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Seasonal Patterns of Abundance, Growth, Gonad Development and Feeding Behavior of *Mugil curema* V., 1836 and *Mugil cephalus* L., 1758 in the Lagoon of Alvarado, Veracruz, Mexico

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ABSTRACT

A study was conducted to analyze the patterns of abundance, growth type, feeding and gonad development of *Mugil curema* and *M. cephalus*, in the Alvarado lagoon, Veracruz, from February 2010 to September 2012. Total 301 individuals were obtained, 221 *M. curema* and 80 *M. cephalus*. Both species were more abundant in the rainy and windy seasons. The sex ratio favored females in both species with values of 1.12 to 1.94 female per male in *M. curema* and from 1.06 to 1.41 females per male in *M. cephalus*. Gonad maturation stages were more advanced for *M. curema* occur in the rainy and windy seasons, for *M. cephalus* advanced stages were recorded in the windy season, this behavior matches the condition factor values of 2.808 and 2.212, calculated for *M. curema* and *M. cephalu*, respectively. Trophic analysis showed that both species feed on detritus and groups associated with this, such as calanoid and harpacticoid copepods and algae in *M. cephalus* and foraminifera and ostracods in *M. curema*. Both species are important in the area and fishing records show that *M. curema* contributes to higher catches regard to *M. cephalus*, so it is important to study the population behavior of these species in estuarine environments of the Gulf of Mexico.

Key words: Gulf Mexico, Mugilidae, Alvarado lagoon, growth, sex ratio

INTRODUCTION

The coastal area of the Gulf of Mexico has a lot of coastal lagoons and estuaries; they are natural frontier between the marine and freshwater environments. These areas are recognized as transition zones (Levin *et al*., 2001; Norris *et al*., 2010) and due to their particular characteristics are considered as one of the most productive ecological systems (Costanza *et al*., 1997) and of multiples ecological functions as well as habitats for a large variety of species of fishes, crustaceans and mollusks in early growth stages (Able, 2005; Gillanders *et al*., 2003; Gunter, 1967; Rogers *et al*., 1984; Heck *et al*., 2003; Houde and Rutherford, 1993).

Of these biological groups, it is recognized that fishes are the most conspicuous ecological component in these systems, it is estimated that coastal lagoons in Mexico could provide food and shelter for more than 400 species of fishes, of which only 5% are exploited as fisheries resource. Of these species *Mugil curema* Valenciennes, 1836 and *M. cephalus* Linnaeus, 1758, belonging to the family Mugilidae, are exploited commercially in diverse localities of the Gulf of Mexico. The annual production in Mexico in 2011 was approximately 12 100 tons per year (SAGARPA-CONAPESCA, 2011); for the state of Veracruz the production was 3 425 tons of *M. curema* and *M. cephalus*, this value represents approximately 28% of the national fishery production.

In Veracruz, both species are exploited in diverse coastal systems for personal consumption and commercial use, though, in recent years the exploitation of their populations has increased, endangering their abundance, so have been enacted at least two periods in the year that restrict their catch, principally in the north of the state and recently in all the state of Veracruz (SAGARPA-CONAPESCA, 2012). In the Alvarado lagoon, *M. curema* is exploited mostly because of its abundance. An important aspect is the ecological roll of both species in this kind of system, mainly the energy flow between coastal lagoon and the ocean (Yañez-Arancibia, 1976).

Mugil curema and *M. cephalus* exhibit a wide world distribution and in many countries are used as food resource for the coastal zone residents (Nash *et al.*, 1974; Nash and Shehadeh, 1980). In the Pacific Ocean as well as in the Atlantic, both species have been subject of diverse studies, within which Benetti and Netto (1991) and Baumar *et al.* (2000), who made studies about the growth of *M. curema*. Okada and Paiva (1980), Radasewsky (1976) and Alvarez-Lajonchere (1981) determined the size of maturity for this species. Other authors as Ibañez-Aguirre and Gallardo-Cabello (1996a, b, 2004), Ibañez *et al.* (1999), Ibañez-Aguirre and Gutierrez-Benitez (2004) have analyzed the age and growth, reproduction and mortality of this species in the north of Veracruz. Additionally morphometric analysis between populations of *M. curema* and *M. cephalus* in the Tamiahua lagoon has been studied (Perez and Ibañez-Aguirre, 1992; Ibañez-Aguirre and Lleonart, 1996). Also the abundance and biomass as temporal elements in the lagoon of Tamiahua, Franco-Lopez and Chavez-Lopez (1992) and a biological and fisheries evaluation in the coasts of Michoacan, Mexico Melendez-Galicia and Romero-Acosta (2010), were performed.

For *M. cephalus* there are several studies about the reproduction in some areas of North and South Carolina, Georgia, Florida and Louisiana (Collins and Stender, 1989; Render *et al.*, 1995), also, studies about the growth and recruitment in estuarine systems in South Carolina, McDonough and Wenner (2003) and the spawning and recruitment of this species in the north of Veracruz, (Ibañez-Aguirre and Gallardo-Cabello, 2004; Ibañez-Aguirre and Gutierrez-Benitez, 2004) have been done. Some author's mention that the migratory and reproductive patterns of this species are from coastal lagoons to the ocean (De Silva, 1980; Torricelli *et al.*, 1982), in which the fishing activity intensifies to take advantage of the species movements and to commercialize the gonads, however, Chang *et al.* (2004) mentioned that in Taiwan, the migratory movements differ from those reported. Additionally, in the center and south of the Gulf of Mexico, these aspects, have not been studied, thus it is necessary to study the biology and ecology of these species.

The present study was conducted to analyze the seasonal behavior of *M. curema* and *M. cephalus* in terms of seasonal variation (Dry, Rainy and Windy) of abundance, growth rate, gonad maturity, length-weight relationship, condition factor and feeding behavior in the lagoon of Alvarado, Veracruz, during the period from February 2010 to September 2012.

MATERIALS AND METHODS

Sampling: *Mugil curema* and *M. cephalus* were sampled from 15 stations throughout the lagoon (Fig. 1). The fishes were collected with a beach seine of 50 m large and 2.5 m width and a mesh aperture of 2.5 cm, the catching area corresponds in all cases to 1500 m^2 towed for each station. The organisms were fixed with formaldehyde at 10% injected in the abdominal cavity to stop the digestive processes. In the laboratory, the species were determined using the taxonomic clues (Fischer, 1978; Hoese and Moore, 1998; Castro-Aguirre *et al*., 1999; Carpenter, 2002a, b).

Each specimen was measured with a conventional ictiometer of 50 cm (+/-0.05) and weighted using a digital scale of 2.6 kg of capacity (+/-0.05). The abundance and biomass were determined for each species and season, covering the main weather seasons that are present in the zone (dry, rainy and windy).

Sex ratio and weight-length relationship: The sex ratio was calculated for each species and season via females/males relation. The gonadic stages were determined following the criteria of Nikolsky (1963) maturation scale that takes into account six stages, from immature organisms to spawned organisms and the external morphology of the gonad.

The weight-length relationship was calculated for each species and based in the records of size and weight for the seasons in which were registered in the lagoon of Alvarado. The Le Cren (1951)

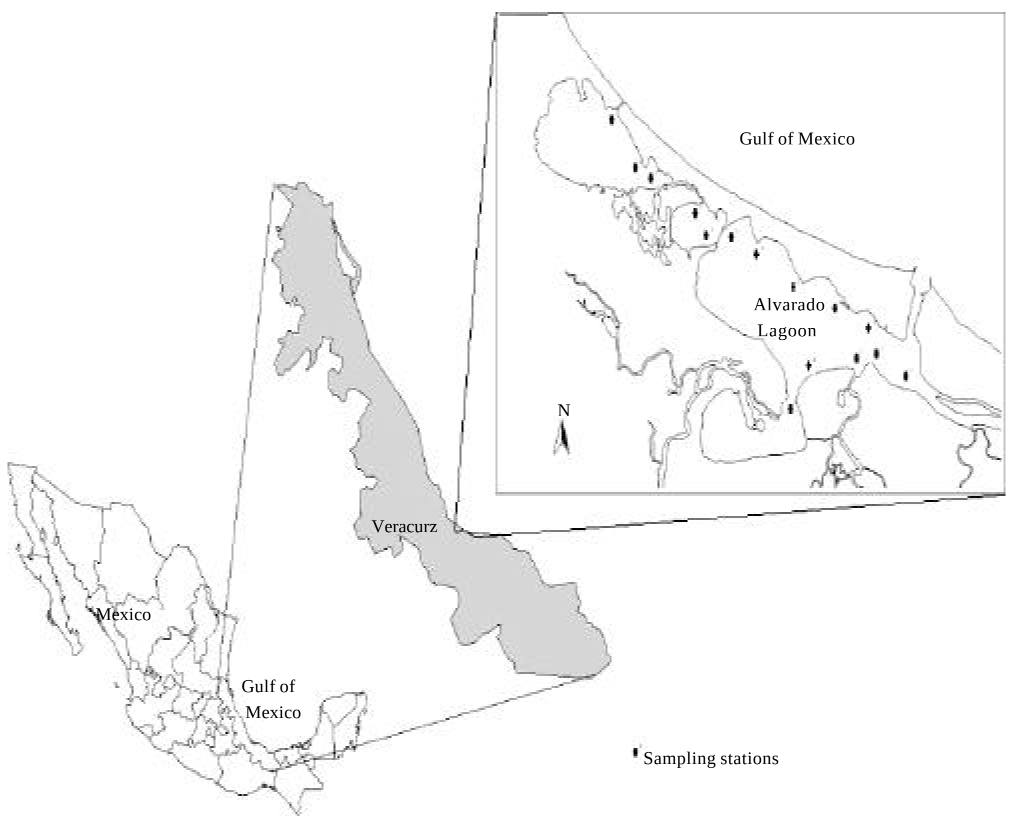

Fig. 1: Study area showing the position of the Alvarado lagoon system in reference to Mexico and the poisition of the fifteen sampling stations

equation was used because it allows adjusting the values through a potential relation of the weight in relation to length of individuals from the equation:

$$W = aL^b$$

Where:
W = Weight (g)
L = Length (cm)
a = y-intercept
b = Slope (allometric factor)

The type of growth was determined with the Student's t-test considering the slope value of the weight-length relationship (b), as the allometric coefficient and determine through the hypothesis $b = 3$, $p<0.05$ if it corresponds to isometric growth in accordance to the equation:

$$t = \frac{(b-3)}{S_b}$$

Where:
t = Student t value calculated
b = Slope of the weight-length relationship
S_b = Standard error of the slope

Fulton's condition factor and diet analysis: The Fulton's condition factor was calculated for each species and season with the data obtained in the weight-length relationship, according this equation:

$$K = \frac{W}{L^b} \times 100$$

Where:
K = Condition factor
W = Average weight (g)
L = Average length (cm)
b = Slope from the weight-length relationship

In fish, the analysis of the condition factor K of Fulton allows comparisons between groups of fish, the higher the value of K, this condition indicates a better group of fish (Ricker, 1975). Some authors consider that the condition factor to estimate temporal variations of the state or condition of the fish, where the condition of the fish is a reflection of their physiological state which results from the biological activities of the species as breeding, feeding, accumulating energy and others that reflect ecological conditions. It is recognized that variations in the values of K factor may relate to the states of gonad maturation or food availability (Wootton, 1999).

The diet analysis was realized by the extraction of the digestive tract, the content was squeezed out and laid on a petri dish and then the alimentary types were registered by type and number and by the percentage method (Bagenal, 1978). The obtained results were processed by the Relative Importance Index (RII) and adjusting the estimation to 100% for each species.

RESULTS

A total of 301 organisms were captured, 221 belong to *Mugil curema* and 80 to *Mugil cephalus*, the records for each season showed that *M. curema* is present throughout the year being more abundant in the rainy and windy seasons, while the records for *M. cephalus* shows that this species is present in the rainy and windy seasons and no records were taken for the dry season.

The size and weight range registered for both species in the lagoon for all the seasons are shown in Tables 1 and 2.

The average values of standard length and weight for both species in all the seasons, shows that the greatest values are registered in the rainy and windy seasons (Fig. 2 and 3).

The sex ratio was determined using the capture percentage obtained for each season, thus the sex of 121 organisms were determined for *M. curema*, of which 30 corresponds to the dry season, 29 to the rainy season and 62 to the windy season for the period of 2010 to 2012. For *M. cephalus* the sex of 48 organisms were determined, as in the other species, in this way, 24 individuals were tested in the rainy season and 24 for the windy season.

In base to the obtained data, *M. curema* exhibited a female-male rate of 1.94:1 in dry season, 1.12:1 in rainy season and 1.24:1 in windy season. For *M. cephalus* the rate was 1.06:1 in rainy season and 1.41:1 in windy season.

The gonadic growth stages that prevailed for *M. curema* were: in the dry season, stages II, III and IV; for the rainy season III, IV and V, finally for the windy season, stages IV, V and VI

Table 1: Range of sizes and weights of *Mugil curema* registered in Alvarado lagoon in the period 2010-2012

Season	n	Length range (cm)	Weight range (g)	Length average (cm)	Weight average (g)
Dry-2010	16	3.1-17.6	0.7-94.5	10.3	47.6
Rainy-2010	20	7.7-21.3	8.2-175.6	14.5	91.9
Windy-2010	46	8.3-26	12.5-356.7	17.2	184.6
Dry-2011	22	3.4-19.4	0.9-114	11.4	61.5
Rainy-2011	19	8.2-21.8	11.0-168	15.0	89.5
Windy-2011	69	8.5-26.8	13.9-396.5	17.7	267.7
Dry-2012	14	3.1-20.1	0.6-131.2	11.6	65.9
Rainy-2012	15	8.6-22	13.0-192.1	15.5	102.5

Table 2: Range of sizes and weights of *Mugil cephalus* registered in Alvarado lagoon in the period 2010-2012

Season	n	Length range (cm)	Weight range (g)	Length average (cm)	Weight average (g)
Rainy-2010	9	11.2-19.8	17.4-85.2	15.5	51.3
Windy-2010	21	21.3-26.9	115.6-223.6	24.1	169.6
Dry-2011					
Rainy-2011	12	11.3-20.0	20.8-89.6	16.0	55.2
Windy-2011	24	22.0-27.9	126.5-238.9	25.0	182.7
Rainy-2012	14	12.3-20.3	21.9-94.6	16.3	58.3

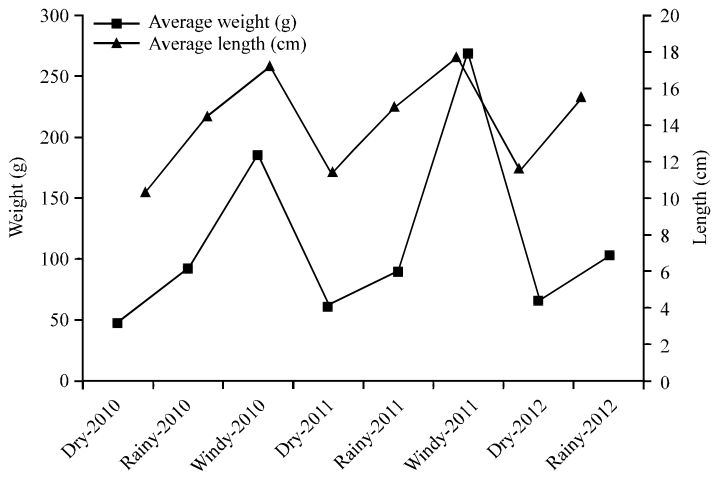

Fig. 2: Seasonal behavior of average length and weight of *Mugil curema*, Alvarado, Veracruz during 2010-2012

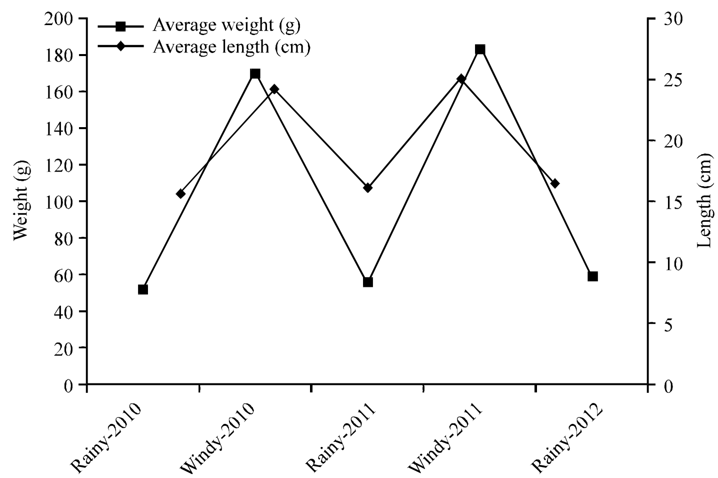

Fig. 3: Average length and weight of *M. cephalus* during dry and windy seasons of 2010-2012

prevailed. For *M. cephalus*, in the rainy season, stages II, III, IV and V were the most abundant while for the windy season were stages IV, V and VI (Table 3 and 4).

The weight -length relationship calculated for both species, for each season and in the overall study are shown in Table 3, the values of the allometric coefficient for both species is higher in the windy season; however the values are higher in *M. cephalus* (Fig. 4 and 5).

The Fulton condition factor showed that the highest values for *M. curema* were recorded in the windy season with a value of 2.808, for *M. cephalus* the value was of 2.212 in the windy season (Table 5).

The results of the students t-test for all the seasons and in the global estimation for *M. curema* and *M. cephalus* indicate an allometric growth ($p>0.05$) (Table 3).

According to the Relative Important Index (RII), the diet of *Mugil cephalus* was composed principally of detritus, with smaller amounts of filamentous and diatom algae. The RII index

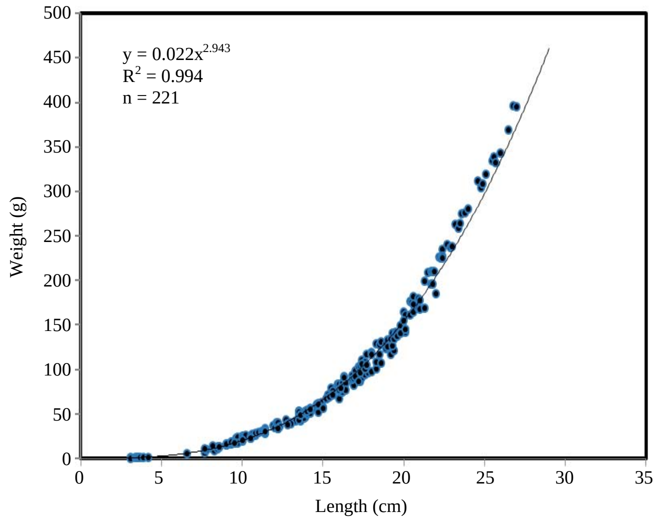

Fig. 4: Weight-length relationship of *Mugil curema*, Alvarado lagoon and Veracruz during 2010-2012

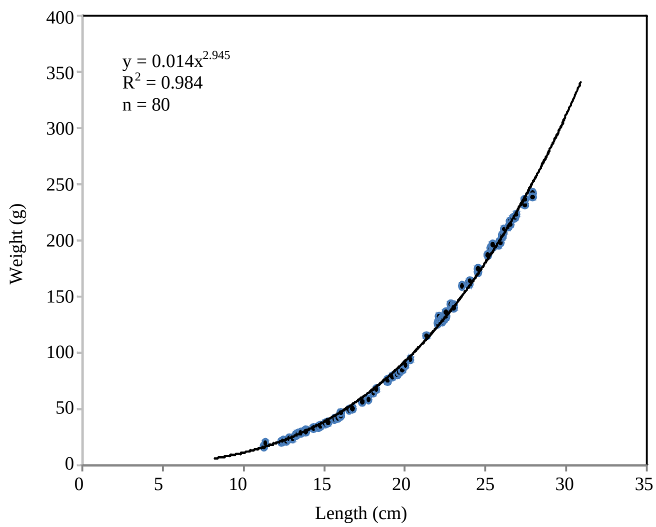

Fig. 5: Weight-length relationship of *Mugil cephalus*, Alvarado lagoon and Veracruz during 2010-2012

Table 3: Proportion of gonad maturation stages of *Mugil curema* by sex and climatic season in the lagoon of Alvarado, Veracruz. 2010-2012

Month/sex	n	I	II	III	IV	V	VI	(%)
Windy								
October	15							
Males	6	-	4.76	26.19	38.09	30.96	-	100
Females	9	-	5.17	25.87	37.93	31.03	-	100
December	25							

Table 3: Continue

Month/sex	n	I	II	III	IV	V	VI	(%)
Males	11	-	-	14.28	42.86	38.78	4.08	100
Females	14	-	-	11.76	39.22	45.09	3.93	100
January	46							
Males	22	-	-	4.16	37.5	41.67	16.67	100
Females	24	-	-	5.77	34.62	40.38	19.23	100
February	29							
Males	13	2.17	-	2.17	21.74	47.83	26.09	100
Females	16	1.85	1.85	3.7	20.38	44.44	27.78	100
Dry								
March	13							
Males	6	4.25	6.38	31.91	36.17	12.78	8.51	100
Females	7	3.77	5.66	32.07	45.28	7.56	5.66	100
April	19							
Males	8	-	14.63	39.02	34.15	9.76	2.44	100
Females	11	-	16.95	32.2	40.68	8.47	1.7	100
May	20							
Males	9	-	26.09	26.09	34.78	13.04	-	100
Females	11	-	33.33	25.93	24.07	16.67	-	100
Rainy								
June	16							
Males	7	-	28.26	30.43	26.09	15.22	-	100
Females	9	-	24.53	33.96	24.53	16.98	-	100
July	14							
Males	6	-	12.77	34.04	40.42	12.77	-	100
Females	8	-	9.43	37.74	39.62	13.21	-	100
August	10							
Males	6	-	7.41	44.44	35.19	12.96	-	100
Females	4	-	4.35	50	34.78	10.87	-	100
September	14							
Males	7	-	-	34	42	24	-	100
Females	7	-	-	32	48	20	-	100

Table 4: Proportion of gonad maturation stages of *Mugil cephalus* by sex and climatic season in the lagoon of Alvarado, Veracruz. 2010-2012

Month/sex	n	I	II	III	IV	V	VI	(%)
Windy								
October	8							
Males	3	-	-	14.29	28.57	47.62	9.52	100
Females	5	-	-	15.52	29.31	44.83	10.34	100
December	11							
Males	5	11.63	-	11.63	27.91	30.23	18.60	100
Females	6	7.02	-	15.79	24.56	35.09	17.54	100
January	10							
Males	5	-	-	4.88	9.76	36.58	48.78	100
Females	5	-	-	5.08	20.34	30.51	44.07	100
February	16							
Males	6	-	-	-	37.50	50	12.50	100
Females	10	-	-	-	31.67	56.67	11.66	100

Table 4: Continue

Month/sex	n	I	II	III	IV	V	VI	(%)
Dry								
March	-							
Males	-	-	-	-	-	-	-	-
Females	-	-	-	-	-	-	-	-
April	-							
Males	-	-	-	-	-	-	-	-
Females	-	-	-	-	-	-	-	-
May	-							
Males	-	-	-	-	-	-	-	-
Females	-	-	-	-	-	-	-	-
Rainy								
June								
Males	-	-	-	-	-	-	-	-
Females	-	-	-	-	-	-	-	-
July	9							
Males	5	-	48.07	36.54	15.39	-	-	100
Females	4	-	62.5	31.25	6.25	-	-	100
August	11							
Males	5	-	17.78	60	22.22	-	-	100
Females	6	-	14.54	63.64	21.82	-	-	100
September	15							
Males	7	-	-	27.08	41.67	31.25	-	100
Females	8	-	-	34.61	28.85	36.54	-	100

Table 5: Weight-length relationship, condition factor (k) by species and the Student 't' test value per season

Seasons	b	a	R^2	k	t_{calc}	n
Mugil curema						
Dry	2.867	0.024	0.986	2.31	-5.323*	52
Rainy	2.873	0.026	0.989	2.666	-6.351*	54
Windy	2.890	0.027	0.993	2.808	-5.000*	115
Global	2.943	0.022	0.994	2.618	-3.825*	221
Mugil cephalus						
Rainy	2.838	0.016	0.976	2.087	-4.153*	35
Windy	3.104	0.010	0.980	2.212	-2.653*	45
Global	2.945	0.014	0.984	2.149	-3.057*	80

*Significant difference

showed values of 65.36 for the detritus, 30.32 for algae and 4.32 for calanoid copepods in the rainy season while for the windy season the diet was composed for 56.14 of detritus, 31.35 of algae, 10.22 of harpacticoids copepods and 2.29 of foraminifera.

According to the RII, the gut content of *M. curema* showed 38.12 of algae, 60.31 of detritus and 1.57 of foraminifera in the dry season. The consumption in the rainy season was 29 of algae, 68.54 of detritus and 1.76 of foraminifera. Finally for the windy season the diet was composed of 49.42 of algae, 49.32 of detritus and 1.26 of ostracods.

DISCUSSION

Many authors recognized that both species of mugilids are catadromous in various localities of the world and in the Gulf of Mexico (Rivas, 1980; De Silva, 1980; Ibañez-Aguirre and

Gallardo-Cabello, 2004), its juvenile phases enter the estuaries to feed and grown, returning to the sea to reproduce (De Silva, 1980; Torricelli *et al*., 1982; Ibañez-Aguirre and Gallardo-Cabello, 2004; Render *et al*., 1995). The abundance data of both species in the Alvarado lagoon, showed a similar pattern because the higher abundance for both species was registered in the windy season.

This pattern of behavior has been observed for both species and is related to the reproductive behavior, where *M. cephalus* spawn in the last months of the year, in localities of the North and center of the Gulf of Mexico (Ibañez-Aguirre and Gallardo-Cabello, 2004; Ibañez-Aguirre and Gutierrez-Benitez, 2004; Render *et al*., 1995), in our study the organisms captured presented a maximum size of 27 cm and weight of 238 g, with high maturation stages in the windy season however, they do not reach the commercial size of capture that establish the NOM-016-PESC (1994) (DOF 24/04/95). According to those reported by Funicelli *et al*. (1989) and Mahmoudi (1991), this species do not realize wide migrations as they stay in a relative small areas where they grow and maturate to return to the coasts after the spawning. However, Wallace and van der Elst (1975) and Lawson and Jimoh (2010) marked that this species shows a constant recruitment during various months in estuaries and it is linked to numerous spawning of *M. cephalus* that also realize during a large period of time, Wallace (1975) although there is evidence that the recruitment of the juvenile phases of this species is realized in estuarine zones every year during short periods of time as mentioned by Young *et al*. (1997).

These aspects are important to explain the dynamics of the populations of this species in the Alvarado lagoon system and the adjacent marine system, due to the fact that the data of the populations are scarce for this region of the state, *Mugil cephalus* do not represent an important fishery resource or for its exploitation in the interior of the lagoon, its populations records have decreased considerably and its catch is minimum.

On the other hand, *Mugil curema* is reported as a species typically of America, with a wide distribution from Cape Cod in the US to Brazil. In the Alvarado lagoon, it was present in different seasons but its abundance was higher in the windy season. The maximum size was 26 cm of standard length, Radasewsky (1976) mentioned that this species reach its size of maturation between length of 28 and 30 cm thus, allowing us to place this individuals in the lagoon as juveniles. Nevertheless, it is contrasting with the minimum size of capture of this species in the lagoon as juveniles due to the NOM-016-PESC (1994) which determines that is of 26 cm and could vary depending of the environmental conditions in which they are developing.

Considering that the production of both species in the center of Veracruz, where the Alvarado lagoon is located, is of 3,425 tons, more than 95% of the captures corresponds to *M. curema*, this is important because if the captures increase, it could affect other populations in the ecological systems where they interact.

The gonadic development of *M. cephalus* show the highest stages in the windy season, this coincide with the results of Ibañez-Aguirre and Gallardo-Cabello (2004) and Ibañez-Aguirre and Gutierrez-Benitez (2004), who mentioned that this species have a reproductive season between November and February. *M. curema* registered the highest stages in the windy and dry season. Anderson (1957), Arnold and Thompson (1958), Moore (1974), Finucane *et al*. (1978) and Render *et al*. (1995) reported that *M. curema* spawn in the Gulf of Mexico in the months of February and May with more activity in April, in our case the highest stages were recorded in December and April with a maximum of gonad maturation in March, this suggest that its reproduction in this zone corresponds to this season. A similar aspect was reported by

Loran-Nuñez *et al.* (2008), in the Sontecomapan lagoon (a locality southerly of Alvarado) and if we compare with that reported by Ibañez-Aguirre and Gallardo-Cabello (1996a) in the Tamihaua lagoon for this species, where the reproductive period is from December to May.

The sex ratio of both species are favorable for females in all the seasons, McDonough *et al.* (2005) and Ibañez-Aguirre and Gallardo-Cabello (2004) reported a sex ratio of 1:1 or greater for *Mugil cephalus* in organisms larger than 235 mm, the organisms captured in this study are under pre-adult stage and as mentioned by Whitfield *et al.* (2012), the sex ratio for the species living in estuaries could be favorable for either sex and when they reach greater sizes, the sex ratio reaches 1:1. For *M. curema* the ratio was favorable for females in all the seasons and unlike *Mugil cephalus* the data for *M. curema* tend to favor females as reported by Ibañez-Aguirre and Gallardo-Cabello (2004), for the Tamiahua lagoon.

The estimation of the weight-length relationship, oscillate between 2.838 and 3.104 for the allometric coefficient (b), with values of the coefficient (a) of 0.016 and 0.01 in the rainy and windy seasons respectively, considering the size range recorded, the reports that evaluate this parameters in localities of the Gulf of Mexico are scarce, only the study of Ibañez *et al.* (1999), whose parameters reported for this species are 2.750 for (b) and 0.0213 for (a), however when we compared with those recorded in other localities of Mexico the results are similar to the ones recorded, as reported by Leal *et al.* (2008) for a coastal lagoon in Yucatan who reported values of 2.934 for (b) and 0.000015 for (a), also there is a study in the Mexican Pacific by Ramos-Santiago *et al.* (2010) who reported report a value of 2.88 for (b) and 0.0139 for (a) in some coastal lagoons of Oaxaca and Chiapas. As reported by several authors, we found that the values of the allometric coefficient (b) in most of the studies show a trend to the negative allometry for this species (Table 3).

Reports on preadult size of *Mugil curema* in coastal areas and in particular the parameters of the weight-length relationship in some localities of the Gulf of Mexico are scarce, particularly for pre-adult sizes, except as reported by Ibañez-Aguirre *et al.* (1999), where the estimated values for the weight-length relationship in different seasons ranged between 2.86 and 2.89 for (b) and 0.024-0.027 for (a), comparing these values with those reported in other parts of Mexico, we found values in the Lagoon of Cuyutlan, Colima of 2.947 for (b) and 0.0000156 for (a), 3.090 for (b) and 0.015 (a) in Baja California Sur, 2.972 and 2.859 for (b) and 0.00015 and 0.00034 for (a) in the southeast of Florida and Tampa Bay in the United States.

This behavior is related with other population parameters of both species such as maturation and feeding processes through the condition factor, this parameter refers to the body conditions of the organisms that is closely related with the gonad maturation and the alimentary processes, thereon for *Mugil cephalus* were recorded values of the condition factor of 2.087 and of 2.212 in the rainy and windy seasons, respectively while for *Mugil curema* the values were of 2.31 to 2.808 for dry and windy seasons. De Silva (1980) mentioned that in juvenile stages of *Mugil curema*, this values vary from 1.2 to 2.2 and then stabilized when they reach the sexual maturity to 2, so that the index variations are related with variations on the feeding, as mentioned by De Silva and Silva (1979).

The records of feeding of *Mugil cephalus* include detritus, algae and copepods in the rainy and windy seasons as well as a small proportion of foraminifera in this last season, in this regard, Blaber and Whitfield (1977), De Silva and Wijeyaratne (1977) and Sanchez-Rueda *et al.* (1997) reported that this species once they leave the larval stage and become juveniles, feed on benthic organisms increasing the detritus consumption as they increase in age. Also Eggold and Motta (1992) mentioned that feeding on copepods plays an important role in juveniles organisms whereas, this can lead them to strong competitive interactions with other species in the early stages of development.

Regarding the importance of algae in the diet of this species, Jana *et al.* (2004) indicated that their nutritional value is generally higher than that of the detritus, this leads to a higher consumption of benthic algae as a food source, as mentioned by De Silva and Wijeyaratne (1977) and Sanchez (2002).

Meanwhile, *Mugil curema* also bases its feeding in detritus, algae, foraminifera and ostracods, the latter occurs only in rainy and windy seasons. In particular, its feeding do not represents significant variations between locations, as pointed by Randall (1967), Yañez-Arancibia (1976) and Bedia-Sánchez and Franco-López (2008), this species feeds on small filamentous algae, planktonic and benthic organisms as well as other organic matter ingested from sand and the particulate organic matter.

CONCLUSION

M. cephalus and *M. curema* are species that have acquired a global interest due to their economic importance and as potential elements for aquaculture, though the records of both species in the central part of Veracruz have declined substantially. Also, the studies that comprise the evaluation of their biological aspects in the coasts of the Gulf of Mexico are important to assess the condition that keep currently the local populations of these and other species that are sustenance for human communities.

The evaluated parameters show that both species present a similar behavior evaluated in other coastal localities of the Gulf, the Caribbean and the Pacific of Mexico. Derived of the records of abundance obtained in the present study showed that it is necessary to highlight that the catches of *M. cephalus* have declined considerably in this area making it necessary to define the fishery exploitation to allow populations of both species to recover their levels of abundance.

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