

# Multitrophic culture of *Mugil cephalus* “lisa” and *Brycon atrocaudatus* “cascafe” in two stocking densities in semi-natural ponds

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**Abstract:** This research was performed in order to determine the effect of planting density on the growth of *Mugil cephalus* "smooth" and *Brycon atrocaudatus* "cascafe" in multi-trophic culture; for which he had two ponds of 900 m<sup>2</sup> and 600 m<sup>2</sup> of area, developing the experimental design paired samples with two treatments without repetition: 1.8 fish / m<sup>2</sup> (Pond 1) and 2.3 fish / m<sup>2</sup> (Pond 2). The fish were fed balanced 28% protein in double time: 09 and 14 hours, with food indices ranged from 10% at the beginning to 2% of the biomass at the end. Biometric checks were made monthly sampling of 50 smooth and 25 cascafes each treatment and analysis of variance and Tukey test were performed to determine significant differences in growth. Growth was affected by planting density in reverse to the "smooth" best grown in lower total density of 1.8 fish / m<sup>2</sup>: 135.47 mm and 31.93 g and in favorable direction for the "cascafe" whose growth it was higher in the density of 2.3 fish / m<sup>2</sup>: 191.64 mm and 82.13 g. The highest yield production was presented in the total density of 2.3 fish / m<sup>2</sup>: 37.37 kg and 622.89 kg / ha. The best conversion factor and greater feed efficiency corresponded to the density of 2.3 fish / m<sup>2</sup>.

**Keywords:** multi-trophic culture, *Mugil cephalus* and *Brycon atrocaudatus*, planting density.

## Cite this article:

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## I. Introduction

Knowledge of the culture technology of the native fishing resources of the department of Lambayeque constitutes one of the main objectives of the line of research in Aquaculture, hence experimental research is constantly being proposed on the fish farming of the species of greatest economic importance. and nutritional status of the area, both at the level of monocultures and polycultures, in semi-intensive and intensive systems.

Since polyculture is a technique that allows increasing the total production of the culture pond, based on the optimal use of natural production at different levels of the water column, an adequate choice of species is essential to take advantage of these spaces and ecological niches. of the aquatic environment; for which extensive knowledge of its bioecology is required, especially its feeding habits and its distribution based on depth; so that competition for space and food is not generated between the organisms that are the reason for polyculture. Thus, in the present study, the execution of a polyculture of *Mugil cephalus*, benthopelagic fish with herbivorous-detritivorous regime, and

*Brycon atrocaudatus*, pelagic species that it occupies the upper levels of the water column and has an omnivorous feeding habit.

In the department of Lambayeque, experiments have been carried out with polycultures of *M. cephalus* with *T. punctulatus* and *Oreochromis spp*, fed with rice dust (López and Lora, 1989a) and with feed for birds (López and Lora, 1989b), as well as of *M. cephalus* with *T. punctulatus*, fed with rice dust (Buendía, 1990), in semi-intensive systems; Likewise, polycultures of other native species such as *T. punctulatus*, *Dormitator latifrons* and *Oreochromis spp* have been carried out (Rivera and Vega, 2013), and *Macrobrachium inca*, *D. latifrons* and *Oreochromis spp* (Cerdán and Sánchez, 2014), as well as polycultures associated with poultry breeding carried out by López and Lora (1990): *T. punctulatus* and *O. niloticus* and López and Lora (1991): *Andinoacara rivulatus*, *O. niloticus* and *Cyprinus carpio*. Talking about *B. atrocaudatus*, a polyculture experience has been carried out with *Tilapia rendalli* and *T. punctulatus* fed with carob pods (Núñez and Martínez, 1988). However, there are no experiences of polyculture of *M. cephalus* with *B. atrocaudatus*, and it is considered necessary to investigate the interaction between these species in a polyculture in the semi-intensive system.

This problematic motivation generated the approach and execution of this research work, which had as objectives: determine and compare the growth of *M. cephalus* and *B. atrocaudatus* in different sowing densities, in multitrophic cultivation and select the treatment that provides the best performance; posing the problem: How does the stocking density affect the growth of *M. cephalus* and *B. atrocaudatus* in the multitrophic culture modality and semi-intensive culture system?, to which the hypothesis was formulated: If the density the stocking density of the pond culture affects the growth of fish in inverse relationship, so the best growth of *M. cephalus* and *B. atrocaudatus* will be greater at the lower density; the same that was contrasted with the Experimental Design of Paired Samples.

## II. Material and Methods

The cultivation process was carried out from May 27 to December 26, 2015, in the “Don Runo” Fish Farm owned by Apolinar Sánchez Manayay, located in the Populated center of Laquipampa Bajo, coordinates: 6°21'08.60" L.S and 79°28'33.52" L.W, at an altitude of 848 meters above sea level, at km 6.5 on the

road to Incahuasi (Incahuasi District, Ferreñafe Province, Department of Lambayeque-Peru); counting with two semi-natural ponds of : 900 m<sup>2</sup> (Pond 1) and 600 m<sup>2</sup> (Pond 2) and a depth of 0.80 m (Fig. 1), which were supplied with water from the Moyán River.

The *M. cephalus* fry were captured in the Mil – Lambayeque Drain, where a sample of 2750 fish between sizes 38 and 50 mm was obtained; the *B. atrocaudatus* fry were captured in the Sangana River, with a sample of 450 specimens whose sizes fluctuated between 45 and 52 mm.

The fish were stocked in stages: first the “lisa” (May 27) and a month later the “cascafe” (June 25) was planted.

The hypothesis testing was carried out with the Experimental Design of Paired Samples, with two treatments without repetition: 1.8 fish/m<sup>2</sup> (Pond 1) and 2.3 fish/m<sup>2</sup> (Pond 2). The stocking density of “cascafe” was 0.30 fish/m<sup>2</sup> in the two ponds; On the other hand, that of “lisa” varied: 1.5 fish/m<sup>2</sup> (Pond 1) and 2 fish/m<sup>2</sup> (Pond 2) (Table 1).

Figure 1: *M. cephalus* and *B. atrocaudatus* culture ponds.

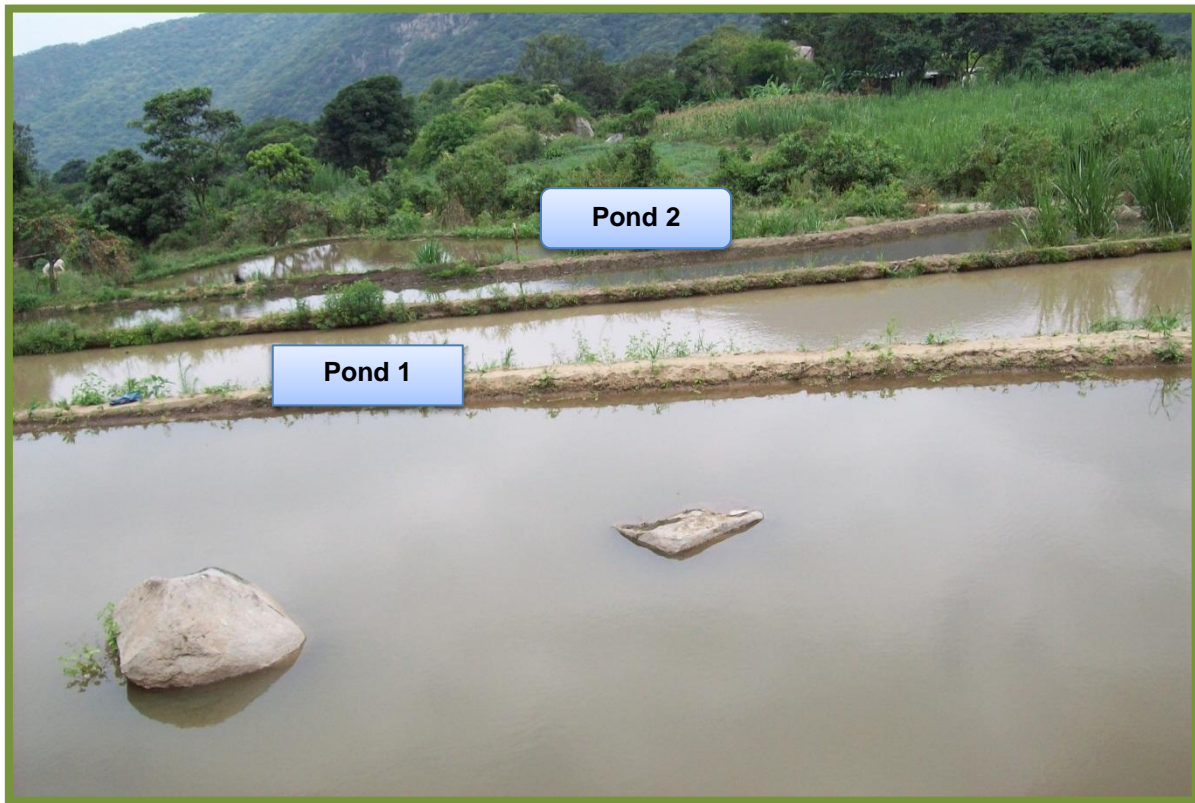


Table 1: Experimental design, name of the ponds, average lengths and weights and total population of *M. cephalus* “lisa” and *B. atrocaudatus* “cascafe”, in multitrophic culture in two stocking densities, june – december 2015.

Ponds	LISA			CASCAFE			Density total (peces/m <sup>2</sup> )	Total population
	Density (fish/m <sup>2</sup> )	Lt (mm)	Pt (g)	Density (fish/m <sup>2</sup> )	Lt (mm)	Wt (g)		
E <sub>1</sub>	1,5	42,90	0,71	0,3	47,50	1,21	1,8	1620
E <sub>2</sub>	2,0	42,90	0,71	0,3	47,50	1,21	2,3	1380

Pond 1 was loaded with a total population of 1,620 fish: 1,350 “lisas” and 270 “cascafes”, while Pond 2 had 1,380 fish: 1,200 “lisas” and 180 “cascafes”

The “lisa” was fed with rice dust during the first month of cultivation at a rate of 20% of the biomass and from the second, together with the “cascafe”, it was supplemented with a balanced diet of 28% protein (purigamitana), at a rate of 5% and 10% of the biomass, respectively; The third month of culture was fed with the feeding index of 3 and 4% of the biomass for each species; the fourth: 2.5 and 3%; and for the fifth and sixth months, 2.5% and

2.25% of the biomass was programmed for both species, respectively.

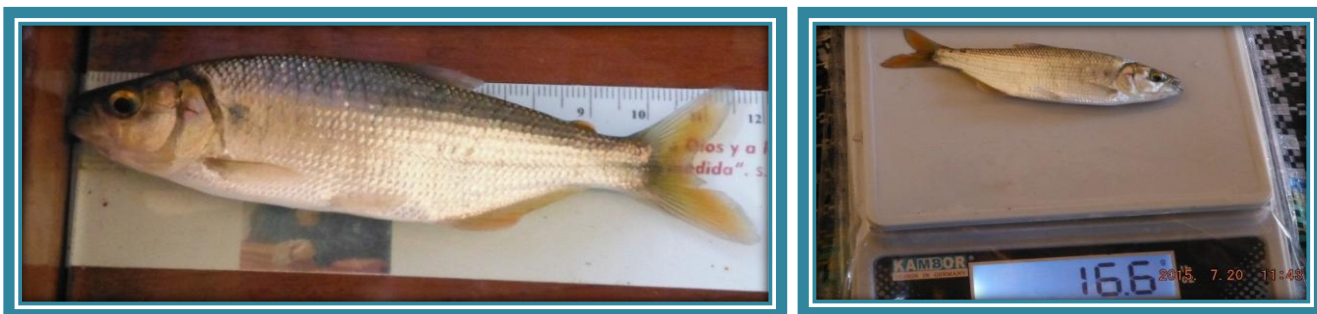
The biometric control of the fish was carried out monthly, for which using an anchovy mesh net 25 m long by 1.5 m high, homogeneous samples of each species were taken: 50 mullet and 25 shellfish. The record was made. total length with ichthyometer graduated in mm and total weight with digital scale (Fig. 2 and 3).

The temperature of the surface water of the ponds and the environment was recorded daily at 08:00 and 13:00 with a digital thermometer. The transparency of the water was controlled weekly using the Secchi disk.

Figura 2: Biometric control in length and weight of *M. cephalus*



Figure 3: Biometric control in length and weight of *B. atrocaudatus*



The effect of stocking density, time and interaction on fish growth was determined through analysis of variance for a factorial model of two fixed factors (Ostle, 1994) and the comparison of the means was carried out using through Tukey's multiple range test.

The statistical analyzes were processed with a HP Laptop with an Intel CORE i5 processor - Windows 7 operating system, using the programs: Excel 2007, SPSS 22 and Minitab 16, with a significance level of 0.05%.

### III. Results

#### 3.1 Growth of *M. cephalus*

The growth of the “lisa”, in length and weight, was greater at the stocking density of 1.5 fish/m<sup>2</sup> (Pond 1), from the first month of culture, achieving at the end 135.47 mm and 31.93 g (Table 2).

Table 2: Average monthly lengths and weights of *M. cephalus* in multitrophic culture with *B. atrocaudatus* at two sowing densities, June-December 2015.

Month	Pond 1			Pond 2		
	n	Lt (mm)	Wt (g)	n	Lt (mm)	Wt (g)
Sowing	1350	42,90	0,71	1200	42,90	0,71
Month 2	50	71,37	4,42	50	68,13	4,33
Month 3	50	86,03	7,85	50	80,47	6,92
Month 4	50	97,10	11,63	50	94,27	11,33
Month 5	50	105,13	15,72	50	99,77	13,58
Month 6	50	120,53	22,20	50	106,73	15,13
Month 7	50	135,47	31,93	50	121,73	22,59

These differences observed in growth in length and weight showed statistical significance when applying the analysis of variance (Table 3), establishing the effect of stocking density, time and the interaction of both factors on the growth of the fish.

The significant differences in growth in length and weight between treatments were evident through the Tukey test (Table 4),

which established that they were in favor of the density of 1.5 fish/m<sup>2</sup>, the last two months of the year crop.

In relation to monthly growth, the Tukey test (Table 5) determined that the growth in length was significant in almost the entire cultivation process, except for the third month; However, in weight, growth was significant only in the last two months of cultivation, in both treatments.

Table 3: Analysis of variance to determine the effect of density, time and interaction on length and weight of *M. cephalus* in multitrophic culture with *B. atrocaudatus* at two sowing densities, June – December 2015.

Sources of variation	Length		Weight	
	F	P	F	P
Density	174,12	0,00	89,06	0,00
Time	32,45	0,00	21,49	0,00
Interacción	2,49	0,03	5,03	0,03

F: Test value F, P: <0.05.

Table 4: Tukey test to determine significant differences between the mean lengths (A) and weights (B) of *M. cephalus* in multitrophic culture with *B. atrocaudatus* at two sowing densities, June December 2015.

(A) Length

MONTHS	P1	P2	RESIDUE	DMS
MONTH 2	71,37	68,13	3,24	6,25
MONTH 3	86,03	80,47	5,56	6,25
MONTH 4	97,10	94,27	2,83	6,25
MONTH 5	105,13	99,77	5,36	6,25
MONTH 6	120,53	106,73	13,80*	6,25
MONTH 7	135,47	121,73	13,74*	6,25

(B) Weight

MONTHS	P1	P2	RESIDUE	DMS
MONTH 2	4,42	4,33	0,09	3,43
MONTH 3	7,85	6,92	0,93	3,43
MONTH 4	11,63	11,33	0,30	3,43
MONTH 5	15,72	13,58	2,14	3,43
MONTH 6	22,20	15,13	7,07*	3,43
MONTH 7	31,93	22,59	9,34*	3,43

Table 5: Tukey test to determine significant differences month by month between the average lengths (A) and weights (B) of *M. cephalus* in multitrophic culture with *B. atrocaudatus* at two sowing densities, June – December 2015.

(A) Length

MONTHS	P1		RESIDUE	DMS
M 2 - M 3	71,37	86,03	14,66*	9,10
M 3 - M 4	86,03	97,10	11,07*	9,10
M 4 - M 5	97,10	105,13	8,03	9,10
M 5 - M 6	105,13	120,53	15,40*	9,10
M 6 - M 7	120,53	135,47	14,94*	9,10

	P2			
M 2 - M 3	68,13	80,47	12,34*	9,10
M 3 - M 4	80,47	94,27	13,80*	9,10
M 4 - M 5	94,27	99,77	5,50	9,10
M 5 - M 6	99,77	106,73	6,96	9,10
M 6 - M 7	106,73	121,73	15,00*	9,10

(B) Weight

MONTHS	P1		RESIDUE	DMS
M 2 - M 3	4,42	7,85	3,43	4,98
M 3 - M 4	7,85	11,63	3,78	4,98
M 4 - M 5	11,63	15,72	4,09	4,98
M 5 - M 6	15,72	22,20	6,48*	4,98
M 6 - M 7	22,20	31,93	9,73*	4,98

	P2			
M 2 - M 3	4,33	6,92	2,59	4,98
M 3 - M 4	6,92	11,33	4,41	4,98
M 4 - M 5	11,33	13,58	2,25	4,98
M 5 - M 6	13,58	15,13	1,55	4,98
M 6 - M 7	15,13	22,59	7,46*	4,98

### 3.2 Growth of *B. atrocaudatus*

The growth of “cascafe”, at the sixth month of culture, was better at the highest total stocking density (2.3 fish/m<sup>2</sup>: Pond 2): 191.64 mm and 82.13 g (Table 6). This characteristic of greater growth in length and weight occurred from the first month of cultivation.

Table 6: Average lengths and weights of *B. atrocaudatus*, in multitrophic culture with *M. cephalus* at two sowing densities, June-December 2015.

Months	P1			P2		
	n	Lt	Wt	n	Lt	Wt
Sowing	270	47,50	1,21	180	47,50	1,21
Month 1	25	82,64	5,47	25	87,20	6,26
Month 2	25	105,20	12,45	25	109,00	13,16
Month 3	25	124,48	25,81	25	140,56	29,96
Month 4	25	150,32	38,07	25	158,04	47,76
Month 5	25	170,12	60,88	25	176,00	66,84
Month 6	25	178,20	66,09	25	191,64	82,13

The differences observed in growth in length and weight between treatments were confirmed by the analysis of variance (Table 7), which determined statistical significance, pointing out the effect of planting density on growth (P = 0.00), in addition of time (P = 0.00) and the interaction of both factors (P =0.03).

The statistical comparison of means between treatments, in length and weight, through the Tukey test (Table 8), showed the greatest growth of the fish cultured in the total density of 2.3 fish/m<sup>2</sup> (Pond 2), in the fourth and sixth month of cultivation.

Depending on time, the statistical evaluation of fish growth, using the Tukey test (Table 9), established that while at the total

density of 1.8 fish/m<sup>2</sup> (Pond 1), growth was significant up to the fifth month of culture, in that of 2.3 fish/m<sup>2</sup> (Pond 2), the growth was significant throughout the culture process.

### 1.3 Production

The total production of the ponds was 48.45 kg at the density of 1.8 fish/m<sup>2</sup> (Pond 1), 31.93 kg corresponding to *M. cephalus* and 16.52 kg to *B. atrocaudatus*; and 37.37 kg at the density of 2.3 fish/m<sup>2</sup> (Pond 2), of which 22.59 kg were *M. cephalus* and 14.78 kg were *B. atrocaudatus*. The gross and net productions were: 538.36 kg/ha and 524.08 kg/ha at the density of 1.8 fish/m<sup>2</sup> and 622.89 kg/ha and 605.06 kg/ha at the density of 2.3 fish/m<sup>2</sup>.

Table 7: Analysis of variance to determine the effect of density, time and interaction on length and weight of *B. atrocaudatus* in multitrophic culture with *M. cephalus* at two planting densities, June – December 2015.

Sources of variation	Length		Weight	
	F	P	F	P
Density	19,16	0,00	16,69	0,00
Time	259,63	0,00	216,43	0,00
Interacción	1,10	0,36	2,48	0,03

F: Test value F P: <0.05.

Table 8: Tukey test to determine significant differences between the mean lengths (A) and weights (B) of *B. atrocaudatus*, in multitrophic culture with *M. cephalus* at two sowing densities, June-December, 2015.

(A) Length				
MONTHS	P1	P2	RESIDUE	DMS
MONTH 1	82,64	87,20	4,56	9,40
MONTH 2	105,20	109,00	3,80	9,40
MONTH 3	124,48	140,56	16,08*	9,40
MONTH 4	150,32	158,04	7,72	9,40
MONTH 5	170,12	176,00	5,88	9,40
MONTH 6	178,20	191,64	13,44*	9,40

(B) Weight				
MONTHS	P1	P2	RESIDUE	DMS
MONTH 1	5,47	6,26	0,79	7,30
MONTH 2	12,45	13,16	0,71	7,30
MONTH 3	25,81	29,96	4,15	7,30
MONTH 4	38,07	47,76	9,69*	7,30
MONTH 5	60,88	66,84	5,96	7,30
MONTH 6	66,09	82,13	16,04*	7,30

Tabla 9: Prueba de Tukey para determinar diferencias significativas mes a mes entre las longitudes y pesos medios de *B. atrocaudatus*, en cultivo multitrófico con *M. cephalus* en dos densidades de siembra, junio-diciembre, 2015.

(A) Length				
MONTHS	P1	P2	RESIDUE	DMS
M1 – M2	82,64	105,20	22,56*	13,68
M2 – M3	105,20	124,48	19,28*	13,68
M3 – M4	124,48	150,32	25,84*	13,68
M4 – M5	150,32	170,12	19,80*	13,68
M5 – M6	170,12	178,20	8,08	13,68

P2				
MONTHS	P1	P2	RESIDUE	DMS
M1 – M2	87,20	109,00	21,80*	13,68
M2 – M3	109,00	140,56	31,56*	13,68
M3 – M4	140,56	158,04	17,48*	13,68
M4 – M5	158,04	176,00	17,96*	13,68
M5 – M6	176,00	191,64	15,64*	13,68

## (B) Weight

MONTHS	P1		RESIDUE	DMS
M1 – M2	5,47	12,45	6,98	10,62
M2 – M3	12,45	25,81	13,36*	10,62
M3 – M4	25,81	38,07	12,26*	10,62
M4 – M5	38,07	60,88	22,81*	10,62
M5 – M6	60,88	66,09	5,21	10,62

	P2			
M1 – M2	6,26	13,16	6,90	10,62
M2 – M3	13,16	29,96	16,80*	10,62
M3 – M4	29,96	47,76	17,80*	10,62
M4 – M5	47,76	66,84	19,08*	10,62
M5 – M6	66,84	82,13	15,29*	10,62

### 3.4 Conversion Factor and Feed Efficiency

Feed conversion and feed efficiency were 1,91 and 52,85 % at the density of 1,8 fish/m<sup>2</sup> and 1,82 y 56,4 % at the density of 2,3 fish/m<sup>2</sup>.

### 3.5 Physical parameters

#### 3.5.1 Surface and ambient water temperature

The water temperature of the ponds differed slightly between treatments, with a tendency to increase as the cultivation process progressed, varying its values from 20.50 °C in June to 23.70 °C in December.

The ambient temperature presented lower values than that of the water, but its trend was similar to that of the water.

#### 3.5.2 Transparency

The transparency of the water in the culture ponds was high in the first months of culture and its values decreased towards the end of the experiment. Generally, transparency varied from 50 cm to 10 cm

## IV. Discussion

The results obtained at the end of the polyculture made it possible to demonstrate partial fulfillment of the hypothesis in the sense of greater growth of the fish at the lowest density, since while in *M. cephalus* the best lengths and weights were achieved at the lowest density (1.5 fish/m<sup>2</sup>), in *B. atrocaudatus* this occurred at the highest total density (2.3 fish/m<sup>2</sup>). This is explained, in the case of the “lisa”, because its growth is sensitive to crop densities as has been reported by López and Lora (1989a), López and Lora (1989b) and Buendía (1990); On the other hand, for *B. atrocaudatus*, the increase in the population density of “lisa” has favored its growth.

The growth of *M. cephalus* in the present study is lower than those achieved by: López and Lora (1989a), who achieved 167.47 mm and 56.50 g, in four months of culture, at the density of 1 fish/m<sup>2</sup>, feeding it with rice powder; López and Lora (1989b), who

reached 172.80 mm and 61.76 g, in four months of culture, at the density of 1.5 fish/m<sup>2</sup>, feeding with chicken purine, in both cases, in polyculture with *Trichomycterus punctulatus* and *Oreochromis* spp; and, Buendía (1990), who obtained 206.06 mm and 96.90 g, in six months of culture, at the density of 1 fish/m<sup>2</sup>, fed with rice dust, in polyculture with *T. punctulatus*. Facts that are explained because in these studies, the sowing lengths and weights were much greater than in the present study. On the other hand, they surpass the results of López and Lora (1990), who achieved 112.20 mm and 17.10 g, in six months of culture, at the density of 1 fish/m<sup>2</sup>, fed with rice dust; which is explained because in this work a balanced diet with a higher protein level was used and because of the cultivation time.

Regarding “cascafe”, the results obtained in the present study surpass those achieved by Martínez and Núñez (1988), who obtained 102.69 mm and 9.66 g, in five months of cultivation, in the density of 1.5 fish/m<sup>2</sup>, feeding it with carob pods, in polyculture with *Trichomycterus punctulatus* and *Tilapia rendalli*; which is explained by the higher protein level of the diet used in this study and longer cultivation time.

The total production of Pond 1 (1.8 fish/m<sup>2</sup>) exceeded that of Pond 2 (2.3 fish/m<sup>2</sup>), which is explained because, despite having a lower stocking density, the number of fishes is greater. in Pond 1 because it has a larger surface area (900 m<sup>2</sup>), compared to Pond 2 (600 m<sup>2</sup>). On the other hand, gross and net productions were higher in the pond with the highest stocking density: 2.3 fish/m<sup>2</sup> (Pond 2). This characteristic of greater gross and net production at the highest densities has also been observed by López and others (2012), in polyculture of *Oreochromis niloticus* var. *Stirling* x *Oreochromis aureus*, *Colossoma macropomum* x *Piaractus brachipomus* and *Dormitator latifrons*, Rivera and Vega (2013), in polyculture of *T. punctulatus*, *D. latifrons* and *O. niloticus* x *O. aureus*, Cerdán y Sánchez (2014) in polyculture of *M. inca* with *Dormitator latifrons* and *Oreochromis niloticus* x *O. aureus*, López and Lora (2015), in polyculture of *Colossoma macropomum* and *Oreochromis* spp. and Farfán and Acosta (2015), in polyculture of *Piaractus brachipomus* and *Oreochromis* spp.

The best feed conversion and feed efficiency corresponded to the density of 2.3 fish/m<sup>2</sup>, where, although it is true, the total production is lower, the feed consumption will have been better despite receiving a smaller amount, compared to the total density of 1.8 fish/m<sup>2</sup>, a treatment that received the greatest amount of food.

The growth of *M. cephalus*, by presenting significant growth in the last month of culture, would indicate that it has not yet reached the asymptotic level in both culture densities; However, in *B. atrocaudatus*, significant growth until the last month occurred at the density of 2.3 fish/m<sup>2</sup>, but this did not occur at the density of 1.8 fish/m<sup>2</sup>, which observed significant growth until the penultimate month, indicating that it would have already reached the asymptotic level of its growth.

The physical parameters of the water were very similar in both treatments, which is an indicator of their homogeneity and that they would not have interfered with the sowing density factor, the reason for the experiment.

The water temperature of the ponds varied, increasing as time passed and this was linked to the seasonal changes that covered the growing period: autumn - winter - spring. Their values were found within the optimal range for warm water fish farming, which according to Boyd (1990), is between 20 and 28°C and according to Huet (1998), between 20 and 30°C.

Regarding the transparency of the water, the decrease in its value with the advancement of cultivation was due to the maturation process of the cultivation ponds due to the development of natural production, which caused the water to take on a dark green color at the end of cultivation.

## V. Conclusions

The growth of the fish was affected by the stocking density of the fish in the multitrophic culture, being better at the lower density for *M. cephalus* and at the higher density for *B. atrocaudatus*.

The best production performance, conversion factor and feed efficiency corresponded to the highest density of 2.3 fish/m<sup>2</sup>.

## References

1. Boyd, C. (1990). *Water quality in ponds for aquaculture*, Alabama Agricultural Experiment Station, Auburn Universidad de Alabama.
2. Buendía, F. (1989). *Policultivo en dos densidades de carga de Trichomycterus punctulatus "Life" y Mugil cephalus "Lisa" suplementados con polvillo*, [Tesis de pregrado], Universidad Nacional Pedro Ruiz Gallo, Lambayeque, Perú.
3. Farfán, R., & D. Acosta (2015). *Policultivo en dos densidades de siembra de Piaractus brachipomus "Paco" y Oreochromis spp. "Tilapia híbrida" (O. niloticus Var. Stirling x O. aureus) en estanques seminaturales*, [Tesis de pregrado], Universidad Nacional Pedro Ruiz Gallo, Lambayeque, Perú.
4. Cerdán, M., & L. Sánchez (2014). *Crecimiento de Macrobrachium inca "Camarón de río" en cuatro densidades de siembra en policultivo con Dormitator latifrons "Pocoche" y Oreochromis niloticus x Oreochromis aureus "Tilapia híbrida" en estanques seminaturales*, [Tesis de

- pregrado], Universidad Nacional Pedro Ruiz Gallo, Lambayeque, Perú.
5. Huet, M. (1998). *Tratado de Piscicultura*, 4ta, Edición, Ediciones Mundi-Prensa, Madrid-España.
6. López, S. J., & M. V. Lora (1989 a). *Policultivo en cinco densidades de siembra de "Lisa", Mugil cephalus "Life" Trichomycterus punctulatus y "Tilapia híbrida" (Oreochromis niloticus hembra x O. hornorum macho) suplementado con polvillo de arroz*, [Trabajo mimeografiado], Departamento Académico de Pesquería y Zoología, Universidad Nacional Pedro Ruiz Gallo, Lambayeque – Perú.
7. López, S. J., & M. V. Lora (1989 b). *Policultivo en cinco densidades de siembra de "Lisa", Mugil cephalus "Life" Trichomycterus punctulatus y "Tilapia híbrida" (Oreochromis niloticus hembra x O. hornorum macho) suplementado con purina*, [Trabajo mimeografiado], Departamento Académico de Pesquería y Zoología, Universidad Nacional Pedro Ruiz Gallo, Lambayeque – Perú.
8. López, S. J., & M. V. Lora (1990). *Policultivo de "Lisa" Mugil cephalus y "Life" Trichomycterus punctulatus y "Tilapia híbrida" (Oreochromis niloticus hembra x O. hornorum macho) suplementados con cuatro índices alimentarios de polvillo de arroz*. [Trabajo mimeografiado], Departamento Académico de Pesquería y Zoología, Universidad Nacional Pedro Ruiz Gallo, Lambayeque – Perú.
9. López, S. J., M. V. Lora., J. Barturén, M. Correa, M. Fernández, I. Guevara, L. Juárez, & F. Solís (2011). *Crecimiento de "Tilapia híbrida" (Oreochromis niloticus var. Stirling x Oreochromis aureus), "Pacotana" (Colossoma macropomum x Piaractus brachipomus) y "Pocoche" (Dormitator latifrons) en policultivo en diferentes densidades de siembra, en estanques seminaturales*, [Trabajo mimeografiado], Departamento Académico de Pesquería y Zoología, Universidad Nacional Pedro Ruiz Gallo, Lambayeque – Perú.
10. López, S. J., & M. V. Lora (2015). *Policultivo en tres densidades de siembra de Colossoma macropomum "Gamitana" y Oreochromis spp. (O. niloticus Var. Stirling x O. aureus) "Tilapia híbrida" en un sistema intensivo*, [Trabajo mimeografiado], Departamento Académico de Pesquería y Zoología, Universidad Nacional Pedro Ruiz Gallo, Lambayeque – Perú.
11. Nuñez, H., & N. Martínez (1988). *Policultivo experimental de Brycon atrocaudatu "Cascafe", Trychomycterus punctulatus "Life" y Tilapia rendalli "Tilapia"*, [Tesis de pregrado], Universidad Nacional Pedro Ruiz Gallo, Lambayeque, Perú.
12. Ostle, B. (1994). *Estadística aplicada*, Limusa Noriega Editores, México.
13. Rivera, P., & J. Vega (2013). *Crecimiento de Trichomycterus punctulatus "Life", "Pocoche" y Oreochromis niloticus x O. aureus "Tilapia híbrida" en policultivo en dos densidades de siembra en estanques seminaturales*, [Tesis de pregrado], Universidad Nacional Pedro Ruiz Gallo, Lambayeque, Perú.
14. Sokal, R., & J. Rohlf (1979), *Biometría: Principios y métodos estadísticos en la investigación biológica*, H. BLUME EDICIONES, Madrid-España.