Distribution and abundance of *Dormitator latifroms* (Richardson) larvae (Pisces: Eliotridae) in the natural protected area "estero El Salado" in Jalisco, Mexico

Distribución y abundancia de las larvas de *Dormitator latifroms* (Richardson) (Pisces: Eliotridae) en el área natural protegida "estero El Salado" en Jalisco, México

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Abstract.- This study presents an analysis of a spatial and temporal variation of the distribution and abundance of larvae of *Dormitator latifroms* (Richardson 1845) in the natural protected area known as "estero El Salado", in Puerto Vallarta, Jalisco, Mexico. Eight diurnal zooplankton tows were conducted seasonally from spring to winter, 2001. Variations in temperature, salinity and fish larval abundance were strongly related to seasonal patterns, which also influenced the reproduction cycle of *Dormitator latifroms,* since higher abundances appeared with an increase in temperature and a low salinity (20-30°C and 6.5 psu). From 12,871 fish larvae collected, 97.8% were *Dormitator latifroms* and only 2.2% corresponded to other species. The variations in temporal and spatial abundance were influenced by the tidal conditions as well as by seasonality, with higher concentrations appearing at sampling site 1 (>12,000 org./1000 m^3) during the summer, related to the rainy season, whereas the lowest records were registered in the spring (20 org./1000 m^3) during the drought period.

Key words: Fish larvae, zooplancton, seasonal variations, environmental factors

Resumen.- Se analizó la variación en espacio y tiempo de la distribución y abundancia de larvas de *Dormitator latifroms* (Richarson 1845) en el estero El Salado, en Puerto Vallarta, Jalisco, México. Se realizaron ocho arrastres zooplanctónicos diurnos, estacionalmente de primavera a invierno del 2001. Las variaciones de temperatura, salinidad y abundancia de larvas de peces están en estrecha relación con el patrón estacional, que a su vez influye en el ciclo de reproducción de *Dormitator latifroms*, ya que las mayores abundancias se presentaron con el incremento de temperatura y una baja salinidad (20-30°C y 6,5 psu). De las 12.871 larvas de peces recolectadas el 97,8% fue de *Dormitator latifroms* y sólo el 2,2% correspondió a otras especies. Se observó que las variaciones de la abundancia espacio temporal estuvieron influidas tanto por las condiciones de marea, como por la época del año, presentándose las mayores concentraciones en el sitio de muestreo 1 (>12.000 org./1000 m^3) y durante el verano, asociado a la época de lluvias, en tanto que, en primavera se presentaron los registros más bajos de todo el período de estudio (20 org./1000 m^3) asociado con el período de sequía.

Palabras clave: Larvas de peces, zooplancton, variaciones estacionales, factores ambientales

Introduction

Fish can be characterized by their variety of forms, their commercial and nutritional importance and the scientific interest. Many open questions exist, whether taxonomic, biological, or evolutionary which, once answered, will not only generate knowledge, but will also allow us to define exploitable resources, as well as the measures for its rational exploitation and conservation (De la Cruz Agüero *et al*. 1997). Ichthyc prospections through ichthyoplanktonic methods are very useful for such a purpose, since they are alternative methods to evaluate the abundance of diverse fishing resources by means of the estimation of the spawning biomass of the fish (Smith & Richardson 1979), and to determine egg laying areas and time periods.

The Eliotridae family, within the Gobioidei suborder, is one whose taxonomic status has not been thoroughly determined. Some authors consider it a subfamily of the Gobiidae family, whereas others classify them as gobioids (Watson 1996). The eliotrids comprise around 300 species that live in fresh waters and shallow estuaries, although some species appear in marine coastal waters of little depth, including the coralline reefs of tropical and subtropical areas (Watson 1996, Allen & Robertson 1998, Leis & Carson-Ewart (2000). The adults of this family are small fish with compressed bodies that can reach a length of 10 to 35 cm, and they have benthonic habits (Fischer *et a*l. 1995, Allen & Robertson 1998, Leis & Carson-Ewart 2000). *Dormitator* is common in coastal marine environments; however, is not well known the biological cycle of the species of the tropical eastern Pacific. Most of the species are probably carnivorous feeding on small crustaceans, vermes, mollusks and small fish (Fischer *et al.* 1995; Allen & Robertson 1998). Females are oviparous (Fischer *et al.* 1995, Schmitter-Soto 1998), and their larvae are planktonic living frequently in marine coastal environments. Despite the fact that none of the species of the eastern Pacific has commercial importance, the organisms of greater size can usually be found in the local markets (Fischer *et al*. 1995).

In the present study, distribution and abundance seasonal patterns of larvae *Dormitator latifroms* (Richardson) were analyzed, as well as its relation with the termohaline structure.

Study area

The Natural Protected Area Estero El Salado, located in the Municipality of Puerto Vallarta, Jalisco, is one of the most important estuary systems in the region on the Pacific's coastal plain, where the Western Sierra Madre Mountain range meets the Southern Sierra Madre range, forming what is known as Bahía de Banderas. The El Salado estuary is found on the delta of the Ameca river and it is located at 20°39'20''N and 105°13'12''W with a total extension of 75 km^2, its connection to the ocean is permanent through a channel of approximately 2 km in length, 20 m wide and approximately 3 m deep. The average depth in low tide is 3 m and 5.7 m at high tide. The tides appear three to four times during the day, with the lowest ones occurring during January and February and the highest from September to October (Cupul-Magaña 1999, 2000). The estuary is surrounded by mangrove vegetation and salt marshes and by two patches of tropical dry forest bordered by aquatic and subaquatic vegetation succession. The climate of the estuary in agreement with Köppen´s system is warm subhumid type (Awo (x) I) (García 1973) (Fig. 1).

Materials and methods

In the study area, two sampling sites located in the first sections of the main channel were visited. Site 1 was located at a distance of 573.5 m (the distance that could be covered by boat allowed by the vegetation) from the bridge and site 2 was located at a distance of 499,5 m from the mouth to the bridge that crosses the estuary resulting in a 1,073 m^2 total surface of the area.

Eight zooplanktonic tows were made from spring to winter in 2001. These tows were conducted from an outboard motor boat, using a "Zeppelin" net with a 505 μm of light mesh sleeve, 1.50 m length and 0.60 m of mouth diameter, equipped with a digital flowmeter to measure the filtered water. The horizontal tows were made in 10 minute periods at 10 cm below the water surface to avoid the large amount of suspended organic matter in the surface. In addition, temperature measurements were made with a graded immersion thermometer (0.1°C precision) as well as measurements of salinity conducted with a field refractometer (ATAGO s/mill-E of 0-100 psu with 1 psu of precision). The material collected was placed in 1 liter transparent plastic bottles and fixed with 4% formalin and 20 mL of sodium borate saturated solution. Fish larvae were separated from the rest of the organisms using stereoscopic microscopes. Once separated, the larvae were placed in plastic bottles (400 and 500 mL) and properly labeled. The larvae were identified up to species level whenever possible. The bibliographical sources used were Sumida *et al*. (1985), Moser & Smith (1993), Moser *et al*. (1994) and Moser (1996) and specifically for *D. latifroms*, Watson (1996) and Leis & Carson-Ewart (2000).

Results

Temperature, salinity and abundance

In terms of temperature values by season, it was observed that the highest values (29.25°C) were registered during the summer whereas records were lower during the winter (23.3°C), with variations of 1.4 and up to 6°C between seasons. With regards to salinity, drastic variations were observed, with maximum average values of 33.5 psu (winter) and minimum averages values (summer) of 6.5 psu (Fig. 2). In relation to temperature and sanility variations by sampling site, it was observed that both of these variables were, in average, higher at site 2 than site 1, with variations of 2°C and 4.24 psu between sampling

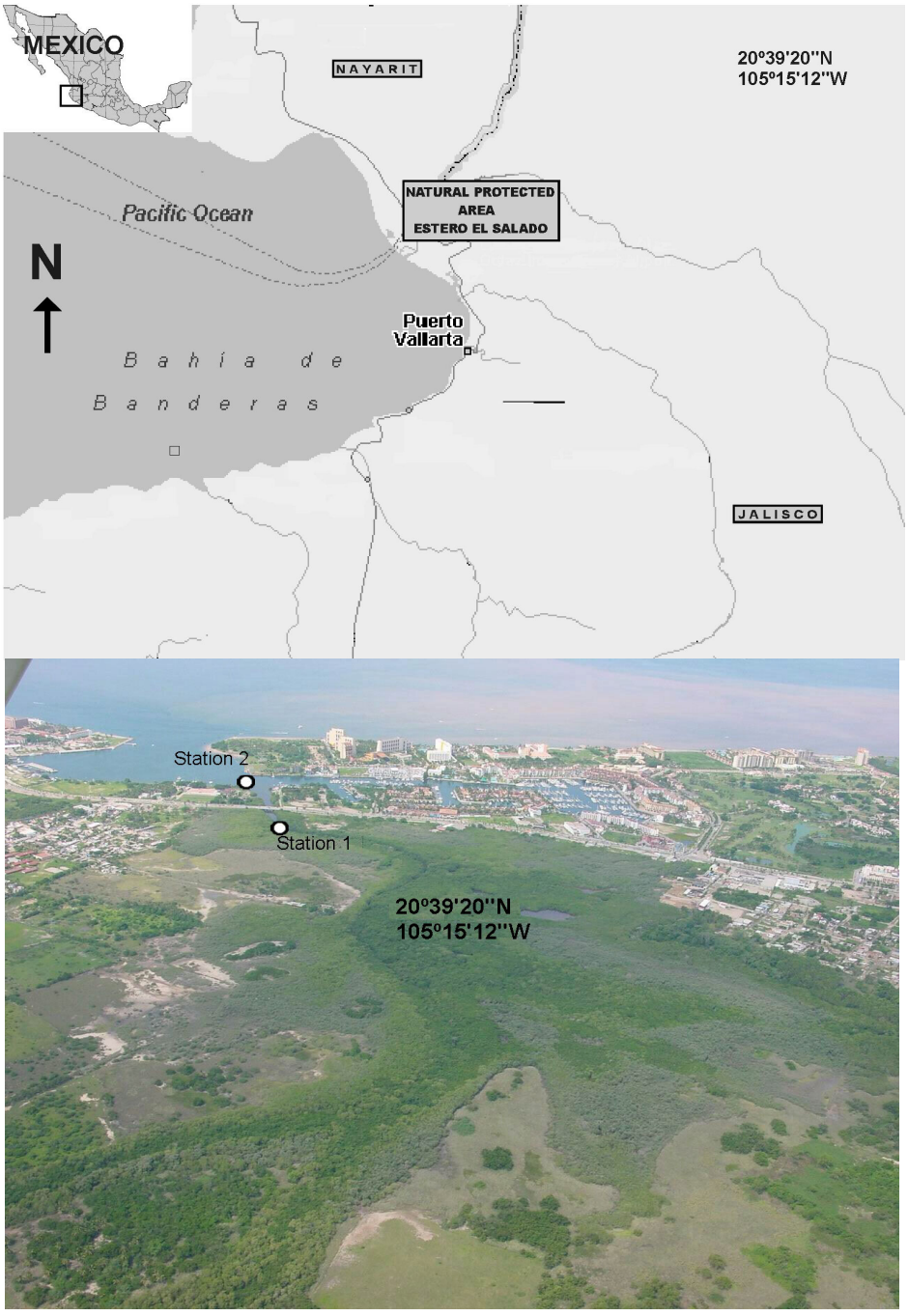

Figure 1

Study area and sampling sites in the Natural Protected Area Estero El Salado, Jalisco, Mexico
Área de estudio y sitios de muestreo en el Area Natural Protegida Estero El Salado, Jalisco, México

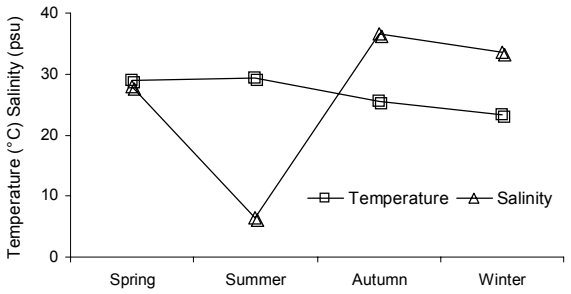

Figure 2

Mean seasonal variation of surface temperature (°C) and salinity (psu) in the Natural Protected Area Estero El Salado, Jalisco, Mexico, spring-winter 2001

Variación promedio estacional de la temperatura (°C) y salinidad (psu) superficiales en el Área Natural Protegida estero El Salado, Jalisco, México, primavera-invierno 2001

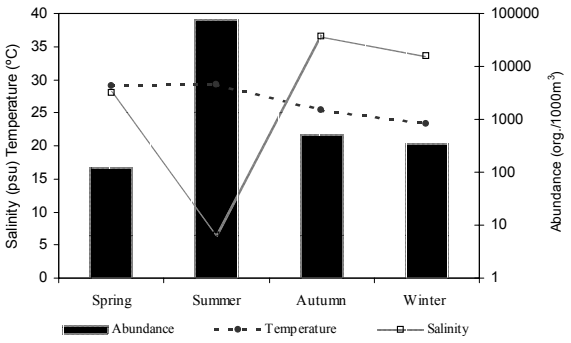

Figure 3

Mean seasonal variation of the temperature (°C) and salinity (psu) at surface, and abundance (org./1000 m^3) of *Dormitator latifroms* larvae in the Natural Protected Area Estero El Salado, Jalisco, Mexico, spring-winter 2001

Variación promedio estacional de la temperatura (ºC) y salinidad (psu) superficiales, y abundancia (org./1000 m^3) de larvas de *Dormitator latifroms* en el Área Natural Protegida estero El Salado, Jalisco, México, primavera-invierno 2001

sites. On the other hand, data variation of temperature, salinity and abundance of *D. latifroms* showed a variation related to seasonal patterns; during the first half of the year warmer temperatures were registered (>30°C); for the rest of the year, there was a temperature decrease (24°C). In contrast, salinity showed an inverse behavior, with values <28 psu registered during the first half of the year, with variations of up to 21.5 psu and a minimum of 6.5 psu during the summer. For the second half of year, the salinity increased during autumn and winter to its highest values (>34 psu), whereas abundances were lower (<90 org./1000 m^3) during spring, autumn and winter. The maximum level of abundance (>12,000 org./1000 m^3) was obtained during summer (Fig. 3).

Spatial and temporal distribution and abundance

From spring to winter 2001, a total of 12,871 (org./1000 m^3) fish larvae were identified. *D. latifroms* constituted 97.8% of the total number of organisms whereas the remaining 2.2% comprised other species. Ninety seven percent of the total abundance of *D. latifroms* appeared during the summer, whereas in spring, autumn and winter only 1% was registered.

In relation to temporal abundance of *D. latifroms* the maximum level occurred during the summer (12,497 org/1000 m^3), followed by autumn and winter (80 and 57 org/1000 m^3 respectively), while the lowest records (20 org/1000 m^3) were during the spring (Fig. 4). In addition, the highest abundance of this species was registered at site 1, whereas at site 2 the values were minimal. Finally, the spatial distribution of *D. latifroms* showed higher concentrations at site 1 (Fig. 5).

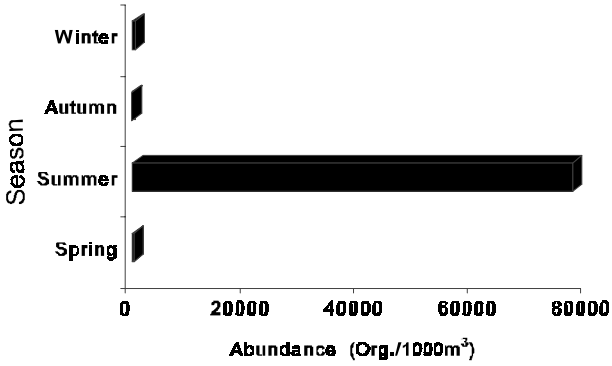

Figure 4

Seasonal variation in abundance (org./1000 m^3) of *Dormitator latifroms* larvae in the Natural Protected Area Estero El Salado, Jalisco, Mexico, spring-winter 2001

Variación estacional de la abundancia (org./1000 m^3) de larvas de *Dormitator latifroms* en el Área Natural Protegida estero El Salado, Jalisco, México, primavera-invierno 2001

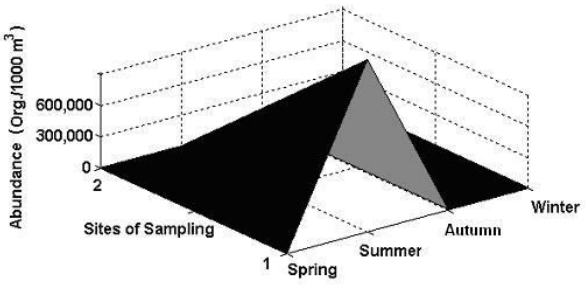

Figure 5

Spatial abundance variation (org./1000 m^3) of *Dormitator latifroms* larvae in the Natural Protected Area Estero El Salado, Jalisco, Mexico, spring-winter 2001

Variación espacial de la abundancia (org./1000 m^3) de larvas de *Dormitator latifroms* en el Área Natural Protegida estero El Salado, Jalisco. México, primavera-invierno 2001

Discussion

Variation in the distribution and abundance, both spatial and temporal, and possibly in the reproductive cycle of *D. latifroms*, were influenced mainly by the conditions created by local dynamics (these bodies of water are in permanent communication with the sea) and by the effect of tides. Navarro-Rodríguez *et al*. (2001), in their study conducted in the coast of Jalisco and Colima, identified three periods related to the seasonal pattern of currents in the eastern Pacific (Wirtky 1996, Badan 1997). First, a warm period during the summer characterized by high temperatures, related to the intensification of the Coastal Current of Costa Rica. Secondly, a period of lower temperatures in the winter, that can be related to the displacement of the Intertropical Convergence, when the Coastal Current of Costa Rica is weak. And finally, a third transition period characterized by an increase in temperature during spring and summer. In relation to the tides, Cupul-Magaña (2000) indicates that the presence of tides has been registered three to four times a day in the area, with lowest values in January and February (winter) and higher values from September to October (summer and autumn) what agrees with a low abundance during the winter, and high abundance mainly in the summer. On the other hand, these variations were also influenced by the rains and dry periods. Cupul-Magaña (2000) indicates that the estuary presents its maximum water-bearing contributions during the rainy season (June to November), including the summer and the autumn, mainly due to by run-off and incoming flows from the streams Contentillo and Agua Zarca. This was the season when the highest abundance concentrations were registered in the estuary. The fact that this body of water is located in the delta of the Ameca river favors even more the increase in abundances. Navarro-Rodriguez *et al.* (2001) indicated that the increase in plankton abundance in some areas (Manzanillo Bay and Cuyutlán Lagoon) during the rainy season can be attributed to its proximity with the opening of rivers, lagoons and bays to the ocean. Alvarez-Cadena *et al.* (1984), Day & Yáñez-Arancibia (1985) and Contreras (1993) indicated that the semienclosed or protected coastal bodies are highly productive systems as well as the transport of rivers favors this productivity by contributing with suspended nutrients and organic materials.

In general, the egg-laying of *D. latifroms* is not well known but high concentrations (>12,000 org./1000 m^3) indicate that egg-laying could occur between summer and autumn. Some authors mention that this sort of pattern is very common in fresh water coastal environments and estuaries, as well as in tropical and subtropical water reefs (Watson 1996, Allen & Robertson 1998, Leis & Carson-Ewart 2000). However, the biological cycle of the species from the tropical eastern Pacific is not well known (Fischer 1995, Allen & Robertson 1998, Schmilter- Soto 1998).

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