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# Biological and Ecological Aspects Regarding *Cynoscion nothus* Holbrook, 1855 (Perciforms: Sciaenidae)

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**Abstract:** A whole amount of 634 individuals pertaining to the species *Cynoscion nothus*, was caught in Las Barrancas beach, Veracruz (Alvarado Municipality), Mexico. Sampling were made over an annual cycle that included climatic characteristics of the region (Dry, windy and rainy seasons). The biggest amount of individuals was captured during the dry season (258), this amount was followed by 200 (windys season) and 176 individuals (rainy season) respectively. This study was conducted in order to determine some biological and ecological parameters of this species. We determined the Seasonal Weight-Length relationship according to the equation proposed by Le Creen. It was observed that growth is allometric. The condition factor was estimated considering Fulton proposal, being this 3.56 for the windys season, 3.22 for the dry season, while the condition factor for the rainy season was 3.29. In the case of windy and rainy seasons we found five size classes and for the dry season, we found four size classes, according to the reading scale rings. The adjustment to the von Bertalanffy growth method showed that values achieved for the windys season, were Lmax. 36.30 cm and k = 0.1399. In the case of rainy season, Lmax was 35.53 cm and k = 0.2020. The sex ratio favored the males, lightly, being this 1:1:10 female-male through our work. The sex ratio according seasonal ratio, was as follows: 1:1.25 and 1:1.10 for the windys season and the dry season respectively, as well as the ratio in the rainy season favored the females (1.08: 1). Regarding gonadic maturity we found that during the windys season stages II, III, IV and V were present, and stages IV and V were predominant. In the case of the dry season, stages I, II, III, IV, V were identified, being the most frequent stages II and III and in the case of rainy season, predominant stages were II and III.

**Key words:** *Cynoscion nothus*, growth, condition factor, Alvarado, Sciaenidae, Veracruz

## INTRODUCTION

Mexico's surface is 1,969,269 km and its geographical location places the country in a privilege position regarding marine resources. Its continental platform considering the 200 m isobath line is 153,000 km for the Pacific littoral and 235,000 km for the Atlantic littoral[25,10,37]. The coastal plain is made of coastal lagoons, estuaries, bays and shores. The shores are coastal sedimentary accumulations. These are easily accessible and they are biologically rich. Therefore they are the best studied region in the continental platform[46].

Due to organism's plenty and diversity existing in this zone, fish species of great commercial value have been identified, such as families Mugilidae, Centropomidae, Gerreidae and Scianidae. The Gulf of Mexico has 270 fish species around 160 genus and 80 families[7]. Some of these families are particularly important because of their abundance, biomass and diversity. Its presence, biological and ecological behavior regarding their nutrition, reproduction and migration largely determine the abundance of tropical coastal resources[46].

The use of living marine resources is a mean to decisively improve the population nutritional levels. It

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is the base of economical and social development of every country. A viable alternative to meet those requirements is the exploitation of fishes considered accompaniment fauna eventually caught with different fishing gear; such fishes are used in a minimum amount for animal nutrition and most of them are sent back to the sea[44,32,17,40,4,19]. Among the various families of fish that occupy the coastal zone as spawning, breeding and feeding area, we may mention the Scianidae family[41,34], which has been widely studied because most members of it have ecological and economical importance as significant resource such as *Cynoscion nebulosus, Cynoscion regalis and C. nothus.*

## MATERIALS AND METHODS

**Description of Study Area:** The study area (Fig. 1) is located off the coastal plain of the central zone of Veracruz State, between parallels 18° 59 and 19° 0, north latitude and meridian lines 95° 57 and 96° 0 west longitude. The weather is type Aw 2 (i) hot, subhumid climate with an mean yearly temperature 26° C and the mean temperature of the coldest month being around 18° C showing oscillations between 5 and 7°. Winds prevail during a good part of the year and they have an east-southeast predominant direction, having an 8 knots maximum speed (exception made of October to February, when predominant winds are from North to Northeast and the speed shows a variation between 20 to 50 knots). The zone has well defined climate seasons. The rainy season occurs from June to September, while the windys season occurs from October to February, and the dry season takes place from February to May[21,13,43].

The region´s topography consists of a plain that goes down lightly from the eastern Sierra Madre, as a typical wide coastal plain with few reliefs. The continental platform is narrow and has been influenced by reef growths in front of Veracruz, however it widens significantly towards Southeast and its surface is covered with a variable amount of unconsolidated sands and limes[9].

**Field Work:** The samples were taken in Las Barrancas beach from 7:00 to 11:00 AM during an annual cycle. Specimens were caught by using a net of 600 m length and 4 m height with 4.5 cm mesh opening.

The collected organisms were injected with formalin through the anus to stop the digestive process "post mortem", then were fixed by immersion in 10% formalin placing them in plastic bags previously tagged and transported to the Laboratory of Ecology, Facultad de Estudios Superiores Iztacala, UNAM, where they were separated and washed with running water for later identification and analysis.

**Laboratory Work:** The organisms were identified by means of Fischer keys[15]. Each organism was weighted by using a semi-analytic scale with a capacity of 2000 g (± 0.01g). Each specimen was measured (pattern length) with a graduated ictiometer (± 0.05 mm). As additional information, sex and length of each individual was measured. An mean of ten scales was taken from the rear portion of the pectoral fin. The scales were taken from specimens that include several recorded lengths. The criteria used for identification and assessment of growth rings were according to FAO, 1982[6].

The gonads were obtained by dissection of 30% of the sample in order to assess the gonadal stage through the maturity phases, following Nikolsky criteria, 1963[31].

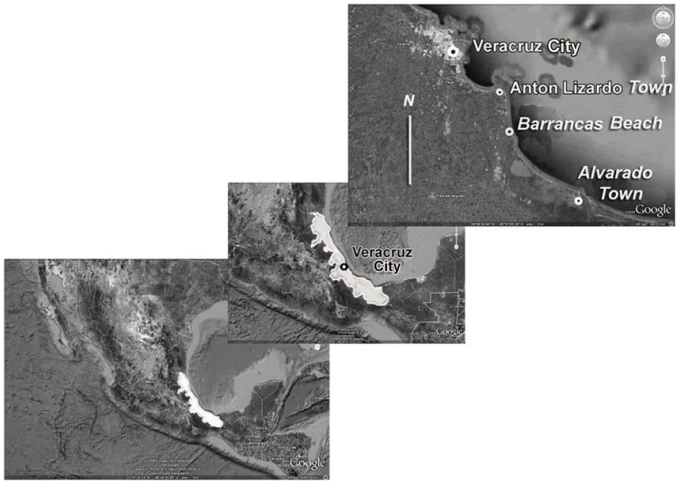


**Fig. 1:** Study area, Las Barrancas beach, Municipality of Alvarado, Veracruz, Mexico

**Sex Ratio:** The sex ratio was calculated according to the weather season, by means of the relations of Females number/Males number.

**Weight-Length Relationship:** The relation weight-length was calculated for each weather season (rainy season, dry season and windys season) by using Le Creen equation (1951)[26, 6], that is mathematically expressed as a potential function of the weight (g), versus length (cm), according the equation:

$W = a\ L^b$

Where:

W = weight
L= pattern length (cm) of the specimen
a = intercept
b= slope (allometry factor)

The species growth types was determined by means of the *t*-Student test, considering the constant b value or allometry coefficient[33, 47], in order to verify if growth type matched the isometric type (b=3, $p<0.05$), was used the following equation:

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

Where:

*t* = t-student value
b = slope
Sb = slope standar error
(See Sokal and Rolf[39] )

**Condition Factor:** Fulton's condition factor (K), was calculated according to values of the weight-length relationship calculated for each weather season, according to the following relation:

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

Where:

*K*= condition factor
*W*= organism weight (g)
*L*= pattern length (cm) of the organism
b= Weight-Length relationship slope
(See Wooton[46] )

**Class Length and Growth Model:** Class length determination was obtained by counting the number of rings found in the scales[6].

Once class length types were obtained, a procedure was made to determine the growth rhythm, according to the model proposed by *von Bertalanffy, (1938)[45].

$$Lt = L\max\left(1 - e^{-k(t-to)}\right)$$

Where:

*L* max = maximum length of the fish if it reaches an infinite age.

*K*= growth ratio, proportional to the organism metabolic index.

$t_o$= the hypothetical time when the fishes´s length is zero.

*Lt*= the length that the fish reaches from the initial time $t_0$ until a time given in t.

*t*= It is age expressed in time periods.

*Growth diminishes as age progresses until a point known as Lmax is reached, Lmax is defined as the point where growth rate is null. This means the closer Lt is to Lmax, the growth rate will be diminishing.

**Results:**

**Abundance:** A total of 634 organisms, were caught, and their lengths oscillated between 8.9 to 29.5 cm pattern length. During the dry season 258 organisms were caught, while 200 were caught for the windys season and 176 organisms were caught for the rainy season (Fig 2).

**Weight-Length relationship:** In order to prove if *C. nothus* growth was adjusted to isometric growth, a t-Student test was performed to compare the value of the slope against the theoretical value 3. The results achieved for the fore-mentioned seasons were as follows: windys season b=2.7116, t= -10.3 and 198 freedom degrees; dry season: b=206563, t= -10.3 and 198 freedom degrees and to rainy season b=2.7056, t= -7.2 and 174 freedom degrees (Table 1).

**Table. 1:** Constant values of the Weight-Length relationship of *Cynoscion nothus* by season. * Significant difference (p> 0.05)

| | a | b | t-Student |
|---|---|---|---|
| Windy | 0.0356 | 2.7597 | -10.3 * |
| Dry | 0.0322 | 2.6563 | -10.7 * |
| Rainy | 0.0329 | 2.677 | -7.2 * |

**Fulton's Condition Factor:** Fulton's Condition Factor for *C. nothus* are shown on Table 2.

**Table. 2:** Condition factor (K) per Season for *C. nothus*

| SEASON | Condition Factor (K) |
|---|---|
| Windy | 3.56 |
| Dry | 3.22 |
| Rainy | 3.29 |

**Gonadic Maturity and Sex Ratio:** A 52.5% male and 47.5% female yearly relationship was found (Table 3). The sex ratio for males in the windys season and dry

season were 1.25:1 and 1.10:1 males per female respectively, while in the case of the rainy season, the sex ratio was 1.08:1 females per male (Table 4).

**Table. 3:** Sex ratio, abundance and seasonal rate of *C. nothus* in Las Barrancas beach

| SEX | Number of organisms | % |
|---|---|---|
| Females | -94 | 47.5 |
| Males | -104 | 52.5 |
| TOTAL | -198 | 100 |

During the windys season, maturity stages II, III, IV and V were found. The stages that showed the larger individuals number, were IV and V. This signified a 79.4% of individuals analyzed in the above mentioned season.

In the case of the dry season, were observed every stage. We found that individuals in stages II and III signified 81.8 % of individuals analyzed for that season.

In the case of the rainy season stages II and III mean an 82.3% of the analyzed individuals whole amount.

**Age and Growth:** Mean values for different observed and expected age classes, are shown in Table 5. The result of equations regarding growth rhythm for each season, are seen in figures 6, 7 and 8.

Values found for Lmax and K (growth ratio) for each season are as follows: windys season Lmax= 36.3 cm, k=-0.2969, dry season Lmax= 32.47 cm k= -0.1399, rainy season Lmax= 35.53 cm k= -0.2020.

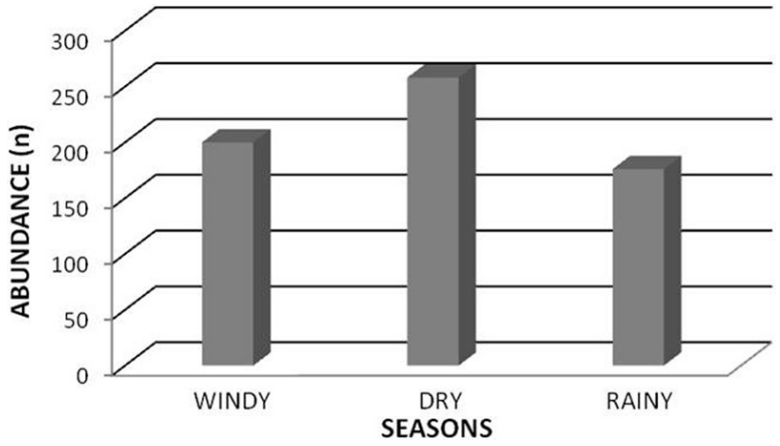


**Fig. 2:** Abundance of *C. nothus* in Las Barrancas beach for each season

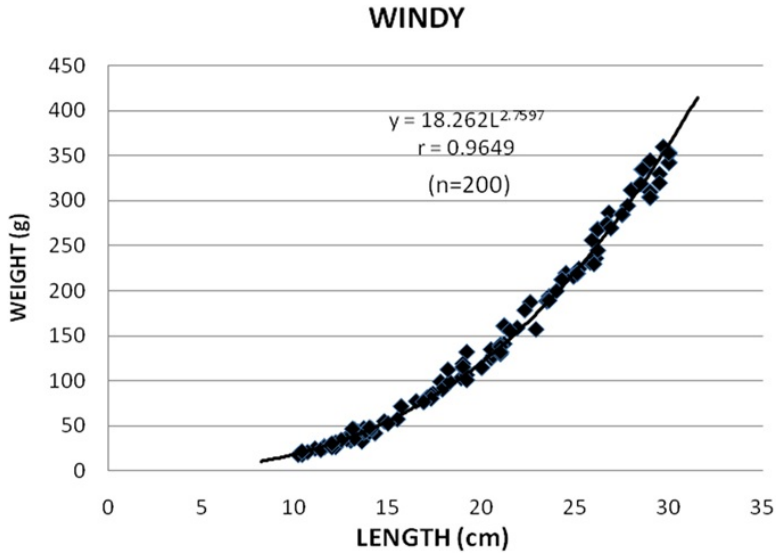


**Fig. 3:** Weight-Length relationship of *C. nothus* in Las Barrancas beach Windys season

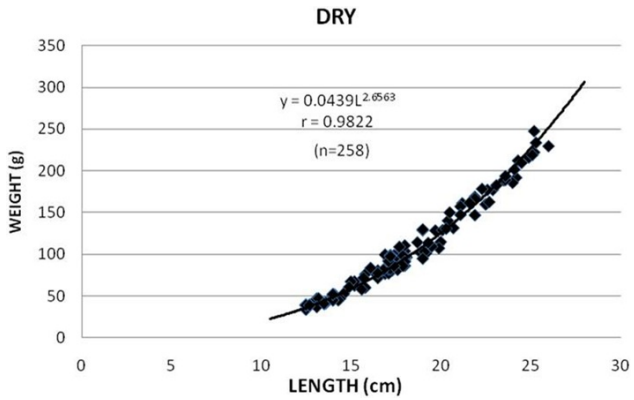


**Fig. 4:** Weight-Length relationship of *C. nothus* in Las Barrancas beach Dry season

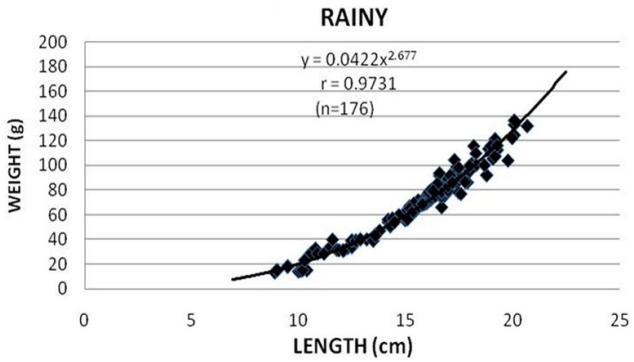


**Fig. 5:** Weight-Length relationship of *C. nothus* in LasBarrancas beach Rainy season

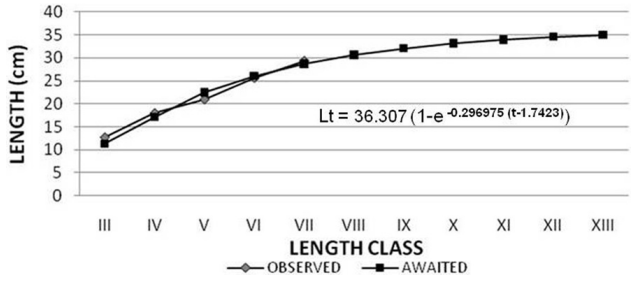


**Fig. 6:** Growth model of *C. nothus* in Las Barrancas beach, in windys season

**Table 4:** Stages of maturation, abundance of males and females recorded during several season of the year

| | Seasonal gonadal maturity | | | | | | |
|---|---|---|---|---|---|---|---|
| SEASONS | STAGES | | | | | Total/sex | Proportion |
| | I | II | III | IV | V | | |
| Windy | | H 1 | H 4 | H 8 | H 18 | H 31 | 1:1.25 |
| | | M 1 | M 10 | M 12 | M 16 | M 39 | |
| Dry | 1 | H 21 | H 8 | H 7 | H 2 | H 38 | 1:1.10 |
| | | M 25 | M 12 | M 4 | M 1 | M 42 | |
| Rainy | 3 | H 8 | H 15 | H 2 | | H 25 | 1.08:1 |
| | | M 8 | M 13 | M 2 | | M 23 | |

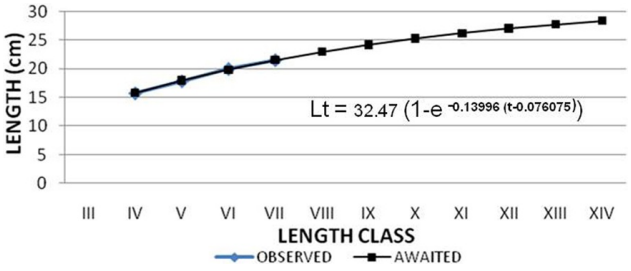


**Fig. 7:** Growth model of *C.nothus* in Las Barrancas beach, in dry season

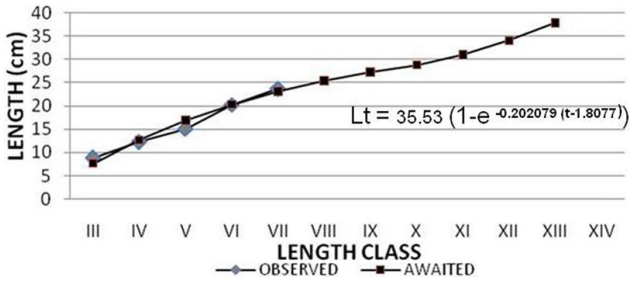


**Fig. 8:** Growth model of *C. nothus* in Las Barrancas beach, in rainy season

**Table. 5:** Size length classes for *C.nothus* in Las Barrancas beach in different seasons of the year

| length classes | Windy S.L. observed | Windy S.L. expected | Dry S.L. observed | Dry S.L. expected | Rainy S.L. observed | Rainy S.L. expected |
|---|---|---|---|---|---|---|
| III | | | | | 8.9 | 7.61 |
| IV | 12.68 | 11.31 | 15.73 | 15.79 | 12.3 | 12.7 |
| V | 17.95 | 17.73 | 17.82 | 17.97 | 15.1 | 16.89 |
| VI | 20.93 | 22.5 | 19.96 | 19.84 | 20.2 | 20.3 |
| VII | 25.6 | 26.05 | 21.5 | 21.51 | 23.7 | 23.08 |
| VIII | 29.3 | 28.68 | | 22.94 | | 25.36 |
| IX | | 30.64 | | 24.19 | | 27.22 |
| X | | 32.1 | | 25.27 | | 28.75 |
| XI | | 33.18 | | 26.21 | | 30.98 |
| XII | | 33.98 | | 27.03 | | 33.99 |
| XIII | | 34.58 | | 27.74 | | 37.82 |
| XIV | | 35.02 | | 28.35 | | |

**Discussion:** *Cynoscion nothus* that is locally known as *trucha blanca* is a species subject to commercial exploitation by the inhabitants of the area[5]. However, its consumption is local because population sizes are not as big as the ones seen in *C. nebulosus,* nevertheless, this species was recorded as a permanent feature throughout the year in different climatic periods in the study area, showing a greater abundance compared to other species obtained as bycatch in the area, in particular the sardine fishing. This may be the result of the species alimentary behavior, because it is an active predator that exists in any place where species used as food are present[24,1,42,7]. We may say as well that it is considered a cosmopolitan inhabitant of the coastal zone, their behavior can also be explained in abundance as a result of growth processes. Highlight the fact that the highest records of abundance occur in the Windyand Dry seasons (Fig. 2),

coinciding with the reproductive stages of this species in the area.

**Condition Factor:** According to several authors, the condition factor, allows the assessment of changes that fishes show in a seasonal manner as a result of internal and external factors, that may be interpreted as a welfare state. Condition factor may change according to species, morphology, sex, age, reproductive state associated to gonadic maturity stage variations[20,46]. In the case of this species, the highest value (3.56) were estimated in the windy season and lowest during the dry season (3.22), coinciding with higher stages of gonadal and reproductive development followed by the rainy season, when the species takes advantage of typical secondary production levels of the zone, which is enhanced by the drag of river systems to the coastal zone, as mentioned by Moran et al., 2005[30].

**Weight-Length Relationship:** The weight and length data analysis, allows to describe in a mathematical way, the relationship between length and weight among the species, so that the weight variation in a fish or group of fishes can be measured as an indicator of alimentary conditions and gonadal development[26,14,40,16]. This information is also important to appraise stocks[23,16].

The analysis performed for the three yearly seasons in the case of this species, indicates that it shows an allometric growth type. The relation between weight and length doesn't change in a drastically from one season to another. A similar result regarding allometric growth has been seen in *Cynoscion guatucupa* in the Brazilian littoral, as reported by Haimovici and Miranda, 2005[24]. However, an obvious difficulty exists when it comes to compare indexes different based on different regions[3]. When b reaches a value equal to 3, it is said the growth type is isometric[35,12]. On the contrary, when growth is different than 3, we say that growth is allometric[35]. When growth is allometric, bodily proportion changes occur[6]. A deviation from expected values for this model, may result of environmental changes, individual metabolism, sexual maturity or fishes age[8].

Values obtained for exponent "b" in this work, were as follows:

Windys season 2.7597, dry season 2.6563 and rainy season 2.677. These results could be related to the fishing device selectivity, because adults pertaining to this and bigger length species are found and recorded in deeper water[7]. Besides, the existence of juvenile lengths in the sampled seasons, suggests a continuous renewal of the species population. This allows a continuous individual incorporation in the area. A similar behavior has been reported by Marcano and Alio, 2001[27]. They say that few individuals of the species *Cynoscion jamacensis* showing lengths higher than 471mm in Venezuela´s eastern region. They relate this behavior to a reproductive strategy, because they found that individuals showing length higher than 471 cm are found in outlets of the estuary zones, where they finish their gonadic development, however, in the case of *C. nothus,* the bigger individuals haven´t been found in estuary outlets close to Alvarado Lagoon[18]. However they have been found in higher depth zones associated to shrimp fishing[1,2].

**Gonadic Maturity and Sex Ratio:** Sex ratio showed to be favorable to females in the rainy season (1.08:1), while for males were windy and dry seasons (1:1.25 and 1:1.10). The variations seen among seasons may be the result of migrations performed by the species because of factors such as food or reproductive season. Saona et al., 2003[38] indicate that sex ratio may vary according to geographical location. Nikolsky 1963[31], says that sex ratio varies in a substantial manner in fishes, however, in most species is close to 1.

Marcano and Alió, 2001[27] report a sex ratio where males were favored speaking about *C. jamaicensis.* Sex ratio was as follows: December (1.78: 1) and January (1.43: 1) in Venezuela's coasts. In present work were *C. nothus* shows bigger male ratio in the windys season (1.25: 1) and the dry season (1.10: 1). This encompasses the last months of the year and the first four months of the following year, showing a similar behavior to the one reported in case of *C. jamaicensis.* Marcano and Alió, 2002[28] think this behavior is directly related to the species reproductive behavior, when they say that a higher male ratio is related to the species reproductive behavior, where females migrate to the estuary outlets to carry out spawning. So males are more susceptible of being caught. While establishing a relationship between sex ratio of *C. nothus* in Las Barrancas beach and gonadic maturity stages, we may observe that bigger lengths (> 28 cm), showed gonadic maturity IV and V in windys season and dry season. These could be related to reproductive movements performed by adults in the littoral zone where organisms were collected. The assessment of this parameter is considered to be important in order to know the species population structure, however we accept that it may suffer differences from the reproductive period, length groups and environmental regulations and species genetical variability[11].

**Age and Growth:** Growth, expressed as the variation of any individual's dimension in a population, considering time as a function, produces as a result an asymptote curve. Therefore, it is a magnitude

susceptible of increasing gradually, becoming slower as time goes till a nearly maximum is reached[29], growth uses showing a curve that corresponds to dimensions equal to lengths in continual times in a population's sample. Therefore, the growth curve is the feature of an individual.

The analysis of growth rings in anatomical structures is very useful to define a growth model, from the assessment of age classes in this group of organisms. Some attempts to determine growth, correspond to early stages of development such as the ones performed by Flores-Coto et al., 1998[16].

They defined growth ratio to in larvae pertaining to the Sciaenidae family in the Gulf of Mexico's South.

Age records in scales allowed defining five age types in the windys season and rainy season and four age types in the dry season.

When adjustments to corresponding model were made, results of the same could be projected even in 14 length types, in order to appraise trends of the model from results obtained. Values for maximum length in this species oscillated between 32 and 36 cm Lmax, regarding data obtained in the catch where values oscillated between 27 to 30 cm pattern length. An aspect that should be highlighted is the absence of bigger length organisms. This behavior may be related to a slant explained by the fishing device as mentioned by Ricker, 1979[36] in case of other species susceptible to be exploited as fisheries.

**Conclusions:** We may conclude that this species belongs to a fish family considered as demersal fauna. Because it is little exploited, we lack data regarding its biology. *C nothus* is a species present during the entire year in the fishing area.

Individuals pertaining to medium lengths prevail, and sex ratio leans towards male organisms (1.25:1 and 1.10:1 for windys season and dry season respectively). Sex ratio leans toward female specimens in the rainy season. Advanced gonadic maturity stages are found in the windys and dry seasons. Early stages are found in the rainy season.

Constants obtained from growth model adjustment from the weight-length relationship in a seasonal manner, reinforce the behavior seen in the gonadic maturity stages, being the condition factor highest in the windys season, respect to other climatic seasons. Adjustment to growth model by means of the use of scales for this species, showed similar results to data obtained bibliographically as maximum size.

Results achieved in this work show that *C. nothus* uses the coastal zone as maturity and growth area during most part of the year, this allows the species reaching big means lengths sizes which are exploited by inhabitants of the zone.

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