Journal of Animal and Veterinary Advances 9 (4): 756-759, 2010
ISSN: 1680-5593

Depth and Seasonal Effects on the Settlement Density of *Mytilus galloprovincialis* L. 1819 in the Dardanelles

Harun Yildiz and Selcuk Berber
Faculty of Fisheries, Canakkale Onsekiz Mart University, 17100-Canakkale, Turkey

Abstract: The seasonal pattern of recruitment of the mussel, *Mytilus galloprovincialis*, on artificial collectors, situated at four different depth (0.5, 4, 8, 12 m) in the Dardanelles. The presence of pediveliger mussels throughout the year and their abundance in march reflects the presence of spawning mussels throughout the year and the occurence of a major spawning period during beginning of spring. Different densities of mussel settlement were detected at the different depths. Mussel seed density was higher at 0.5 m (surface) and 4 m than 8 and 12 m throughout the year. Artificial collectors should be hung within the first 8 m (especially within 4 m) of the water column in order to exploit the highest settlement in the upper parts.

Key words: Mussel, *Mytilus galloprovincialis*, depth, settlement, dardanelles

INTRODUCTION

One of the most important bottlenecks in aquaculture sector is the difficulty in obtaining seed. Obtaining desired amounts of seed without the need for any hatchery production (Gosling, 1992; Acosta *et al*., 2009), has enabled the rapid development of mussel farms all over the world. The fact that approximately half of the total expenses of fish culture is due to the feed costs whereas, there is no such problem for mussels that feed by filtering the water (Bilecik, 1989; Lok *et al*., 2007) is another important factor that enabled the rapid development of this sector. The mussel culture studies in the country are yet very new. Whereas in 2006, 94.5% of the world's mussel production of 1,998,000 tons was made by culturing, only 14% of the 10.779 tons of mussels produced were grown by aquaculture (FAO, 2007). Therefore, for the interest of our country, mussel culture studies should be accelerated.

Colonization of natural and artifical substrates by mussels, *Mytilus* sp. may occur by settlement of competent pediveliger larvae or by settlement of drifting post-larvae (Davies, 1974; King *et al*., 1989; Yildiz, 2004). It is presumed that initial settlement would prefentially occur at a depth chosen by the larvae upon their attainment of competence, assuming the larvae had immediate accessibility to a suitable substrate at that depth (Freeman *et al*., 2002). In designing this experimental, we were concerned with mussel settlement season, quantities of seed which could be collected, the best depths for setting out seed collectors in Dardanelles and space in order to generate advice to the mussel industry.

MATERIALS AND METHODS

Field studies were carried out on *Mytilus galloprovincialis* L. in Dardanelles of Turkey from February, 2002-December, 2002 (Fig. 1).

Collectors of net rope material were tied in February, May, August, November months onto main body made than polyprophylen rope. Each net collector prepared as

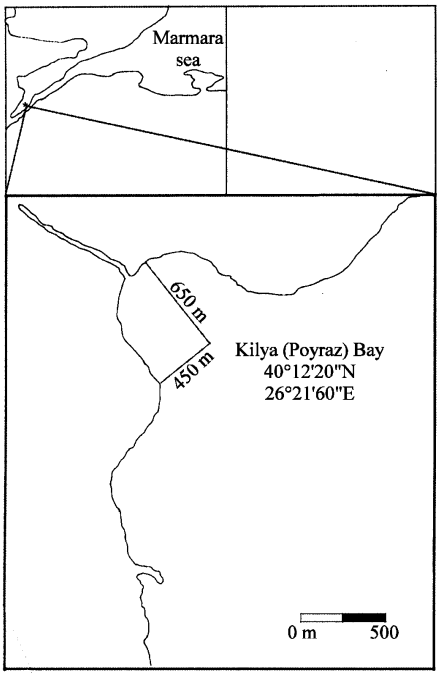

Fig. 1: The study area

Corresponding Author: Harun Yildiz, Faculty of Fisheries, Canakkale Onsekiz Mart University, 17100-Canakkale, Turkey

25 cm long and 4 cm wide (100 cm^2) on average. Main bodies suspended from beneath buoys in such a way that collectors were situated at four depths (0.5, 4, 8 and 12 m). After one month of submersion, the main bodies were retrieved. These collectors were untied from the main bodies and two small pieces of 8 cm^2 (lenght: 2 cm, weight: 4 cm) each were randomly cut from each collector. Mussel seeds were removed from the net rope by vigorous agitation in water. They were drained on to a 100 μm nylon-mesh fitler. Larvaes were then carefully taken with a Pasteur pipette and transferred to a Petri dish. Density of settlement (number of mussels per 8 cm^2) was determined by counting the pediveliger and postlarvae mussels contained in each sieve under a binocular microscope of Dolphus camera. Lenght measuring was carried out on randomly selected mussels with a micrometer. The identification of pediveliger larvae (<0.470 mm) was possible to genus (*Mytilus*) using the keys and observations from Rees (1950), Lutz and Hidu (1979) and Le Pennec (1980). All *Mytilus* pediveliger larvae were considered *Mytilus galloprovincialis* since this species is the only *Mytilus* species present in this area. Post-larvae (>0.470 mm) were easily identified as *Mytilus galloprovincialis*. Total longevity of sample collector parts of each collectors (4 cm^2×2 collector parts = 8 cm^2) rated to the whole collector lenght (100 cm^2). Total mussel number was calculated and lenght groups were determined.

Friedman test was used in order to analyze the effects of the different seasons and depths on the number of mussel seeds. The Z ratio test was applied to compare the depths for the number of mussel seeds during each season.

RESULTS

Pediveliger mussel larvaes have been observed in all the samples taken from the research area, thus it has been determined that spawning continues throughout the year. It has been determined that main spawning period is between February-March and that among the individuals attachment onto the collectors at the surface (0.5 m), 4, 8, 12 m; 88, 88, 91 and 85% were at pediveliger stage, respectively. Whereas, during the months of june, september and december, it has been observed that of the mussel seed that attach onto the collectors at different depths, an average of 75, 69% and 61, 25% were pediveliger mussels, respectively (Table 1-4).

As a result of the Friedman test performed in order to analyze the effect of different seasons and depths on the number of mussel seeds, it has been determined that seasons greatly affect the number of mussel seeds (p = 0.007) and that the greatest number of mussel settlements were observed in march and that the lowest number was observed in december. Friedman test was reapplied in order to analyze the effects of depth on the number of mussel seeds and it was determined that depth also greatly affects the number of mussel seeds (p = 0.019). As a result of the Z ratio test carried out in order to compare the depths with regards to the number of mussel seeds during each period, it was determined that the percentage in total of the number of mussel seeds at a depth of 4 m was greater. It was also determined that the percentage in total of the number of mussel seeds at the surface was greater during the June period.

Table 1: Amount of mussel attachments at the different depths in March 2002

	March 2002				
	Pediveliger		Postlarvae		
Values (m)	Number	%	Number	%	Total
0.5	40754	88	5558	12	46312
4	42875	88	5847	12	48722
8	23125	91	2287	9	25412
12	5425	85	957	15	6382

Table 2: Amount of mussel attachments at the different depths in June 2002

	June 2002				
	Pediveliger		Postlarvae		
Values (m)	Number	%	Number	%	Total
0.5	4497	68	2117	32	6614
4	4809	76	1519	24	6328
8	3898	81	914	19	4812
12	1136	75	378	25	1514

Table 3: Amount of mussel attachments at the different depths in September 2002

	September 2002				
	Pediveliger		Postlarvae		
Values (m)	Number	%	Number	%	Total
0.5	6317	76	1995	24	8312
4	5014	52	4628	48	9642
8	5091	77	1521	23	6612
12	1395	71	570	29	1965

Table 4: Amount of mussel attachments at the different depths in December 2002

	December 2002				
	Pediveliger		Postlarvae		
Values (m)	Number	%	Number	%	Total
0.5	411	40	617	60	1028
4	801	61	512	39	1313
8	779	68	367	32	1146
12	467	76	147	24	614

DISCUSSION

In the first stages of their life, cycles mussels move as pelagic and search for a suitable substrate to pass onto

sessile life (McGrath *et al*., 1988; Hunt and Scheibling, 1997; Yildiz *et al*., 2005). It was observed both in their natural environment and at laboratory conditions that mussel seed settle on filament surfaces such as bryozoa, hydroid and filiform alg species (Eyster and Pechenik, 1987; Folino-Rorem *et al*., 2006). It has been proved that especially artificial collectors with filamentous structure are effective in the settlement of mussel seeds (Davies, 1974; Petersen, 1984; Lekang *et al*., 2003). In the study, it has been observed that the net collectors that are used due to this principle are very effective. When it is considered that Çanakkale is a fishing city, we can suggest using old fish nets, which can be purchased for low prices to be used as mussel collectors.

It is known that in populations of mussel from different regions of the world, after a main spawning season, minor spawning during the year may occur (Seed, 1976; Ferran, 1991; Villalba, 1995). In this study, the presence of pediveliger mussels throughout the year and their abundance in March reflects the presence of spawning mussels throughout the year and the occurence of a major spawning period during beginning of spring. It has been observed that the results are in accordance with the results of the study made by Karayücel *et al*. (2002) at the Black Sea region. Again the fact that 75% of the mussel seeds obtained in June, 69% of those in September and 61, 25% of those obtained in December are mussels with pediveliger competence, whereas 88% of the mussels obtained in March are pediveliger mussels shows that the main spawning period starts close to the period in which sampling was made.

Vertical distribution of bivalve larvae prior to settlement depends on various factors, both active, in response to environmental stimuli (Bayne, 1976) and passive, as a consequence of physical forces (Mann, 1986). Mussel seeds begin to settle on the ropes near the surface because of the high temperature, abundance of light and available food (Karayücel *et al*., 2002). Fuentes and Molares (1994) found that settlement of the mussel *Mytilus galloprovincialis* was high at shallower dephts in a seaward site of the Ria de Arousa Bay in northeastern Spain. In this study, different densities of mussel settlement were detected at the different depths. Mussel seed density was higher at surface and 4 m than 8 and 12 m throughout the year. A similar pattern of vertical variation was obtained by Kautsky (1982) in a Baltic Sea population of *M. edulis*, Margus and Teskeredzic (1986) in the River Krka Estuary of Adriatic Sea, Joschko *et al*. (2008) German Bight coastal areas of the North sea.

CONCLUSION

In this study, the management of mussel spat collection in the Dardanelles are as follows. Mussel collectors should be hung from the rafts or long line systems before February in order to make full use of the main peak of settlement. Ropes should be hung within the first 8 m (especially within 4 m) of the water column in order to exploit the highest settlement in the upper parts. Such productive sites will be extremely useful in supplying seed for mussel farms.

REFERENCES

Acosta, V., M.E. Glem, Y. Natera, T. Urbano, Himmelman, H. John, M. Rey-Méndez and C. Lodeiros, 2009. Differential growth of the mussels *Perna perna* and *Perna viridis* (Bivalvia: Mytilidae) in suspended culture in the golfo de cariaco, Venezuela. J. World Aquac. Soc., 40: 226-235.

Bayne, B.L., 1976. Marine Mussels: Their Ecology and Physiology. Cambridge University Press, Cambridge, UK., ISBN: 0521210585, pp: 1-495.

Bilecik, N., 1989. Mussel and culture. Ministry of Agriculture Aquaculture Research Institute of Bodrum. Series A, No. 2, pp: 1-38.

Davies, G., 1974. A method for monitoring the spatfall of mussel (*Mytilus edulis* L.). J. Conseil, 36: 27-34.

Eyster, L.S. and A.J. Pechenik, 1987. Attachment of *Mytilus edulis* L. larvae on algal and byssal filaments is enhanced by water agitation. J. Exp. Mar. Biol. Ecol., 114: 99-110.

FAO. (Fisheries and Aquaculture Information and Statistics Service), 2007. GFCM capture production 1970-2005. Fishstat Plus-Universal Software for Fishery Statistical Time Series. Food and Agriculture Organization of the United Nations. http://www.fao.org/fi/statist/FISOFT/FISPLUS.asp.

Folino-Rorem, N., J. Stoeckel, E. Thorn and L. Page, 2006. Effects of artificial filamentous substrate on zebra mussel (*Dreissena polymorpha*) settlement. Biol. Invasions, 8: 89-96.

Freeman, K.R., E. Kenchington and P. Macquarrie, 2002. Comparative settlement depths of *Mytilus edulis* Linnaeus, 1758 and *M. trossulus* Gould, 1850: I. A. Mesocosm study. J. Shellfish Res., 21: 59-65.

Fuentes, J. and J. Molares, 1994. Settlement of the mussel *Mytilus galloprovincialis* on collectors suspended from rafts in the Ria de Arousa (NW of Spain): Annual pattern and spatial variability. Aquaculture, 122: 55-62.

Gosling, E., 1992. The Mussel *Mytilus*: Ecology, Physiology, Genetics and Culture. Elsevier Science Publishers, Amsterdam, ISBN: 0444887520, pp: 589.

Hunt, H.L. and R.E. Scheibling, 1997. Role of early post settlement mortality in recruitment of benthic marine invertebrates. Mar. Ecol. Prog. Ser., 155: 269-301.

Joschko, T.J., B.H. Buck, L. Gutow and A. Schroder, 2008. Colonization of an artificial hard substrate by *Mytilus edulis* in the German bight. Mar. Biol. Res., 4: 350-360.

Karayücel, S., M. Erdem, O. Uyan, S. Saygun and I. Karayücel, 2002. Spat settlement and growth on a long-line culture system of the mussel, *Mytilus galloprovincialis*, in the southern Black sea. Isr. J. Aquac. Bamidgeh, 54: 163-172.

Kautsky, N., 1982. Growth and size structure in a Baltic *Mytilus edulis* population. Mar. Biol., 68: 117-133.

King, P.A., D. McGrath and E.M. Gosling, 1989. Reproduction and settlement of *Mytilus edulis* on an exposed rocky shore in Galway Bay, west coast of Ireland. J. Mar. Biol. Assoc., 69: 355-365.

Le Pennec, M., 1980. The larval and post-larval hinge of some families of *Bivalve molluscs*. J. Mar. Biol. Assoc. UK., 60: 601-617.

Lekang, O.I., T.K. Stevik and A.M. Bomo, 2003. Evaulation of different combined collectors used in longlines for blue mussel farming. Aquac. Eng., 27: 89-104.

Lok, A., H. Yildiz and M. Palaz, 2007. Reproduction density and growth performance of mediterranean mussels, *Mytilus galloprovincialis* lamarck, 1819 in winter season in dardanelles. J. Fish. Int., 2: 54-59.

Lutz, R.A. and H. Hidu, 1979. Hinge morphogenesis in the shells of larval and early postlarval mussel (*Mytilus edulis* L. and *Modiolus modiolus* L.). J. Mar. Biol. Assess. UK., 59: 111-122.

Mann, R., 1986. Sampling of Bivalve Larvae. In: North Pasific Workshop on Stock Assessment and Management of Invertebrates, Jamieson, G.S. and N. Bourne (Eds.). Vol. 92, Canada Special Publication, Fishery Aquatic Science, Canada, pp: 107-116.

Margus, D. and E. Teskeredzic, 1986. Settlement of mussels (*Mytilus galloprovincialis* L.) on rope collectors in the estuary of the River Krka, Yugoslavia. Aquaculture, 55: 285-296.

McGrath, D., P.A. King and E.M. Gosling, 1988. Evidence for the direct settlement of *Mytilus edulis* larvae on adult mussel beds. Mar. Ecol. Prog. Ser., 47: 103-116.

Petersen, J.H., 1984. Larval settlement behaviour in competing species: *Mytilus californianus* conrad and *M. edulis* L. J. Exp. Mar. Biol. Ecol., 82: 147-159.

Rees, C.B., 1950. The identification and classification of lamellibranch larvae. Hull Bull. Mar. Ecol., 19: 73-104.

Seed, R., 1976. Ecology. In: Marine Mussels: Their Ecology and Physiology, Bayne, B.L. (Ed.). Cambridge University Press, Cambridge, UK., pp: 13-65.

Villalba, A., 1995. Gametogenic cycle of cultured mussel, *Mytilus galloprovincialis*, in the bays of Galicia (NW Spain). Aquaculture, 130: 269-277.

Yildiz, H., 2004. Researches on the mussel (*Mytilus galloprovincialis* L.1819) in Dardanelles. Ph.D. Thesis, Ege Üniversity Sciences Institute, Department of Aquaculture, Bornova, Izmir, pp: 148.

Yildiz, H., A. Lök, S. Serdar, S. Acarli and A. Köse, 2005. Mussel (*Mytilus galloprovincialis* L. 1819) spat settlement and growth performances on artificial collectors in Dardanelles. J. Fish. Aquat. Sci., 22: 257-261.