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Growth of *Dormitator latifrons* cultured in fresh, brackish (15 ‰ – 17 ‰) and marine water, under laboratory conditions

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***Abstract**: The present work of research was made with the objective to determine the effect of the salinity of water on the growth of Dormitator latifrons cultured in laboratory conditions during four months. It developed the Experimental Design of Growing Stimulus with two treatments and a witness, with three repetitions each one: fresh water (witness); aquariums 1a, 1b and 1c; brackish water (15 $^{o}/_{oo}$ – 17 $^{o}/_{oo}$); aquariums 2a, 2b, and 2c and marine water; aquariums 3a, 3b and 3c; for it was disposed of nine aquariums of 0-75 x 0-30 x 0-40 m with a volume of water of 50 liters, placed ten fish in each one. The biometric control of the growth was made monthly and taking samples of the total population of each aquarium and the statistics differences between treatments were made for the analysis of variance to an inserted mixed design and the test of Duncan. Also, were made records of some physics – chemistry parameters. The growth of D. latifrons was affected by the salinity of water being better in the brackish water: 135.23 mm and 42.03 g. In this treatment got the best rate of nourishment transformation: 3.05. The physics – chemistry characteristics of the water were similar in all treatments and were inside of rank of good growth for this species.*

***Key words:** Aquaculture, Dormitator latifrons, Salinity of water.*

Introduction

D. latifrons ”pococheˮ is a native species inhabiting the fresh and mixohaline waters of our department that, according to the studies of its bioecology and the farming experiences carried out, constitutes a fishing resource with enormous potential to develop its fish farming; since it is a fish that is very resistant to adverse conditions, it accepts the artificial food that is provided and shows good growth, to which is added the quality of its meat, which is white, without intramuscular spines, with a very good flavor and texture. In addition, this resource is an export product to the United States and Canada from the neighboring country of Ecuador, with an unsatisfied demand from Asian and European countries.

Its cultivation has been experimented with variable results in various countries such as Ecuador: General Directorate of Fisheries and Fisheries Development (1980), reports forms of extensive cultivation of *D. latifrons* for two to four months in lagoons, not indicating sowing or harvest sizes. In this same line of work, Loor (2000) points out that in eight months of culture of *D. latifrons* in artificial pools, without complementary feeding to the natural one, it obtained sizes of 18 to 20 cm and an approximate average weight of 600 g , starting from fry of 5 – 8 cm. On the other hand, Ecocostas (2006 a), in a culture of *D. latifrons* in Manabí, for nine months, obtained fish of 19.9 cm and 127.76 g, starting from 22.35 g at a density of 5 fish/m^2 and supplementing it with a diet of 11.88% protein (4.5 months) and 12.94% protein (4.5 months). In the same way, Ecocostas (2006 b) in culture of this species in the farm La Siberia, for one year obtained fish with an average weight of 150 grams, starting from 28 g. at a density of 1.3 fish/m^2 with balanced feed. In Peru: López and Lora (1994), established that this species grows better at a density of 2 fish/m^2: 105.93 g, supplementing it with chicken manure for nine months. Likewise, Torres (2000) determined that *D. latifrons* presented better growth when the balanced food (40%, 30% and 20% protein) was administered at two frequencies, for seven months: 348.88 g. While López and Lora (2003), experimenting diets of 15%, 20% and 25% protein, found that it grows better with the 25% protein diet: 164.70 g. And in Mexico: Larumbe (2002), obtained 258 mm and 447.1 g, during 11 months of culture at a density of 1.15 fish/m^2 and feeding it with a diet of 35 ‰ protein. While Castro et al. (2005), in culture separated by sexes and combined, established that males have greater growth: 144.80 g, during 100 days of culture at a density of 1.2 fish/m^2 and a diet of 30% protein. Experiences that have the common characteristic of having been carried out in fresh water, a resource whose scarcity is becoming more and more acute and for which serious conflicts of competition for use between human, agricultural and livestock consumption are generated, to which would be added the development of *D. latifrons* fish farming. Hence the

need to investigate its culture in brackish and marine water, whose availability has no limits, even more so if it is known that each species has an optimum culture salinity that allows its best growth.

These conditions motivated the execution of this research work entitled "Growth of *Dormitator latifrons* cultivated in fresh, brackish (15 ‰ - 17 ‰) and marine water, under laboratory conditions", in which the effect of the salinity of the soil has been determined. water on the growth of this species; posing the problem: ¿How does the salinity of the water affect the growth of *D. latifrons* cultivated in laboratory conditions? Formulating the hypothesis: If the increase in salinity exerts a positive effect on the growth of euryhaline fish, then the growth of *D. latifrons* will be higher as the salinity of the water increases; and applying the Experimental Design of Increasing Stimulus.

Methods

The specimens of *D. latifrons*, used in the present study, were obtained through experimental captures carried out in the lower part of the Reque River, at the height of Ciudad Eten: 6º 54' 37.26" L.S and 79º 53' 01.80" L.W (District of Eten, Chiclayo Province, Lambayeque Department), using an anchovy cloth squeegee of 5-meter-long and 2-meter-high, with the support of local fishermen. The captured specimens were placed in plastic buckets with 20 liters of water, and then transferred to the Fisheries Biology Laboratory of the Pedro Ruiz Gallo-Lambayeque National University, where they were distributed in plastic tubs with water and equipped with aerators.

Subsequently, three groups of 30 specimens each, of the size class 90 - 112 mm, were selected, which were measured and weighed in their entirety and then placed, separately, in three aquariums of 0.75 x 0.30 x 0.40 m. with 50 liters of water and provided with their respective aerators (Figure 1).

From each group of 30 specimens, three subgroups of 10 specimens each were randomly separated, which were placed in 9 aquariums measuring 0.75 x 0.30 x 0.40 m., filled with water to a height of 0.24 m. and conditioned with SOBO Aquarium Internal liquid filter WP-177F pumps. Previously, the acclimation of the fish was carried out, by subgroups of 10 specimens, to seawater and brackish water.

The acclimation process, in subgroups of 10 fish, of *D. latifrons* to seawater, was carried out gradually with salinity increases of 5 $^{0}/_{00}$ for six days; At the same time, the last three days the fish were acclimated to brackish water (15$^{0}/_{00}$). During this process, the first day salinity increases were made every four hours: three salinity runs from 5$^{0}/_{00}$ to 15 $^{0}/_{00}$ for the first subgroup of fish, two for the second from 5 $^{0}/_{00}$ to 10 $^{0}/_{00}$ and one for the third (5 $^{0}/_{00}$); on the second day, two salinity runs were made every seven hours for the three subgroups and, from then on, the salinity increases were made every 24 hours, until the acclimatization process was completed at 35 $^{0}/_{00}$. The acclimation of the fish to seawater was carried out in 0.56 m plastic tubs. in diameter and 0.25 m. high (Figure 2); while the acclimation to brackish water was done in aquariums of 0.40 x 0.25 x 0.30 m (Figure 3); using, in both cases, a volume of water of 12 liters.

Figure 1

Location of the groups of 30 specimens of D. latifrons, in aquariums of 0.75 x 0.30 x 0.40 m. and treatment assignment

Figure 2

Acclimatization of D. latifrons in plastic tubs, to salinity 35 ‰

Figure 3

Acclimatization of D. latifrons in aquariums of 0.40 x 0.25 x 0.30 m., at a salinity of 15 ‰

The preparation of the water at various salinities, during the acclimatization process, was done by diluting common salt and once the process was completed, seawater obtained in front of Caleta San José was used.

The fish culture process covered the months of november 2009 to march 2010 and to test the hypothesis, the Experimental Design of Growing Stimulus was developed with two treatments and a control, with three repetitions each: Freshwater: Aquariums 1a, 1b and 1c (Control), Brackish Water (15 ‰ – 17 ‰): Aquariums 2a, 2b and 2c and marine water: Aquariums 3a, 3b and 3c (Table 1) (Figure 4).

Table 1

Experimental design, denomination of the aquariums, total population and average stocking lengths and weights of D. latifrons, cultured in the Fisheries Biology Laboratory

Aquariums	Treatments	Total population	Length (mm)	Weight (g)
a	Sweet water (T)	10	103.83	15.56
1 b	Sweet water (T)	10	103.83	15.56
c	Sweet water (T)	10	103.83	15.56
a	Brackish water	10	103.43	14.74
2 b	Brackish water	10	103.43	14.74
c	Brackish water	10	103.43	14.74
a	Marine water	10	102.57	14.37
3 b	Marine water	10	102.57	14.37

c	Marine water	10	102.57	14.37

Note. T: Witness

Figure 4

Arrangement of the aquariums for the cultivation process of D. latifrons, according to the Experimental Design of Growing Stimulus

The fish were fed with a diet of 40 % protein during the first two months and 30 % protein, the third and fourth month; being the food index of 5 % of the biomass, the first month, 4 % the second and 3 % the last two months. The delivery of the food was made in double schedule: 08:00 and 13:00 h, in the form of 2 mm pellets. in diameter and 3 – 5 mm long during the first month and 3 mm in diameter and 3 mm long, the following months (Figure 5, a and b). The composition of the diets was as follows:

Supplies	(40 % Protein) Percentage	(30% Protein) Percentage
Ground corn	10.00	31.10
Wheat bran	6.50	10.00
Rice powder	8.50	11.50
Fish flour	48.50	28.90
Soybean cake	26.00	18.00
Suplamín	0.10	0.10
Salt	0.40	0.40

Figure 5

Feeding process: (a) Delivery of pelleted feed and (b) D. latifrons feeding

The monthly biometric control of the growth of the fish was carried out by sampling the entire population of each aquarium, for which a hand tracing was used (Figure 6). Total length was determined with an ichthyometer graduated in mm. and total weight with digital scale of 0.1 g sensitivity (Figure 7, a and b).

Figure 6

Sampling of D. latifrons with calcal

Figure 7

Biometric Control: (a) Length registration with ichthyometer and (b) Weight with digital scale

The temperature of the water in the aquariums and the environment was recorded daily with a TAYLOR digital thermometer (-40 ºC – 230 ºC), at 08:00 and 13:00 h (Figure 8).

Figure 8

Water temperature recording with digital thermometer

The pH of the water was determined weekly with a PEN TYPE PH METER Digital Potentiometer (0 – 14) (Figure 9). Likewise, dissolved oxygen and carbon dioxide in the water were recorded weekly following the methodology proposed by Boyd (2000). The salinity of the water was also measured with a Digital Conductivity Meter.

Figure 9

Water pH recording with digital potentiometer

In order to eliminate the residues from the bottom, the bottom of the aquariums was siphoned every other day, renewing 10% - 20% of the water. The cleaning of the pumps was done in the same interval of time

After the culture process, to determine the effect of water salinity on fish growth, the analysis of variance was applied for a mixed embedded design (Ostle, 1994), with the model being:

$$\mathbf{Y_{ijk} = U + Ai_{+} Bj + Eijk}$$

Where:
Y_{ijk} : Any measurement
U : True average length or weight
A_i : Effect of water salinity level on growth
B_j : Effect of replicates within water salinities on growth
E_{ijk} : Experimental bug

Then the average, in length and weight, of each treatment was estimated and the analysis of variance was applied for a factorial model of two fixed factors (Ostle, 1994):

$$\mathbf{Y_{ijk} = U + A_{i+} Bj + (AB)_{ij} + Eijk}$$

Donde:
Y_{ijk} : Any measurement
U : True average length or weight
A_i : Effect of water salinity level on growth
B_j : Effect of the time factor on growth
$(AB)_{ij}$: Effect of the interaction of the two factors on growth
E_{ijk} : Experimental bug

The following hypotheses were raised:
Ho: The salinity factor of the water, time and their interaction do not affect the growth of the fish
Ha: The salinity factor of the water, the time and their interaction do affect the growth of the fish
Decisions were made based on the following:
Accept Ho if F calculated is less than or equal to F tabulated
Accept Ha if F calculated is greater than F tabulated

Using Duncan's test (Ostle, 1994), was evidenced in favor of which treatment presented significant differences in growth.

The weight-length equations were calculated for each treatment and then compared through the analysis of covariance (Zar, 1996). On the other hand, the t test was applied for the exponent b (Snedecor and Cochram, 1967), in order to establish if it differs statistically from three and typify the type of growth.

To establish if the growth pattern of the fish is affected, in addition to salinity, by the physical-chemical parameters of the water, the BIOENV analysis was carried out (Carbajal, 1998).

The statistical analyzes were processed with a Pentium IV computer, using the programs: Excel, SPSS 9.0 and Primer 5.2.2, with a significance level of 0.05.

Results

Acclimation of *D. latifrons* to seawater and brackish wáter

The acclimatization process of the 30 specimens of *D. latifrons*, in three groups of 10, to the salinity of the water of 35 ‰, lasted six days and was carried out without any problem for the fish that tolerated the salinity changes very well at those who were subjected, not registering any mortality. Likewise, the acclimatization of the 30 specimens to brackish water (15 ‰), was carried out in three days without major setbacks.

Growth of *D. latifrons*

After the culture process, which lasted four months, it was observed that the growth of *D. latifrons* varied from one repetition to another in each treatment, being more uniform in freshwater; however, the greatest lengths and average weights were achieved in the brackish water treatment (Table 2). Graphically (Figure 10), it is evident that the growth of fish grown in brackish water exceeded the other treatments from the third month of culture; characteristic that was also possible to appreciate when comparing the growth in the repetitions with the same alphabetic denomination (Figure 11, A and B).

Table 2

Mean stocking and monthly lengths and weights, in repetitions (a), (b) and (c) of each treatment, of D. latifrons cultivated in the Fisheries Biology Laboratory

	Sweet water (Witness)								
	Aquarium 1a			Aquarium 1b			Aquarium 1c		
Month	n	Lt	Wt	n	Lt	Wt	n	Lt	Wt
Sowing	10	103.83	15.56	10	103.83	15.56	10	103.83	15.56
Month 1	10	107.70	18.01	10	108.60	16.89	10	107.40	15.29
Month 2	10	110.70	20.18	10	115.90	23.05	10	114.10	21.87
Month 3	10	111.50	21.01	10	120.20	27.14	10	118.90	25.75
Month 4	10	118.40	26.23	10	126.80	33.03	10	126.00	30.06

	Brackish water								
	Aquarium 2a			Aquarium 2b			Aquarium 2c		
Sowing	10	103.43	14.74	10	103.43	14.74	10	103.43	14.74
Month 1	10	103.50	12.49	10	106.80	16.15	10	107.70	16.89
Month 2	10	103.70	14.29	10	112.70	22.23	10	116.80	26.02
Month 3	10	109.00	17.45	10	127.10	30.96	10	132.60	39.02
Month 4	10	116.90	22.40	10	140.10	46.81	10	148.70	56.89

	Seawater								
	Aquarium 3a			Aquarium 3b			Aquarium 3c		
Sowing	10	102.57	14.37	10	102.57	14.37	10	102.57	14.37
Month 1	10	106.60	18.22	10	105.60	14.98	10	106.20	15.69
Month 2	10	115.60	24.87	10	107.50	15.96	10	108.80	16.82
Month 3	10	120.00	28.55	10	107.80	16.12	10	112.30	19.21
Month 4	10	128.60	36.55	10	113.30	20.11	10	115.20	21.85

Note. n: Number of fish; Lt: Average total length (mm); Wt: Average total weight (g)

Figure 10

Monthly variations of: (A) Lengths and (B) Mean weights, in repetitions (a), (b) and (c) of each treatment, of D. latifrons cultured in the Fisheries Biology Laboratory

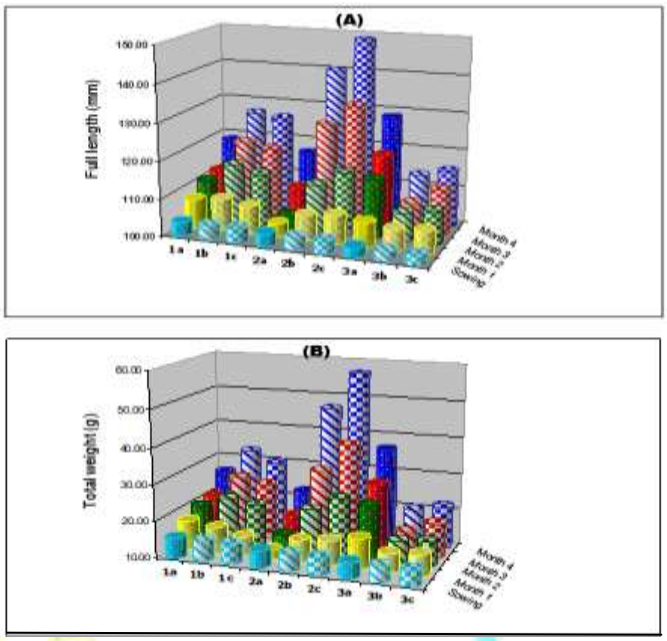
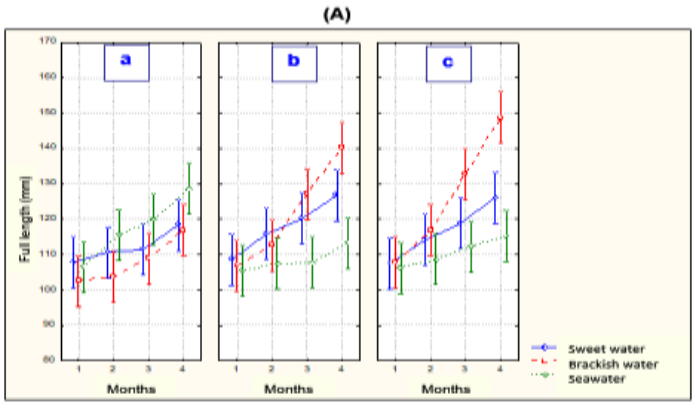
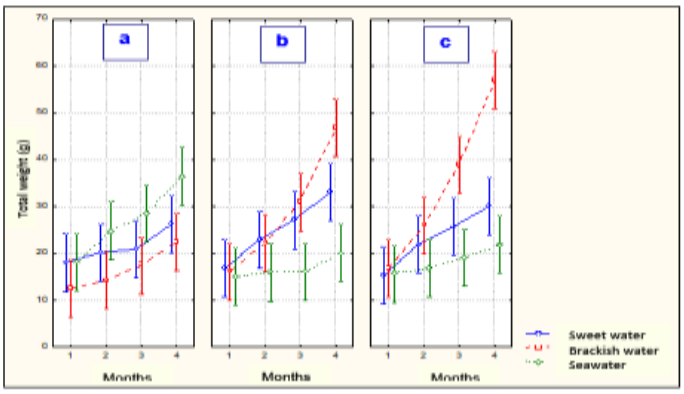


Figure 11

Monthly variations of: (A) Lengths and (B) Mean weights, in the repetitions of the same alphabetic denomination, of D. latifrons cultured in the Laboratory of Fisheries Biology





The analysis of variance (Table 3) determined that the differences observed between lengths and average weights are statistically significant between treatments, but not between repetitions of each treatment.

As there were no significant differences between the repetitions, the joint monthly mean lengths and weights of each treatment were calculated (Table 4), where it can be clearly seen that the brackish water treatment presented the best growth in the final two months of the culture process (Figure 12, A and B). Then the analysis of variance based on time (Table 5) was applied, establishing that growth is affected by treatments, time and the interaction of both factors.

Table 3

Analysis of variance to determine significant differences in growth in length and weight, between treatments and replicates, of D. latifrons cultivated in the Fisheries Biology Laboratory

	Length		Weight	
Source of variation	Fc	Ft	Fc	Ft
Treatments	4.560 *	3.14	7.873 *	3.14
Replays	0.227	2.42	0.132	2.42

Note. Fc: Calculated F value; Ft: F Value from Tables; *: Significant value at the 0.05 level

Table 4

Mean stocking and monthly lengths and weights, in each treatment, of D. latifrons cultivated in the Fisheries Biology Laboratory

Month	Sweet water (T)			Brackish water			Seawater		
	n	Lt	Wt	n	Lt	Wt	n	Lt	Wt
Sowing	30	103.83	15.56	30	103.43	14.74	30	102.57	14.37
Month 1	30	107.90	16.73	30	106.00	15.18	30	106.13	16.30

Month 2	30	113.57	21.70	30	111.07	20.85	30	110.63	19.22
Month 3	30	116.87	24.63	30	122.90	29.14	30	113.37	21.29
Month 4	30	123.73	29.77	30	135.23	42.03	30	119.03	26.17

Figure 12

Monthly variations of: (A) Lengths and (B) Mean weights, in each treatment, of D. latifrons cultivated in the Laboratory of Fisheries Biology

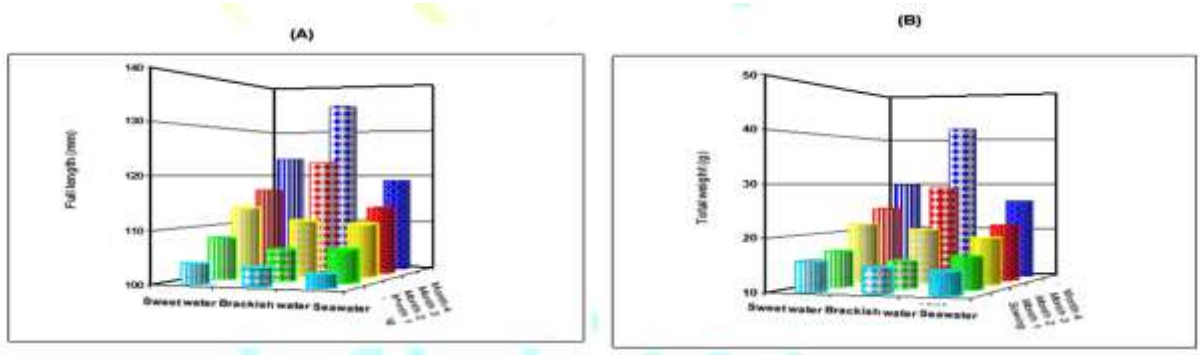


Table 5

Analysis of variance to determine the effect of the treatments, the time and their interaction on the growth, in length and weight, of D. latifrons cultivated in the Laboratory of Fisheries Biology

	Length		Weight	
Source of variation	**Fc**	**Ft**	**Fc**	**Ft**
Treatments	8.73*	3.00	7.59*	3.00
Time	35.29*	2.60	38.41*	2.60
Interaction	3.91*	2.10	3.39*	2.10

Duncan's test (Table 6, A and B) established that the statistical differences in growth in favor of fish grown in brackish water occurred in the final two months of culture; likewise, it was evidenced that there are no significant differences in growth between fish grown in freshwater and seawater.

Table 6

Duncan's test to determine significant differences between the mean lengths (A) y weights(B) of each treatment, of D. latifrons cultivated in the Laboratory of Fisheries Biology

(A)

	Medium lengths			
Month	Sweet water (t)	Brackish water	Difference	A.E.D.
Month 1	107.90	106.00	1.90	7.08
Month 2	113.57	111.07	2.50	7.08
Month 3	116.87	122.90	6.03	7.08
Month 4	123.73	135.23	11.50*	6.73
	Sweet water (t)	Seawater		

Month 1	107.90	106.13	1.77	6.73
Month 2	113.57	110.63	2.94	7.27
Month 3	116.87	113.37	3.50	7.08
Month 4	123.73	119.03	4.70	7.08
	Brackish water	Seawater		
Month 1	106.00	106.13	0.13	6.73
Month 2	111.07	110.63	0.44	6.73
Month 3	122.90	113.37	9.53*	7.46
Month 4	135.23	119.03	16.20*	7.27

(B)

Note. A.E.D.: Duncan Studentized Breadth; *: Significant Value at nivel 0.05.

Duncan's test as a function of time (Table 7, A and B), showed that fish grown in brackish water showed significant growth in the third and fourth month of culture, while fish grown in freshwater and seawater showed

	Medium weight			
Month	Sweet water (t)	Brackish water	Difference	A.E.D.
Month 1	16.73	15.18	1.55	5.95
Month 2	21.70	20.85	0.85	6.43
Month 3	24.63	29.14	4.51	6.43
Month 4	29.77	42.03	12.26*	5.95
	Sweet water (t)	Seawater		
Month 1	16.73	16.30	0.43	5.95
Month 2	21.70	19.22	2.48	6.43
Month 3	24.63	21.29	3.34	6.26
Month 4	29.77	26.17	3.60	6.43
	Brackish water	Seawater		
Month 1	15.18	16.30	1.12	5.95
Month 2	20.85	19.22	1.63	5.95
Month 3	29.14	21.29	7.85*	6.59
Month 4	42.03	26.17	15.86*	6.43

insignificant growth during the third and fourth months of culture. a month, throughout the cultivation process.

Table 7

Duncan's test to determine significant differences month by month between: (A) Lengths and (B) Mean weights, in each treatment, of D. latifrons cultured in the Fisheries Biology Laboratory

(A)

Month	Medium lenght Sweet water (T)		Diference	A.E.D.
Month 1 - Month 2	107.90	113.57	5.67	7.46
Month 2 - Month 3	113.57	116.87	3.30	6.73
Month 3 - Month 4	116.87	123.73	6.86	7.27
Brackish water				
Month 1 - Month 2	106.00	111.07	5.07	7.46
Month 2 - Month 3	111.07	122.90	11.83*	7.57
Month 3 - Month 4	122.90	135.23	12.33*	7.08
Seawater				
Month 1 - Month 2	106.13	110.63	4.50	7.08
Month 2 - Month 3	110.63	113.37	2.74	7.08
Month 3 - Month 4	113.37	119.03	5.66	7.27

(B)

Month	Sweet water (T)		Diference	A.E.D.
Month 1 - Month 2	16.73	21.70	4.97	6.59
Month 2 - Month 3	21.70	24.63	2.93	5.95
Month 3 - Month 4	24.63	29.77	5.14	6.26
Brackish water				
Month 1 - Month 2	15.18	20.85	5.67	6.59
Month 2 - Month 3	20.85	29.14	8.29*	6.70
Month 3 - Month 4	29.14	42.03	12.89*	6.26
Seawater				
Month 1 - Month 2	16.30	19.22	2.92	5.95
Month 2 - Month 3	19.22	21.29	2.07	6.26
Month 3 - Month 4	21.29	26.17	4.88	6.43

Note. A.E.D.: Duncan Studentized Breadth; *: Significant Value at nivel 0.05.

The analysis of the monthly increase rates, in length and weight (Table 8), shows, on the one hand, that the fish farmed in freshwater and marine water, presented low values and with a tendency to decrease towards the third month of cultivation and, on the other, that the fish from the brackish water treatment, their rates increased in a sustained manner until the fourth month of cultivation and with higher values.

Table 8

Monthly increases in length and weight, in each treatment, of D. latifrons cultured in the Laboratory of Fisheries Biology Laboratory

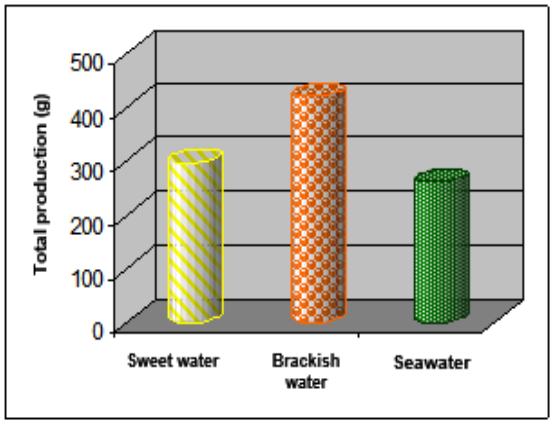
Month	Sweet water (T)		Brackish water		Seawater	
	Lt	Wt	Lt	Wt	Lt	Wt
Sowing - Month 1	4.07	1.17	2.57	0.44	3.56	1.93
Month 1- Month 2	5.67	4.97	5.07	5.67	4.50	2.92
Month 2- Month 3	3.30	2.93	11.83	8.29	2.74	2.07
Month 3- Month 4	6.86	5.14	12.33	12.89	5.66	4.88

Production Yield

The average total productions of each treatment were: 297.70 g (Fresh water), 420.30 g (Brackish water) and 261.70 g (Marine water). As can be seen, the best performance corresponded to brackish water (Figure 13).

Figure 13

Average total production of each treatment of D. latifrons cultivated in the Laboratory of Fisheries Biology



Feed Conversion Rate

The conversion rate, in general, was high the first month and its value decreased as the culture process elapsed (Table 9). The best total conversion rate occurred in the brackish water treatment: 3.05.

Table 9

Feed conversion of the diet in each treatment, in the culture of D. latifrons in the Laboratory of Fisheries Biology

Month	Sweet water (T)	Brackish water	Sea water
Month 1	17.95	36.45	10.05
Month 2	4.04	3.28	6.69
Month 3	6.67	2.26	8.36
Month 4	4.31	2.03	3.93
Total	**5.83**	**3.05**	**6.39**

Mortality

In the first week of the culture process, the death of three fish in aquarium 1c (Freshwater) was recorded, the same ones that were replaced by specimens of the same sizes and weights; likewise, a specimen died in aquarium 1a, fifteen days before the end of the experiment.

Weight-Length Ratio

The weight-length equations were estimated for each treatment (Table 10) and when constructing the respective growth curves (Figure 14), the highest growth of fish cultured in brackish water is observed.

The analysis of covariance to compare these equations determined that there are no significant differences between regressions (FR: 1.58 Fc y 2.37 Ft), origins (Fb: 2.73 Fc y 3.00 Ft), and slopes (Fa: 0.43 Fc y 3.00 Ft).

The t test for the exponent b (Table 10), established that its value does not differ statistically from 3 for the three treatments, typifying that the growth is of the Isometric type.

The Comparative Allometric Condition Factor, allowed to show that the fish grown in brackish water presented the best physiological condition (Table 10).

Table 10

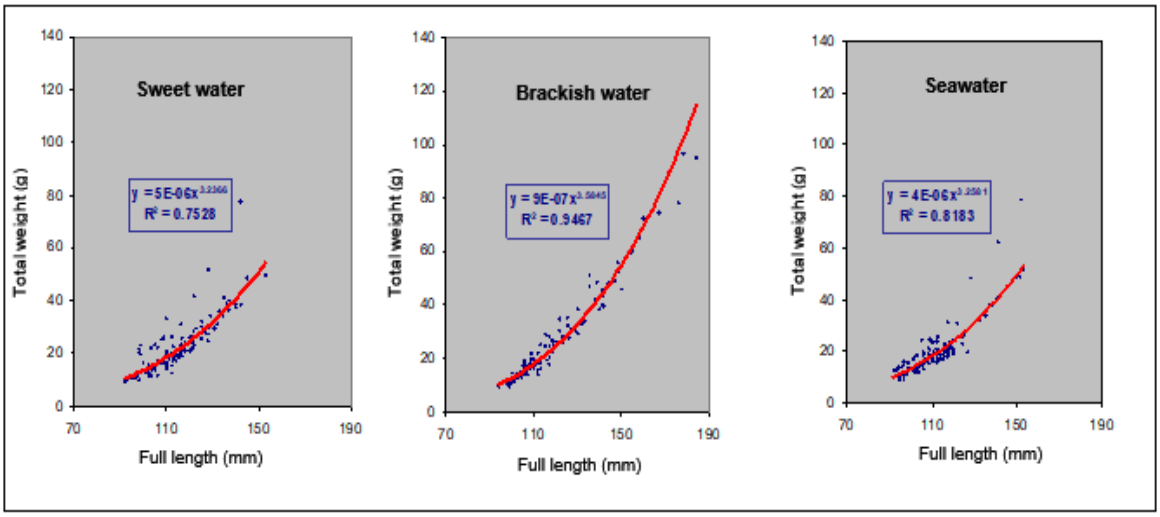
Parameters of the weight-length relationship, comparative allometric condition factor and t test for exponent b, in each treatment, of D. latifrons cultured in the Fisheries Biology Laboratory

Treatments	a (1) a x 10 $^{-6}$	a (2) a x 10 $^{-6}$	r	b	t_c	t_t
Sweet water (T)	5.00	2.0678	0.8676	3.2380	0.1283	1.96
Brackish water	0.90	2.1698	0.9730	3.5845	0.3152	1.96
Sea water	4.00	2.0368	0.9046	3.2581	0.1628	1.96

Note. (T): Witness; a (1): Allometric condition factor; a (2): Comparative allometric condition factor; b: Exponential regression coefficient; t_c: t value calculated; t_t: t value in tables; r: Correlation coefficient

Figure 14

Curves of the weight-length equations, in each treatment, of D. latifrons cultured in the Laboratory of Fisheries Biology



Physical - Chemical Characteristics of Water

Water and Ambient Temperature

The average monthly temperature of the water in the aquariums was very similar for all the treatments and with a tendency to increase as the culture process progressed (Table 11). In general, it varied from 23.41 ºC the first month to 28.06 ºC the fourth month.

The ambient temperature also observed the same trend. It varied from 23.97 ºC to 27.78 ºC.

Table 11

Ambient and water temperature (ºC) of D. latifrons culture aquariums, of each treatment, in the Fisheries Biology Laboratory

Month	Temperatura ambiental	Sweet water (T)			Brackish water			Seawater		
		1a	1b	1c	2a	2b	2c	3a	3b	3c
Month 1	23.97	23.47	23.41	23.42	23.67	23.63	23.67	23.59	23.64	23.63
Month 2	25.75	25.50	25.52	25.49	25.59	25.58	25.59	25.59	25.60	25.56
Month 3	27.42	26.92	26.91	26.95	26.98	26.99	27.02	27.03	27.00	26.96
Month 4	27.78	27.73	27.79	27.83	27.92	27.99	28.01	28.06	27.95	27.83

pH

The pH of the aquarium water showed high values during the first months of cultivation and decreased towards the end of the experiment, in the three treatments (Table 12). Their values also decreased, with the increase in the salinity of the water, but they were always above 7, indicating that it is alkaline water. In fresh water it ranged from 7.82 to 7.42, in brackish water from 7.84 to 7.20 and in marine water from 7.68 to 7.23.

Table 12

pH of the water from the culture aquariums of D. latifrons, of each treatment, in the Fisheries Biology Laboratory

Month	Sweet water (T)			Brackish water			Seawater		
	1a	1b	1c	2a	2b	2c	3a	3b	3c
Month 1	7.82	7.70	7.76	7.74	7.74	7.75	7.49	7.55	7.57
Month 2	7.61	7.61	7.59	7.84	7.77	7.79	7.61	7.67	7.68
Month 3	7.64	7.55	7.48	7.51	7.55	7.48	7.49	7.46	7.47
Month 4	7.59	7.48	7.42	7.37	7.21	7.20	7.23	7.39	7.41

Dissolved oxygen

The concentrations of dissolved oxygen in the water were similar between the repetitions of the treatments, noting that in the first two months, their values were lower in seawater (Table 13). The oxygen content varied from 3.50 mg/L to 6.75 mg/L in fresh water, from 4.00 mg/L to 5.75 mg/L in brackish water, and from 3.25 mg/L to 5.25 mg/L in seawater.

Table 13

Dissolved oxygen of the water (mg/L) of the culture aquariums of D. latifrons, of each treatment, in the Laboratory of Fisheries Biology

Month	Sweet water (T)			Brackish water			Seawater		
	1a	1b	1c	2a	2b	2c	3a	3b	3c
Month 1	6.75	4.75	6.00	5.00	4.50	4.25	3.75	3.75	3.75
Month 2	3.50	4.00	4.75	4.00	4.25	4.50	3.25	3.25	3.25
Month 3	5.50	5.25	5.75	5.75	5.25	5.25	5.25	5.00	4.50
Month 4	5.25	4.75	5.25	5.00	4.75	4.00	5.00	5.25	5.25

Dissolved Carbon Dioxide

The level of carbon dioxide dissolved in the water reached low and similar values in all the aquariums of the three treatments (Table 14). Their concentrations ranged from 0.88 mg/L to 2.17 mg/L in fresh water, from 1.00 mg/L to 3.00 mg/L in brackish water, and from 1.38 mg/L to 3.00 mg/L in seawater.

Table 14

Carbon dioxide of the water (mg/L) of the culture aquariums of D. latifrons, of each treatment, in the Laboratory of Fisheries Biology, FCCBB - UNPRG, Lambayeque, november 2009 – march 2010.

Month	Sweet water (T)			Brackish water			Seawater		
	1a	1b	1c	2a	2b	2c	3a	3b	3c
Month 1	1.36	1.15	2.17	3.00	2.27	3.00	2.00	3.00	2.00
Month 2	2.00	1.86	1.58	2.39	2.18	2.55	2.27	2.00	2.15
Month 3	1.75	1.96	1.88	1.65	1.84	1.93	1.69	1.77	1.85
Month 4	0.88	1.38	1.38	1.00	1.00	1.00	1.58	1.50	1.38

Salinity

The saline concentration of the aquarium water observed the tendency to increase its value as the culture process progressed, but with different values according to the treatment (Table 15); thus it varied from 0.33 ‰ to 0.44 ‰ in fresh water, from 15.16 ‰ to 16.63 ‰ in brackish water and from 31.02 ‰ to 33.03 ‰ in marine water.

Table 15

Water salinity (‰) of D. latifrons culture aquariums, of each treatment, at the Fisheries Biology Laboratory

Month	Sweet wáter (T)			Brackish water			Seawater		
	1a	1b	1c	2a	2b	2c	3a	3b	3c
Month 1	0.33	0.33	0.34	15.17	15.16	15.17	31.04	31.02	31.03
Month 2	0.34	0.35	0.34	15.45	15.35	15.38	31.34	31.33	31.32
Month 3	0.35	0.35	0.35	16.28	16.28	16.20	32.26	32.24	32.25
Month 4	0.40	0.44	0.44	16.62	16.63	16.62	33.02	33.02	33.03

BIOENV analysis

The BIOENV analysis registered low values of the correlation coefficient, indicating that the growth pattern of the fish was not affected by the physicochemical parameters of the water (Table 16).

Table 16

BIOENV analysis to determine the correlation of the physicochemical parameters with the growth in length and weight of D. latifrons cultured in freshwater (t), brackish water and seawater, in the Fisheries Biology Laboratory

Month	Sweet water(T)			Brackish water			Seawater		
	1a	1b	1c	2a	2b	2c	3a	3b	3c
Month 1	0.33	0.33	0.34	15.17	15.16	15.17	31.04	31.02	31.03
Month 2	0.34	0.35	0.34	15.45	15.35	15.38	31.34	31.33	31.32
Month 3	0.35	0.35	0.35	16.28	16.28	16.20	32.26	32.24	32.25
Month 4	0.40	0.44	0.44	16.62	16.63	16.62	33.02	33.02	33.03

Discussion

The results obtained in this research work, allow us to affirm that the hypothesis raised in the sense that the higher the salinity of the water, the greater the growth, was partially fulfilled since *D. latifrons* grew better when it was cultivated in brackish water (15 ‰ -17 ‰). , a fact that was confirmed by the analysis of variance and Duncan's test, which statistically established the best growth of this species in the treatment indicated above; situation that would be explained because brackish water (15 ‰ – 17 ‰) would be the isoosmotic level of the water that allows the fish a minimum expenditure of energy for the osmoregulation process, which would result in a greater availability of energy for their body development; while freshwater and seawater would be representing the hypoosmotic and hyperosmotic levels, respectively, which would demand a higher energy consumption for the osmoregulation process, which would affect their growth (Jesús et al., 2006; Calderer, 2001 and Levinton, 1982). On the other hand, these results coincide with those obtained by Salgado et al. (2006), who found that *Chirostoma promelas* juveniles optimize their growth and survival rate when they are cultured in salinities of 10 ‰ to 15 ‰, compared to the salinities of 0‰, 5‰, 20‰ and 25‰.

The results of the variance analysis of the present study do not coincide with the report by Mena et al. (2001), who for "Red Tilapia" (*Oreochromis mossambicus* (Peters) x *Oreochromis niloticus* (Linnaeus), found no significant differences in growth between water sweet and salinity of 15 ‰, but with respect to salinities of 25 ‰ and 35 ‰; neither does it coincide with Banegas (2007), who for the same hybrid "Red Tilapia" did not show significant differences in growth between salinities of 17,500 p.p.m. and 35,000 p.p.m.. Both works under laboratory conditions.

The fact that *D. latifrons* has tolerated gradual changes in salinity from freshwater to 35 ‰ salinity, without mortality problems, would indicate that it is a euryhaline species. This resistance to salinity of 35 ‰ was favored by the gradual change in salinity to which this species was subjected, since as Chung (2000) maintains, the type of change, gradual or abrupt, affects tolerance to salinity.

It is necessary to note that although the analysis of variance does not indicate significant differences between the repetitions of each treatment, the non-uniform growth observed would be due to the fact that the fish were obtained from the natural environment and probably would not belong to the same family groups or reproductive stocks.

Through the Duncan test, it was determined that the fish grown in brackish water showed significant growth until the last month of culture, which is an indicator that they have not yet reached the asymptotic level of their growth, which is not the case with freshwater. and marine water that would have already reached this level as they did not present significant growth. This was ratified by the monthly increase rates, which in brackish water increased their values as the culture process elapsed, while in fresh water and marine water their values were low.

The analysis of covariance, by establishing that there are no significant differences between the parameters of the weight-length equations of the treatments, did not agree with the analysis of variance and did not reflect the effect of water salinity on fish growth. In the same way, the t test for the exponent b, established the same type of growth (Isometric) for the three treatments. However, the Comparative Allometric Condition Factor, when stating that the fish grown in brackish water presented a better degree of fatness, did show the effect of water salinity on growth.

The higher average production yield of the fish grown in brackish water is due to the higher growth that the fish presented in this treatment for the reasons already stated above.

The feed conversion rate was too high in the first month of culture, in all treatments, and it was due to the fact that the fish initially did not get used to artificial food, offering some resistance to consuming it. The best total conversion rate was presented in favor of the fish grown in brackish water, which would be explained because in this treatment the fish showed greater avidity for food, making a greater consumption of it because "salinity affects the intake and the feed conversion efficiency" (Jesús et al., 2006); Likewise, Rubio et al. (2003) found that in the "Sea Bass" *Dicentrarchus labrax* L., the salinity of the water affected the food intake, which decreased when the salinity was reduced from 25 ‰ to 7 ‰ and 0 ‰. On the other hand, this conversion rate is higher than those obtained by Torres (2000): 1.58 and López and Lora (2003): 1.45, which is explained because they are relative conversion rates as they were semi-intensive crops where fish, in addition from artificial food, they have taken advantage of the natural food from the culture pond; which has not happened in the present study where the growth was due solely and exclusively to the food delivered, since it was an intensive culture and an absolute conversion rate.

The physical-chemical characteristics of the aquarium water were very similar in all the treatments and this reflects the homogeneity of the parameters; This fact was corroborated by the BIOENV analysis, which determined that they did not affect the growth pattern of *D. latifrons* and therefore did not interfere with the applied treatments.

The water temperatures in the aquariums coincide with those recorded by Torres (2000): 23.18 ºC - 26.45 ºC and with the tolerance range indicated for this species by Haz (2002): 24 ºC - 27 ºC. In the same way, they fall within the optimal level for warm water fish farming, which according to Boyd (2000), is between 20 ºC and 28 ºC. Its variations were linked to seasonal changes (Spring-Summer).

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The dissolved oxygen content in the water was above 3 mg/L, exceeding the tolerable minimum for this species, which according to Haz (Op. cit.) is 0.4 mg/L

The dissolved carbon dioxide in the water presented low values with a maximum of 3 mg./L in some months, an acceptable characteristic since in intensive aquaculture, it is considered that values above 10 mg./L can cause harmful effects to the fish. Boyd (Op.cit.).

The increase in the salinity of the water in the aquariums as the culture process progressed would be linked to the process of evaporation of the same, which resulted in a higher concentration of salts.

Conclusions

1. The salinity of the water positively influences the growth of *D. latifrons* up to the brackish water level (15 ‰ – 17 ‰).
2. *D. latifrons* is a euryhaline fish that tolerates freshwater to seawater.
3. The physico-chemical characteristics of the water were within the range of good growth for this species.

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