surrounded by connective tissue. Follicles were not able to be observed.

2nd stage: Initial phase of gametogenesis. Follicles were seen in the connective tissue in females. The wall of follicle were covered by oogonia and newly generated oocytes. Numerous spermatogonia were seen among the follicles in males.

3rd stage: Development phase. Amount of connective tissue among the follicles both in males and females was reduced. In females, most of the oocytes became pedunculated. A few matured oocytes could be seen among the follicles. In males, follicles were developed rapidly, and numerous spermatocytes were seen among the follicles. Typical banded spermatocytes started to developed. A few spermatozoons could be seen in the follicle lumen.

4th stage: Ripened phase: In females, peduncle of oocytes become thinner. Thickness of the follicular connective tissue was reduced and follicles reached their maximum sizes. Follicle lumen included ripened oocytes. In males follicles reached their maximum sizes. Bands of spermatocytes could easly be seen. In this stage, stained follicles appeared in dark colour. Follicles contained spermatid and spermatozoons; the follicle lumen contained spermatozoons as well.

5th stage: Spawning phase. Regular structure of the follicles were disappeared in females. In males a few number of mature oocytes were present in the follicle; follicles were clearly visible and the containing spermatocytes band became thinner. The number of spermatogonia and spermatocytes in the follicles was increased. A decreasing in the number of the spermatozoe in the follicle lumen was observed.

6th stage: In both male and female, follicles were empty or contained a few number of remaining gamet. Diameter of the follicles rapidly diminished. Connective tissue started to surround the gonad area. Gametogenesis finished and resting stage started.

Results

Average values of length, live weight, shell weight and flesh weight of the clams collected from Çardak Lagoon are presented in Table 1. Changes of the average condition index (C.I.) of clams during the research period are shown on Figure 2.

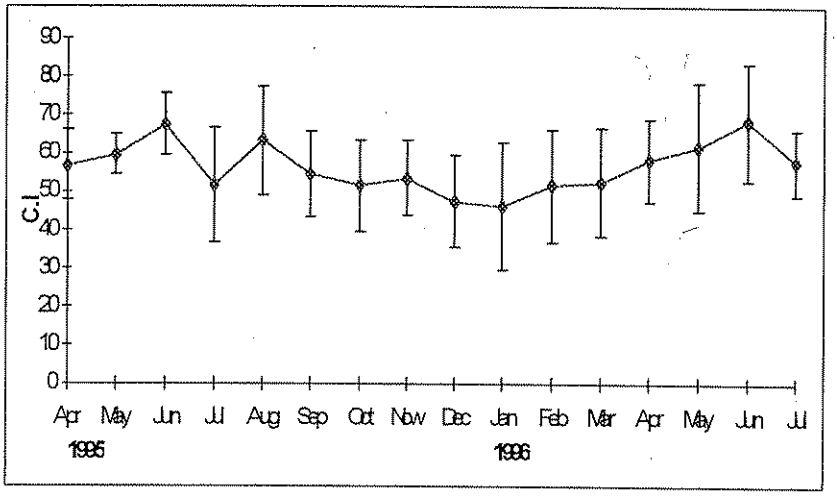

Figure 2. Variations in condition index of *R.decussatus*

The average C.I. value of the collected clams was 59.54±9.44 in April 1995. An increasing in the C.I. value was observed from June 1995. C.I. value was recorded as 67.45±8.29 in June 1995 and decreased to 51.45±11.19 ($p>0.05$) in July 1995. C.I. value increased to 63.19±14.55 in August 1995, then a gradual decreasing of C.I. value was observed in September (54.42±9.63) and in October (91.52) ($p>0.05$). C.I. value increased again in November. Decreasing of this value was observed again in December and January. The minimum C.I. value was observed in January (46.09±10.77). An increase of the C.I. value was observed between February and June of 1996. The maximum C.I. value was

observed in June 1996 (68.20±8.72). The average C.I. value was decreased to 57.54±8.72 in July 1996 ($p>0.05$).

Decreasing of the C.I. values observed in July, September and October was important because of indicating that *R. decussatus* spawned in this months. The low values of the C.I. observed in winter months could be explain by the insufficient feeding (Figure 2).

A total of 1120 *R. decussatus* specimens were examined, and 474 of them (42,32 %) were females and 385 were males (34,38 %). The sex of the remaining 261 specimens (23,30 %) couldn't be determined. Male / female ratio was 1:1.23. The length of the smallest clam carrying eggs was 15,7 mm. Monthly frequency distributions of egg diameters, and monthly average egg diameters are shown on Figs. 3 and 4, respectively. It was found that gametogenesis started in March or April. An increasing was observed in monthly average values of egg diameters from March to July. The average value of the egg diameters exhibited significant decreasing in July ($p>0.5$). This value exhibited an increase in August and September, and significantly decreased in October ($p>0.5$) (Fig.4). The number of the eggs of small diameters increased in July and October. These results showed that *R. decussatus* spawned in July and October.Water temperatures and salinity values recorded during the research period are shown on Figs 5 and 6.

When taking in to account of the monthly changes of chlorophyll a values determined in Çardak Lagoon, the maximum value was observed in May 1995 (6.56 mg/m^3) and the minimum in March 1996 (3.42 mg/m^3) (Fig.7). Development stages of the gonads of 320 *R. decussatus* specimens from Çardak Lagoon are given in Table.2.

Table 1.Montly averages of biometrical measurements of *R.decussatus*

	Length (mm)			Live weight (g)			Shell weight (g)			Flesh weight (g)		
Months	Min	Average	Max	Min	Average	Max	Min	Average	Max	Min	Average	Max
April	38.4	47.13 ± 4.02	56.2	12.6	21.17 ± 5.06	32.10	6.45	11.30±3.07	19.99	2.65	6.43 ±1.85	8.98
May	26.0	46.63 ±6.78	58.0	5.61	25.95±12.33	45.3o	2.85	13.32±6.18	25.36	1.25	7.97 ±3.81	15.59
June	34.0	45.04 ±6.23	52.8	8.65	23.11 ±8.29	36.68	4.88	12.01±4.34	17.50	2.72	8.02 ±2.88	12.36
July	26.0	40.34 ±7.92	55.0	3.19	13.66 ±8.02	38.64	2.85	8.33 ±4.46	21.75	0.94	4.32 ±2.40	11.98
August	23.6	39.72 ±4.06	52.0	3.72	19..11 ±5.27	31.25	1.89	8.89 ± 2.79	15.75	1.15	5.50 ±1.82	9.54
Septemb	27.o	41.27 ±6.29	52.0	7.65	17.40 ±6.99	36.70	3.26	8.88 ± 4.65	21.30	1.85	4.68 ±2.17	8.72
October	27.o	40.38 ±6.10	52.0	4.72	14.78 ±8.10	36.68	2.65	8.52 ±5.22	21.20	0.98	4.27 ±2.38	10.72
Novembe	23.5	36.50 ± 4.12	48.0	3.17	8.34 ±3.63	20.59	2.06	4.74 ±1.93	12.26	0.85	2.60 ±1.10	6.05
Decembe	21.5	30.01 ±5.77	42.0	2.48	6.06 ±3.53	14.10	1.58	3.56 ±2.08	8.51	0.91	1.67 ±1.03	4.35
January	22.0	28.7o ±4.93	41.0	2.29	5.72 ±3.05	14.20	1.51	2.72 ±1.46	7.40	0.72	1.29 ±0.78	4.27
February	22.5	27.71 ±4.63	42.5	2.89	6.85 ±4.91	20.50	2.00	4.06 ±3.30	12.54	0.55	1.97 ±0.48	5.84
March	19.0	30.50 ±7.16	48.5	1.93	6.61 ±4.78	22.34	0.52	3.58 ± 2.67	12.34	0.44	1.72 ±0.24	5.97
April	14.6	40.47 ±7.82	57.0	4.54	13.23 ± 7.88	38.06	1.81	8.13 ± 4.39	20.91	0.98	4.53 ±2.23	11.44
May	20.0	38.80 ±8.20	59.0	4.10	14.38 ±8.63	40.06	2.65	7.30 ± 4.54	19.51	1.18	4.34 ±2.58	12.42
June	15.5	37.97 ±9.77	56.4	1.55	11.96 ±8.05	38.76	0.72	7.12 ± 4.23	21.85	0.49	4.84 ±2.93	15.05
July	15.0	37.23 ±9.40	54.0	1.35	13.27 ±7.89	38.20	0.89	6.12 ± 4.63	17.85	0.42	4.03 ±1.78	12.05

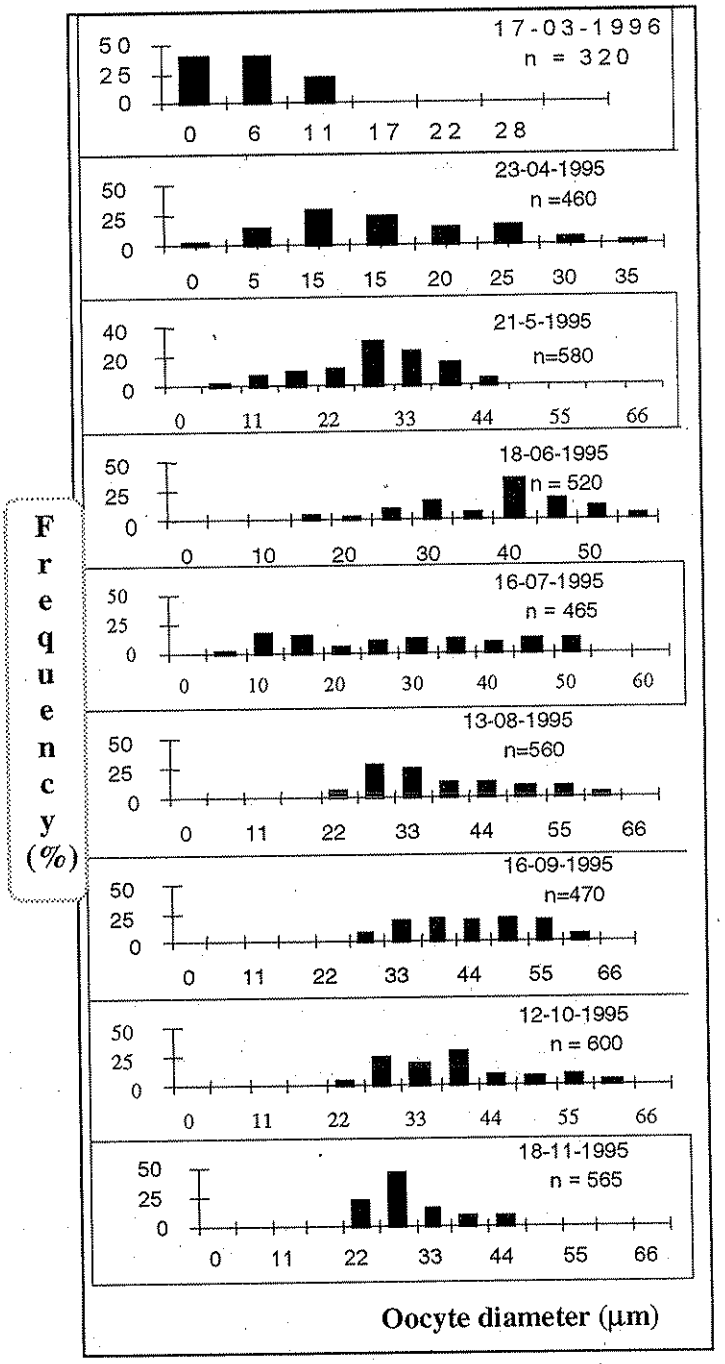

Figure 3. Monthly frequency distribution of egg diameters

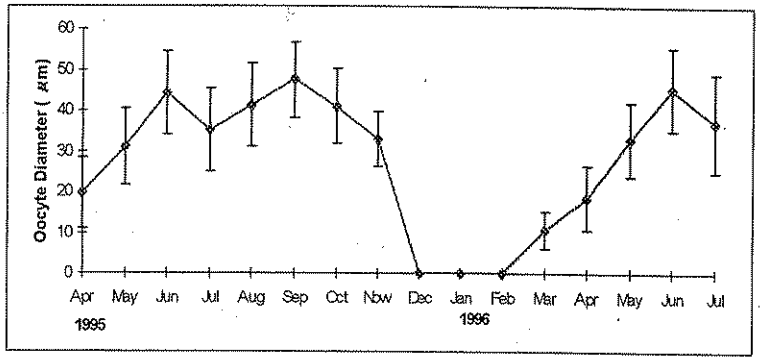

Figure 4. Monthly average values of egg diameters

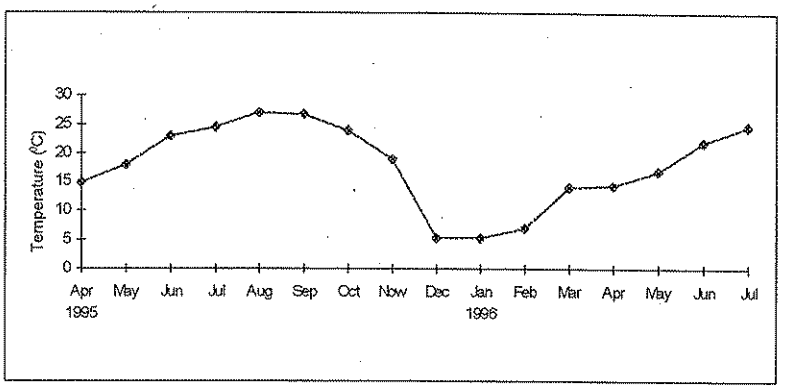

Figure 5. Monthly variation of water temperature values

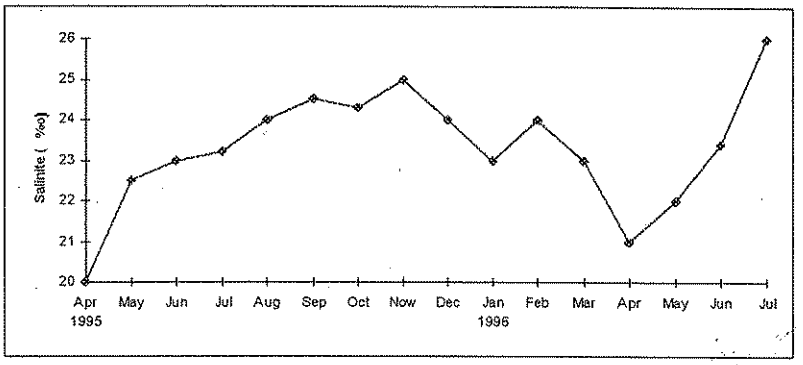

Figure 6. Monthly variation of salinity values

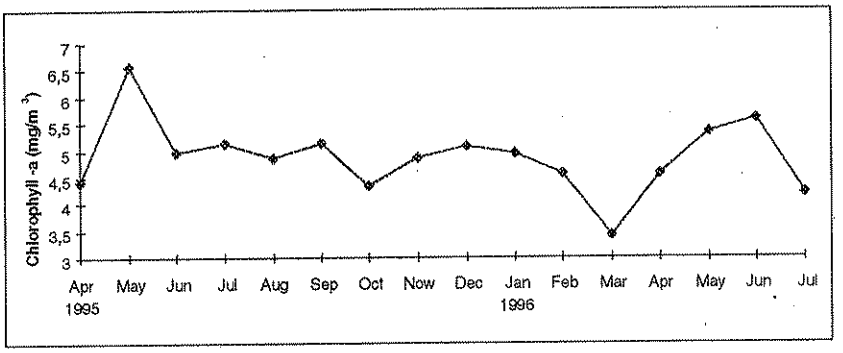

Figure 7. Monthly variation of chlorophyll a values

Examination of the histological sections showed that, in April 1995, development of gonad have been started in the 80 % of the specimens (1st stage) (Figure 8). Among them, 75 % of the specimens in the 2nd stage, and 5 % in the 3rd stage. Developing follicles were present in the females of 2nd stage, and oogonia and oocytes were also observed in the follicle walls (Figure 9). In the males of the 2nd stage, most of the gonad area was covered by connective tissue, and among the connective tissue developing follicles which contained spermatogonia and spermatocytes, were observed (Figure 10).

No specimen of 1st stage was observed in the samples collected in May 1995. 5 % of the collected specimens were of 2nd stage and 95 % of 3rd stage. In the females of the 3rd stage, diameter of the follicles became enlarged, and follicles was filled by stalk-oocytes, and connective tissue between the follicles became reduced (Figure 11). In the males of 3rd stage, a reduction of the connective tissue between the follicles and the development of the typical spermatocytes bands in the follicles, were observed (Figure 12).

No specimen of 1st and 2nd stages was observed in the samples collected in June 1995. 30 % of the collected specimens were of 3rd stage, and 70 % of 4th stage (Ripening stage). In the females of the 4th stage, follicles were completely filled by the mature oocytes, and the oocytes stalks became thinner (Figure 13). In the males of the 4th stage, follicles reached their maximum size, intergolicular connective tissue was highly reduced, spermatocytes bands were clearly visible, and follicle lumen was filled by numerous spermatozoa (Figure 14).

Table 2. Stages of the gonad developmentof *R.decussatus* and their monthly percentage distribution

Months	Sex			Stages of the gonad development and their monthly percentage					
	Male	Fem.	İndefin.	1 %	2 %	3 %	4 %	5 %	6 %
April-95	7	9	4	4 20	15 75	1 5	-		
May	7	13	-	-	1 5	19 95	-		
June	8	12	-	-	-	6 30	14 70		
July	6	14	-	-	-	1 5	4 20	15 75	
August	11	9	-	-	-	14 70	4 20	2 10	
September	8	12	-	-	-	-	9 45	6 30	5 25
October	11	9	-	-	-	-		7 35	13 65
November	7	7	6	6 30	-	-	-	-	14 70
December	1	2	17	17 85	-	-	-	-	3 15
Junuary-96	-	-	20	20 100	-	-	-	-	-
February	-	-	20	20 100	-	-	-	-	-
March	4	5	11	11 55	9 45	-	-	-	-
April	8	10	2	2 10	18 90	-	-	-	-
May	9	11	-	-	2 10	18 90	-	-	-
June	7	13	-	-	-	7 35	13 65	-	-
July	8	12	-	-	-	2 10	3 15	15 75	-

In July 1995, 5 % of the collected specimens were of 3rd stage, 20 % of 4th stage, and 75 % of 5th stage. 5th stage is the spawning stage, and the sperma was also discharged in this stage. In the females of the 5th stage, deformations were observed in the regular structure of the follicles (Figure 15). In addition to the unspawned mature oocytes, developing stalked-oocytes and the new generation oocytes were also observed in the oocytes (Figure 16). In the males of the 5th stage spermatocytes bands became thinner. Stained follicles were dark in colour near their centers, and light near the follicle wall and the amount of the spermatozoa in the follicle lumen was reduced (Figs 17 and 18).

In August 1995, 70 % of the collected specimens were of 3rd stage, 20 % of 4th stage, and 10 % of 5th stage. The presence of the specimens of 5th stage in August suggested that spawning also took place in this month with a reducing rate.

In September, 45 percent of the collected specimens were of 4th stage, 30 % of 5th stage, and 25 % of 6th stage. Gametogenesis was terminated in the specimens of 6th stage. Although a few number of oocytes were present in the females' follicles, the structure of the follicles became disturbed, connective tissue started to cover the gonad area, and remaining oocytes in the follicles were observed (Figure 19). Similarly structure of the males' follicles became disturbed, remains of the gametes were present in the follicle walls and the gonad area was covered by connective tissue (Figure 20).
In October, 35 % of the collected specimens were of 5th stage, 65 % of 6th stage. The presence of the specimens of 5th stage in October indicated a considerable spawning in this month.

In November, 70 % of the collected specimens were of 6th stage, and 30 % of 1st stage.

In December, 85 % of the collected specimens were of 1st stage, and 15 % of 6th stage.

In January and February, 100 % of the collected specimens were of 1st stage.

In March 1996, development of gametes were observed in the samples from this area. 55 % of the collected specimens from Çardak Lagoon were of 1st stage, and 45 % of 2nd stage.

In April 1996, 10 % of the specimens collected from Çardak Lagoon were of 1st stage, and 90 percent were of 2nd stage.

In May 1996, 10 % of the specimens collected from the lagoon were of 2nd stage, and 90 percent of 3rd stage.

In June 1996, 35 % of the specimens collected from the lagoon were of 3rd stage, and 65 % of 4th stage.

In July 1996, 10 % of the specimens collected from the lagoon were of 3rd stage, 15 % of 4th stage, and 75 % of 5th stage.

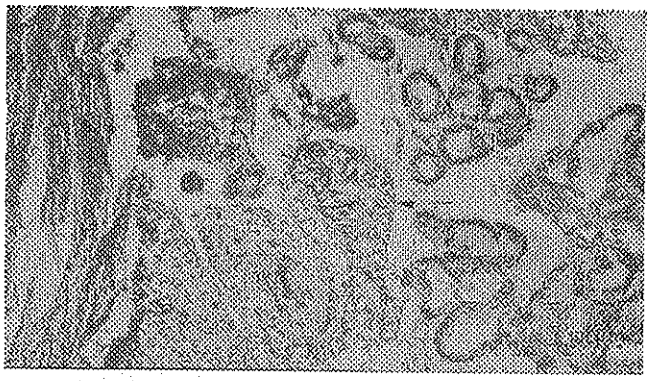

Figure 8. Gonad section of *R. decussatus* in resting stage (1st stage)

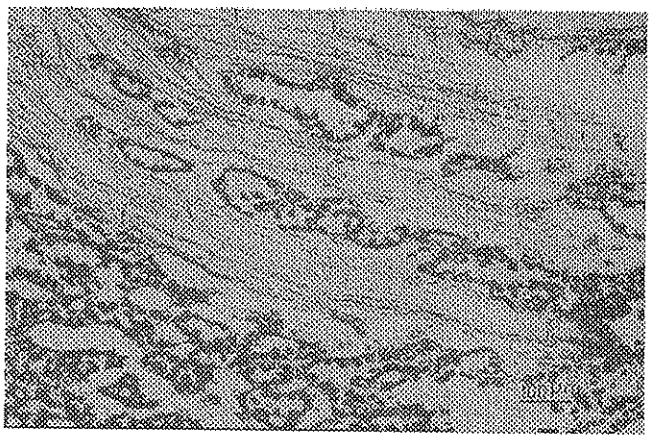

Figure 9. Beginning of the gonad development in female *R. decussatus* (2nd stage)

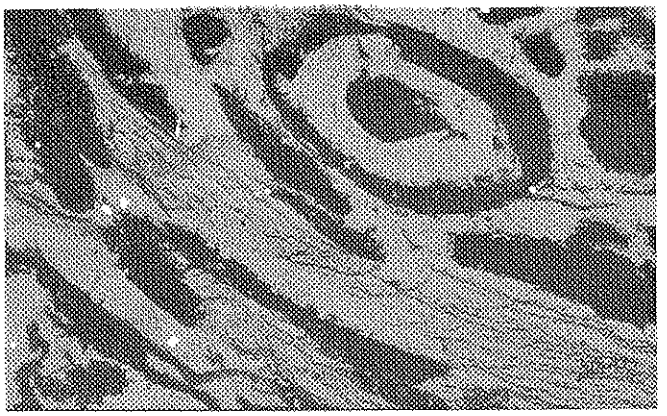

Figure 10. Beginning of the gonad development in male *R. decussatus* (2nd stage)

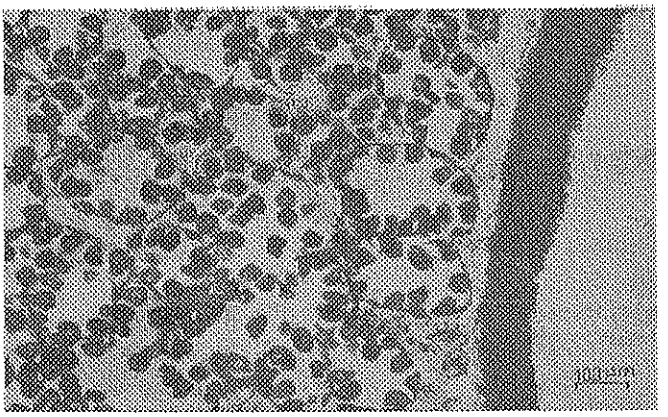

Figure 11. Gonad section of female *R. decussatus* in 3rd stage

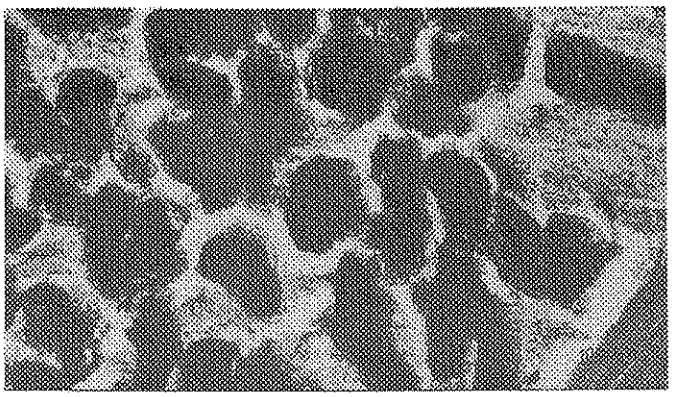

Figure 12. Gonad section of male *R.decussatus* in 3 nd stage

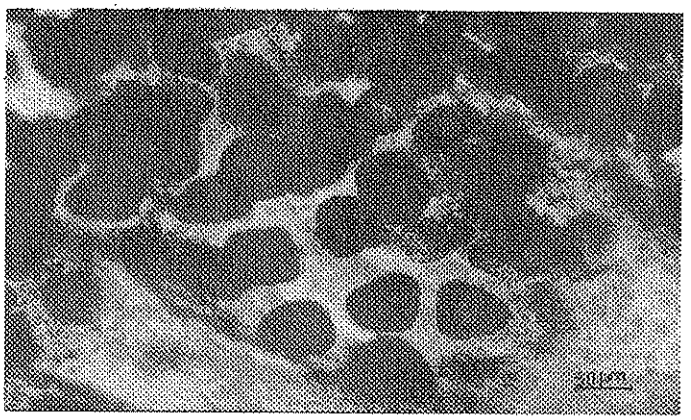

Figure 13. Gonad section of female *R. decussatus* in ripening stage 4th stage

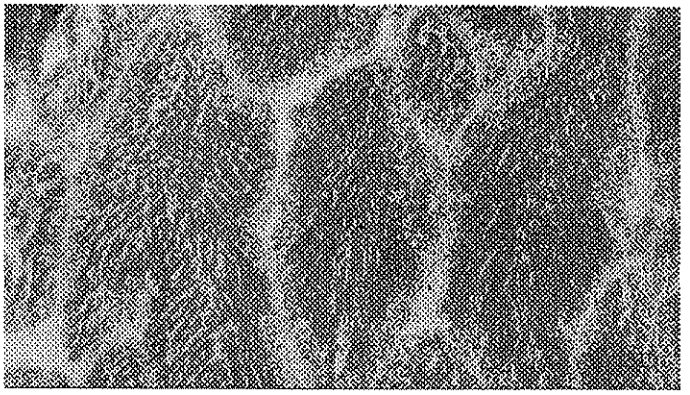

Figure 14. Gonad section of male *R. decussatus* in ripening stage 4th stage

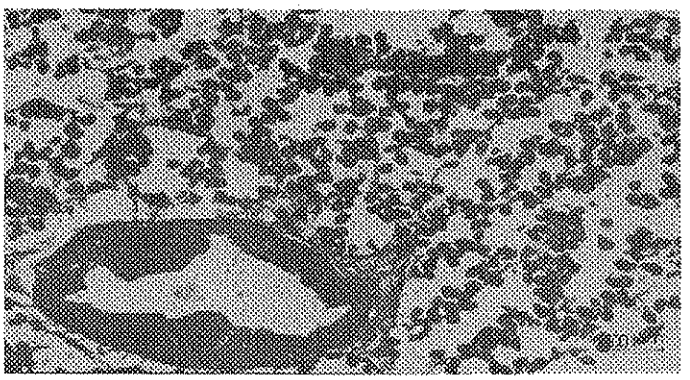

Figure 15. Gonad section of *R. decussatus* after spawning

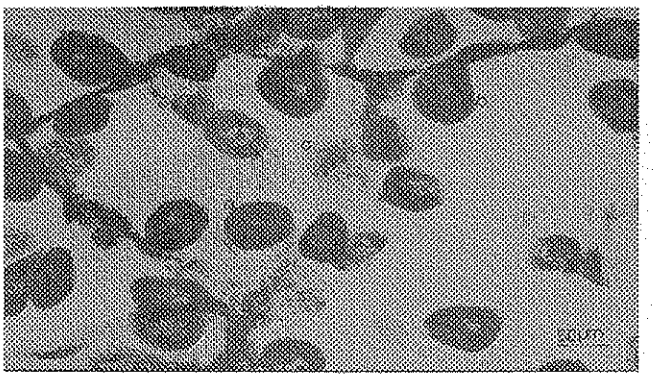

Figure 16. Oocysts in the follicles of *R. decussatus* after spawning, a-mature oocyststst, b-stalked oocysts, c-newly formed oocysts"

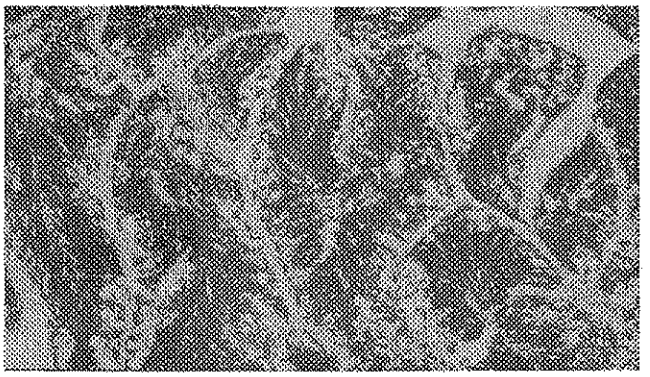

Figure 17. Gonad section of male *R. decussatus* in 5th stage

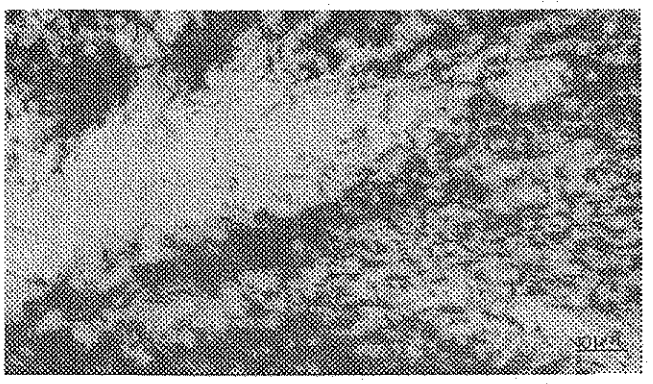

Figure 18. View of the spermatozoan in the follicle lumen of male *R.decussatus* in 5th stage

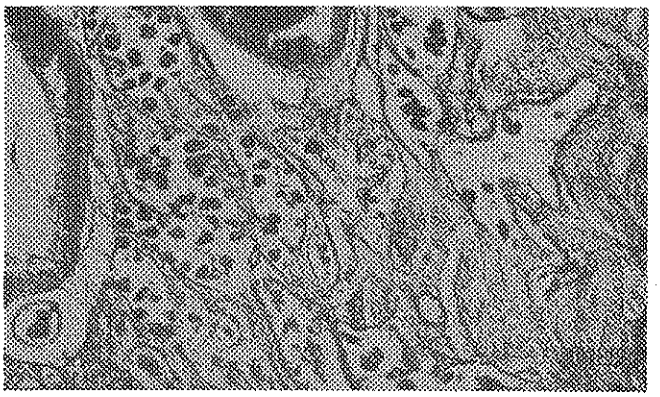

Figure 19. Gonad section of female *R. decussatus* in 6th stage

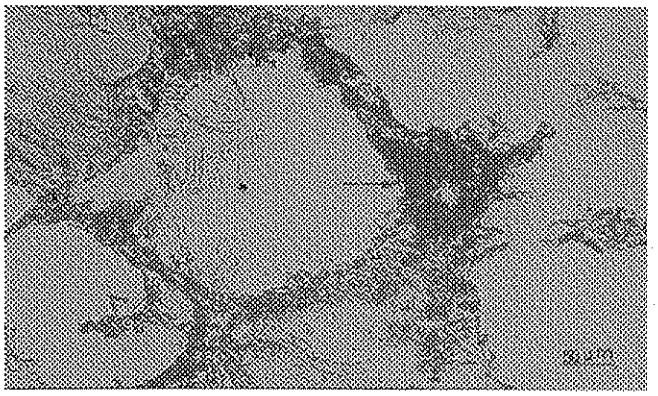

Figure 20. Gonad section of male *R. decussatus* in 6th stage

Discussion and Conclusions

According to Shpigel and Fridman (1990) male : female ratio of one year old *Tapes semidecussatus* was 1.14:1. In the present study ratio of the females was higher than males. Main reason of the difference between two results was geographic variations as well as one year old specimens exclusively taken into account by Shpigel and Fridman (1990).Length of the smallest egg-containing specimen collected in the Çardak Lagoon was 15-7 mm.

According to Devauchelle (1990) clams were matured at 15-20 mm length. Toba *et al* (1992) stated that clams were matured at 15-21 mm

length. According to Gutierrez (1991) *Tapes semidecussatus* was matured at 6-10 mm length.

Results of the present study were almost similar with the findings of Toba *et al.* (1992) and Devauchelle (1990), while they differred from the findings of Gutierrez (1991). This circumstance could be explained by the different ecological conditions of the research areas.

At first eggs were seen in the gonad sections of *R. decussatus* in March-April. This indicated that the gametogenic development was started in March. An increase was observed in the monthly egg diameter values until July. In July, a decrease was observed in the average egg diameter value. This indicates that spawning took place in July. Egg diameters were re-increased in August and September. Increasing of the egg diameter in September was higher than those observed in June. This circumstance could be explained by the number of the ripened eggs in September which was higher than those in June. Decreasing of the average egg diameter which was observed in October indicated that a second spawning took place in the late September and in October. No gametogenic development was observed from November to March. This indicated that the period from November to March was the resting stage of *R. decussatus* from this area.

Examination of the histological sections revealed that, gametogenic development continued from March to October. It was found that *R. decussatus* was subjected to a resting stage from November to March. The maximum number of mature specimens was observed in June. A considerable spawning activity was observed in July. A few number of spawning individuals were observed in August and September, and a second considerable spawning was observed in October. Several spawning individuals entered to a resting stage in October.

Annual distribution of the average values of condition index were parallel with the results of histological sections. An increase was observed in the average of condition index from March to June. This finding coincided with the monthly increasing of the average egg diameter and changing of the number of the mature specimens determined by the histological sections. This shows a relationship between the increasing of the number of mature specimens and condition index. Condition index decreased in June, increased in August, and re-decreased in September and October. Condition index re-increased in November, and decreased from November to March. The reason for the decreasing of the condition index

in July, September and October, was the spawning occurred in these months. Increasing of condition index in August could be explained by the few number of spawning individuals in this month, as well as the conditioning of the July spawning individuals. Decreasing of the condition index through the period from November to March could be explained by the decreasing of the feeding ratio caused by the low water temperatures. Valence and Peyre (1990) stated that filtration rate increased four times in carpet shells between 10 and 20 °C. This corresponded to our suggestion about the decreasing of the condition index occurred in winter. It was determined that the ripening of the gamets of *R. decussatus* corresponded to temperature, salinity and chlorophyll-a. Gametogenesis was first observed in March and spawning occurred over 24 °C. Mann (1979) stated that spawning occurred at 21 °C. Loosanof and Davis (1963) stated that carpet shell spawned between 20 and 27,5 °C. According to Valence and Peyre (1990) egg development of *Tapes philippinarum* and *T. decussatus* increased over 20 °C and spawning occurred over 20 °C. Borsa and Millet (1992) stated that spawning of *T. decussatus* occurred between 23 and 26,8 °C. In the present study *R. decussatus* was found to spawn between 24 and 27 °C. This finding corresponded to the results of Valence and Peyre (1990), Loosanof and Davis (1963), Borsa and Millet (1992), while differred from Mann (1979). In the present study, salinity ranged from 20 ‰ to 26 ‰. Toba *et al.* (1992), Valence and Peyre (1990), and Loosanof and Davis (1963), stated that optimal salinity for carpet shell ranged from 24 ‰ to 32 ‰. Beninger and Lucas (1984) reported a highly variable reproductive cycle of *R. decussatus* and *R. philippinarum* from Sud-Finistere in Great Britain. These authors reported that reproductive cycle of *R. decussatus* started in April and proceeded to mid September and March. Same authors also reported that reproductive cycle of *R. philippinarum* lied between the early March and mid October. In both species, oocytes emitted during the last months of the reproductive cycle and no oocytes was observed in the gonads during the resting stage.
In the present study, reproductive cycle of *R. decussatus* was found to lay between March and October and spawning took place between July and October. These findings corresponded to the results of Beninger and Lucas (1984), however, no emitted oocytes were observed in the gonads during the resting stage.

Laruelle *et al.* (1994) studied the comparative reproductive biology of *R. decussatus* and *R. philippinarum* from Gulf of Brest, Etel Ria, and Gulf of Morbihan (Great Britain), and found that the reproductive activity of *R. decussatus* was slower than *R. philippinarum.* In the Gulf of Brest,

spawning of *R. decussatus* took place from July to October, and *R.philippinarum* spawned twice. In the Gulf of Morbihan, *R. philippinarum* spawned three times per year, and *R. decussatus* twice. In Etel Ria, *R. decussatus* spawned three times (mid June, early September and early July). In conclusion, the authors stated that reproductive cycle *R. decussatus* lay between May and October.

Some similarities were observed between the present study and Laruelle *et al.*(1994). Our findings correspond to the results obtained in Brest and Morbihan Gulfs. Spawning months of the present study and in Etel Ria were almost similar, and the slight differences might have resulted by the different ecological conditions.

Eversole (1989) stated that spawning of *R. philippinarum* would take place from June to late September in North America Shafee and Daoudi (1991) stated that, along the Atlantic Coast of Morocco, development of the gonads of *R. decussatus* started in mid winter, gametogenesis proceeded from May to late September, spawned two times per year (May-June, August-September), and resting stage took place from October to December. According to Moscoso *et al.* (1993), resting stage of *R. philippinarum* lied between October and December, and spawning took place between June and October, along the north-western coast of Spain. In *R. philippinarum* spawning took place between August and September, in Arcochon Bay, France (Robert *et al.*, 1993).

According to Xie and Burnell (1994) gonad development of *R. philippinarum* started in March, mature individuals firstly occurred in May and spawning took place in September along the coast of southern Ireland. Same authors stated that gonad development of *R. decussatus* started in April and spawning took place in August. The present study corresponded to results of Eversole (1989), Shafee and Daoudi (1991), Moscoso *et al.* (1993), Robert *et al.* (1993), and Xie and Burnell (1994), due to summer spawning. Mature specimens of *Tapes japonica* was observed all the year round in an experimental upwelling culture unit in Virgin Islands (Rodde *et al.*, 1976).

Shpigel and Fridman (1990) stated that, mature specimens of *Tapes semidecussatus* were present throughout the year in a discharging area of fish ponds in Eilat, Israel. In the present study mature specimens were observed only for four months (June to September) throughout the year. Rodde *et al.* (1976), and Spigel and Fridman (1990) explained the presence of mature specimens throughout the year by the optimal

temperature and nutrient conditions of the environment. Toba and Miyama (1991)stated that *R. philippinarum* which fed on *Pavlova lutheri* at 18 °C, matured in 30 to 40 days and spawned at the beginning of 50th day.

Moscoso *et al.* (1993) stated that *T. decussatus* which fed on *Tetraselmis suecica, Phaeodactylum trionutum* and *Isochrysis golbana* at 16 to 18 °C spawned 4 to 5 months earlier (in March).

In the present study, mature specimens were observed three months and spawners were observed four months after the beginning of gonad development. Our results differed from the findings of Toba and Miyama (1991), and Moscoso *et al.*(1993). Differences may have resulted from the using of special diets and constant temperature conditions of later studies.

Consequently, reproductive cycle of *R. decussatus* started in March, and terminated in October, spawning took place between July and October, and resting stage lied between November and February in Çardak Lagoon.

Özet

Bu araştırma akivades (*Ruditapes decussatus* Linnaeus,1758)'in üreme periyodunu tespit etmek amacı ile yapılmıştır. İncelenen örneklerin % 43.32'ini dişiler, % 34.38'ini erkek bireyler oluştururken, erkek : dişi oranı 1: 1.23 bulunmuştur. Yapılan mikroskobik incelemeler sonucu ilk yumurtalı bireylere Mart-Nisan aylarında rastlanılmıştır. Gonad gelişiminin Mart ayında başladığı, yumurtlamanın Temmuz-Ekim ayları arasında gerçekleştiği tespit edilmiştir. Histolojik olarak yapılan incelemede, gonad gelişiminin Mart ayında başlayıp Ekim ayında sona erdiği görülmüştür. Kasım ayından Mart ayına kadar ise örneklerin dinlenme evresinde oldukları gözlemlenmiştir. Histolojik olarak en fazla sayıda olgun bireye Haziran ayında rastlanılmıştır. Kondisyon indeksinin histolojik preparat bulguları ile paralellik gösterdiği belirlenmiştir. Sıcaklık, tuzluluk ve klorofil-a değerleri saptanarak, *R. decussatus*' un su sıcaklığı 24 °C ve üzerinde iken, tuzluluğun ise ‰ 20-26 arasında olduğunda yumurta bıraktığı tespit edilmiştir.

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