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# GROWTH AND AGE OF JUVENILE AMERICAN CROCODILES (*CROCODYLUS ACUTUS*) IN LA VENTANILLA ESTUARY, OAXACA, MEXICO

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***Abstract.*—We analyzed growth rates of wild American Crocodiles (*Crocodylus acutus*) of the Oaxacan coast from 2000–2009. We also estimated the age of crocodiles at the study site based on their total length (TL), using growth rates and the von Bertalanffy model. Growth rates for TL and body weight were 0.056 ± 0.049 cm/day (n=45) and 1.092 ± 0.47 g/day (n=16), respectively. Individuals with the highest growth rates in length did not necessarily have the highest growth rates in weight. For the von Bertalanffy model, we used growth rate data for 23 individuals with mean TL from 700 to 1352 mm between capture and recapture. Thus, the model pertained only to young individuals. Based on model estimates, American Crocodiles from the coast of Oaxaca are larger than crocodiles of the same age from two other sites in Mexico (Banco Chinchorro and Puerto Vallarta). Although results of this study seem to agree with patterns found in other regions for this species, it is necessary to evaluate the factors influencing growth of *C. acutus* inhabiting Oaxaca's coast, especially salinity, environmental temperature variations, and precipitation.**

*Key Words.*—age estimate; American Crocodile; *Crocodylus acutus*; growth rates; mark-recapture; Mexico; Oaxaca

## INTRODUCTION

Length and weight of crocodiles are important parameters for the study of crocodilian population dynamics as they provide a basis to estimate growth rates and ages (Webb and Smith 1987; Cupul-Magaña et al. 2004). These parameters influence fundamental demographic variables such as size and fecundity of individuals, and are consequently helpful in making informed decisions with respect to management, conservation, or exploitation of wild and captive populations (Nichols 1987; Webb and Smith 1987). In Mexico, wild populations of American Crocodiles (*Crocodylus acutus*) were heavily depleted from 1930 to 1970 as a result of intense commercial hunting (Casas-Andreu and Guzmán-Arroyo 1970). However, the national ban on crocodile exploitation established in 1970 in Mexico (SEMARNAT 2000) allowed for the conservation of remaining populations. Currently, efforts are being made to assess the conservation status and distribution of crocodilian species in Mexico (Sánchez-Herrera et al. 2011; García-Grajales and López-Luna 2010). Crocodylus acutus (Fig. 1) is classified by the International Union for the Conservation of Nature as "Vulnerable" (IUCN. 2011. IUCN Red List of Threatened Species. Version 2011.2. Available from http://www.iucnredlist.org [Accessed 10 January 2012]), is listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora(CITES. 2011. Appendices I, II and III. Available from http://www.cites.org [Accessed 10 January 2012]) and is considered as a "species subject to special protection" by the Mexican law (Diario Oficial de la Federación 2010).

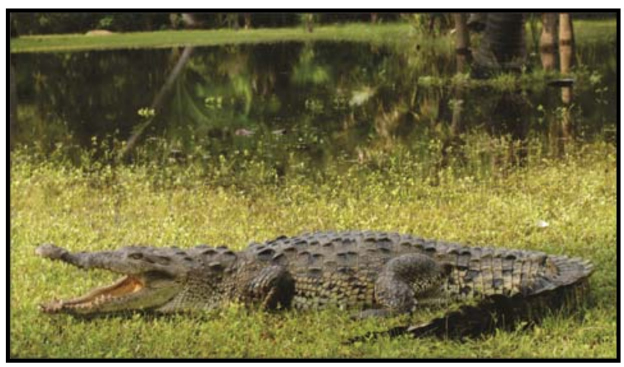

**FIGURE 1.** American Crocodile (*Crocodylus acutus*) in La Ventanilla estuary, Oaxaca, Mexico. (Photographed by Jesus García-Grajales)

The importance of growth rates (total length and weight) in crocodiles and the factors that affect them have been discussed by Charruau et al. (2010). Although the number of studies on *C. acutus* increased notably in Mexico between 1991 and 2010, very few long-term studies provide information on growth rates

 

(García-Grajales and López Luna 2010). Recently, Charruau et al. (2010) published length and weight data of *C. acutus* from wild populations of the Yucatan Peninsula through compilation of data from several projects. That work is the only study that reports this kind of information for wild populations of *C. acutus* from Mexico.

Growth rates are obtained by recaptures of previously marked and measured individuals (Charruau et al. 2010). Nevertheless, the mark-recapture technique increases the wariness of individuals, which tends to increase their escape distance and decreases the recapture rate (Webb and Messel 1979; Bayliss 1987; Ron et al. 1998; García-Grajales et al. 2007b). Knowledge of growth rates of wild crocodiles allows estimation of the age of individuals based on their size using the model of von Bertalanffy, provided that sample sizes are sufficient (Hutton 1987; Cupul-Magaña 2002; Charruau 2011). Knowing the age of individuals is essential for examining population structure, demographics, and dynamics (Nichols 1987; Webb and Smith 1987), which are critical for developing effective management actions for species conservation. Although several techniques of age determination exist for a multitude of species (Henry 2001), in crocodiles and other reptiles this task is difficult due to their ecological and biological characteristics (Hutton 1987; Charruau 2011). For example, crocodiles have no horns or antlers, which serve to determine age of cervids or bovids (Gray and Simpson 1985). In others mammals, age of individuals can also be determined by the growth or the wear of teeth (Leyssac and Madsen 2001), a technique that also cannot be used in crocodiles because they replace their teeth constantly during their life (Poole 1961; Erickson 1996).

Two methods exist for determining the age of crocodilians (Hutton 1987). The first is skeletochronology, which consists of making a transverse cut of certain bones and counting the concentric growth rings, corresponding to the minimal age of the individual (Hutton 1986). However, this technique is invasive because the individual must be killed or particular bones, like osteoderms, have to be surgically removed (Hutton 1987; Richardson et al. 2002). The second method uses growth data of recaptured individuals and the growth model of Ludwig von Bertalanffy (Hutton 1987; Cupul-Magaña 2002; Charruau 2011). The model uses various parameters, such as the asymptotic size (maximum size that individuals can reach in a studied population), the initial size (size of individuals at birth), and a time constant. These parameters are obtained by making regressing growth rates of individuals against their size. This method is preferred in population studies as it is noninvasive.

Recent studies on wild populations of *C. acutus* in Oaxaca have provided information on size and status of populations (Martínez de Melo 2005; Brandon-Pliego 2007; García-Grajales et al. 2007a), morphology (García-Grajales et al. 2009), population genetics (Serrano-Gómez 2009), and parasites (García-Grajales and Buenrostro-Silva 2011). However, none have focused on growth rates or age estimate. The objectives of this study were to obtain data on growth rates of total length and weight of wild *C. acutus* in a coastal locality of Oaxaca, and to estimate age as a function of size using the von Bertalanffy model. Data obtained will help to estimate/determine fundamental demographic parameters (e.g., population structure, age and size at maturity, and life expectancy of individuals), which permit study of the population dynamic and can be used to implement management/conservation actions if needed. Growth rate can also be used as an indicator of environmental change and condition because growth depends on several environmental factors.

## Materials and Methods

***Study area***.—The study took place in La Ventanilla estuary (15º40´37.36´´N, 96°35´12.30´´W, 15º40´29.07´´ N, 96º34´24.30´´W, 15°40´11.49´´N, 96°34´40.25´´W, 15°40´22.18´´N, 96º35´10.78´´W), Oaxaca, Mexico, which is formed directly by the Tonameca River on the west side and indirectly through subterranean drains on the north and northeast sides of the river basin (Marini 1999). The Tonameca River originates in the highlands of Oaxaca State and provides an intermittent current. During the rainy season the river floods areas of its mouth, which are part of La Ventanilla estuary (Marini 1999). The estuary is 57,000 ha in extent. Vegetation of the area consists of low deciduous forest and mangrove (*Rhizophora mangle*, *Laguncularia racemosa*). Vegetation of the flooded zone includes Narrow Leaf Cattail (*Typha angustifolia*), "Palo de Agua" (*Bravaisia integerrima*), and barnyard grass (*Echinochloa* sp.). Coastal dune vegetation includes seashore Salt Grass (*Distichlis spicata*), Sea Purslane (*Sesuvium portulacastrum*), cactus (*Opuntia* spp.), and sparse leguminous shrubs such as *Prosopis* sp. (Marini 1999).

***Field work***.—We determined growth rates of *C. acutus* with mark-recapture data obtained from surveys made during several projects in the area from 2000 to 2009 (García-Grajales and Espinosa Reyes 2001; García-Grajales 2005; García-Grajales et al. 2009). Captures we made during the surveys used the same technique described in García-Grajales et al. (2007a). We made spotlight surveys in La Ventanilla using a small boat propelled by paddling, and each crocodile we observed was approached as closely as possible to be capture by hand or noose, depending on crocodile size. We measured the ventral total length (cm) from the snout tip to the end of the tail, and the weight (g) of each captured crocodile. We also determined the sex of each individual by cloacal examination (Chabreck 1963). We marked each crocodile by notching a unique pattern of tail scutes for later identification (Bayliss 1987) and then released crocodiles at their capture sites. We classified captured crocodiles according to their total length (TL): class I (hatchlings and yearlings, TL < 60.0 cm), class II (juveniles, 60.1 < TL < 120.0 cm), class III (subadults, 120.1 < TL < 180.0 cm) and class IV (adults, TL > 180.1 cm; García-Grajales et al. 2007a).

***Analysis.***—We calculated growth rates by dividing the difference in length (cm) or weight (g) between initial capture and recapture of individuals by the number of days elapsed between those captures. We performed a linear regression between growth rates of TL (mm/d) and mean TL of individuals between their initial capture and recapture (mm), for which the equation is:

$$\Theta TL = a\ TLm + b \qquad \text{(equation 1)}$$

where ΘTL is the growth rate of total length (TL), a is the regression coefficient or slope of the regression line, b is the ordinate value where the regression line is intercepting the Y-axis, and TLm is the mean total length of the individual between captures. To reduce bias in the analysis due to individuals that did not end a complete growth season, we only used data from crocodiles recaptured after a time lapse of n complete ± 0.2 y (e.g., 1.0, 1.1, 1.2, 1.8, 1.9, 2.0, and not 2.6, 1.3, 3.5; Hutton 1987). We used G-Stat student to generate the regression analysis (Zar 1999). Results were declared significant at $P \leq 0.05$.

To determine the age of crocodiles from TL, we used the von Bertalanffy model, for which the equation (von Bertalanffy 1934) is:

$$t = \tau \ln [(TLA-TL0)/(TLA-TLt)] \text{(equation 2)}$$

where t is the age of the crocodile in days. To obtain the age in years, the value of t is divided by 365, τ is a time constant that corresponds to the inverse of the slope of the regression line (equation 1): τ = 1/a, ln is the natural logarithm, TLA is the asymptotic TL (maximum length that an individual can reach) and corresponds to the quotient between the intercept and the slope of the regression line (equation 1): TLA = b/a, TL0 is the initial TL or TL at hatching, and TLt is the TL of crocodile at time t. For this work, we used the mean TL of *C. acutus* at hatching in La Ventanilla estuary. We calculated all parameters necessary to use equation 2 and we estimated age of crocodiles from La Ventanilla for different TL values.

## RESULTS

We captured 1,125 crocodiles over 10 y, but we captured only 45 crocodiles (10 females and 35 males). We obtained growth rates in length for 45 individuals and in weight for 16 individuals. Thirty-eight crocodiles changed size classes between their first and second capture: 35 from class I to class II in a time lapse of 70–2,495 d, two from class II to class III in a time lapse of 1,514–2,525 d, and one from class I to class III in 913 d (Table 1). Mean time between capture and recapture was 849 ± 631 d (70–2,525 d, Table 1).

Mean growth rates in length and weight were 0.056 ± 0.049 cm/d (n = 45) and 1.092 ± 0.47 g/d (n = 16), respectively. Growth rates were highly variable among individuals, from minimum rates of 0.0020 cm/d and 0.0002 g/d to maximum rates of 0.280 cm/d and 2.873 g/d (Table 1). Crocodiles with higher growth rates in length did not necessarily have higher growth rates in body weight (Table 1). There was an exponential relationship between TL and weight of crocodiles that we captured (Weight = $93.552\ e^{0.0288TL}$, $r^2$ = 0.8935; Fig. 2).

For the von Bertalanffy model, we used 23 of the 45 length growth rates obtained. There was a power relationship between growth rate of TL and the mean TK of individuals between their first and second captures (Growth Rate = $72346TLm^{-1.799}$, $r^2$ = 0.274; Fig. 3). However, because the von Bertalanffy model needs a linear relation for those data, we performed a linear regression and obtained a significant result with growth rate of TL negatively correlated to the mean TL (Spearman's r = -0.496, $P$ = 0.016) of individuals. From the regression equation (ΘTL = -0.001 TLm + 1.407), we obtained parameters τ = 1,000 and TLA = 1,406.8. The mean TL at hatching (TL0) was 270 mm based on data from151 hatchlings of *C. acutus* captured in 2011 in La Ventanilla estuary (unpubl. data). With all the parameters calculated we obtained the following von Bertalanffy equation:

$$t = 1{,}000 \ln [(1{,}406.8 - 270)/(1{,}406.8 - TLt)]$$

From this equation we estimated the age of crocodiles from La Ventanilla with TL from 280 mm to 1,200 mm. Ages ranged from 0.02 y for an individual 280 mm TL to 4.67 y for a crocodile 1,200 mm TL (Table 2).

## DISCUSSION

***Growth rates***.—Mean growth rate in length of *C. acutus* obtained in this study (0.056 ± 0.049 cm/d) was higher than that obtained in the Yucatan Peninsula (Charruau et al. 2010; 0.044 ± 0.033 cm/d) and lower than that obtained in Jalisco (Cupul-Magaña et al. 2004; 0.185 cm/d). This difference is likely because growth rate in length decreases with the increase of length of individuals in *C. acutus* (Thorbjarnarson 1988; Pérez and Escobedo-Galván 2007; Meráz et al. 2008; Charruau et al. 2010) as in other crocodilian species (Webb et

**TABLE 1.** Data on captured-marked-recaptured *Crocodylus acutus* in La Ventanilla, Oaxaca, México. M: male, F: female, TL: total length, GRL: growth rate in length, GRW: growth rate in weight.

| ID | Sex | TL Capture (cm) | Size Class | Weight Capture (g) | TL Recapture (cm) | Class | Weight Recapture (g) | Growth in Length (cm) | Growth in Weight (g) | Days Between Captures | GRL (cm/d) | GRW (g/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | M | 107.0 | II | — | 163.4 | III | 3,000 | 56.4 | — | 2,525 | 0.022 | — |
| 56 | M | 46.5 | I | — | 105.0 | II | 1,500 | 58.5 | — | 2,495 | 0.023 | — |
| 177 | M | 63.0 | II | 450 | 116.5 | II | 2,900 | 53.5 | 2450 | 2,190 | 0.024 | 1.118 |
| 163 | M | 51.0 | I | — | 103.4 | II | 1,500 | 52.4 | — | 1,833 | 0.029 | — |
| 234 | F | 78.0 | II | — | 117.5 | II | 2,400 | 39.5 | — | 1,673 | 0.024 | — |
| 160 | F | 65.0 | II | — | 122.0 | III | 2,800 | 57.0 | — | 1,514 | 0.038 | — |
| 252 | M | 73.5 | II | — | 114.2 | II | 2,600 | 40.7 | — | 1,479 | 0.028 | — |
| 269 | M | 74.0 | II | — | 105.0 | II | 2,100 | 31.0 | — | 1,456 | 0.021 | — |
| 326 | M | 58.3 | I | — | 88.4 | II | 1,300 | 30.1 | — | 1,403 | 0.021 | — |
| 338 | M | 50.5 | I | 370 | 112.5 | II | 2,650 | 62.0 | 2,280 | 1,369 | 0.045 | 1.665 |
| 315 | M | 47.5 | I | — | 74.8 | II | 680 | 27.3 | — | 1,319 | 0.021 | — |
| 367 | M | 50.0 | I | — | 81.9 | II | 1,200 | 31.9 | — | 1,228 | 0.026 | — |
| 481 | M | 44.0 | I | 390 | 87.2 | II | 1,500 | 43.2 | 1,110 | 1,013 | 0.043 | 1.095 |
| 411 | M | 50.5 | I | — | 82.0 | II | 1,200 | 31.5 | — | 914 | 0.034 | — |
| 437 | F | 48.0 | I | — | 80.6 | II | 1,500 | 32.6 | — | 914 | 0.036 | — |
| 486 | F | 48.0 | I | — | 83.2 | II | 2,000 | 35.2 | — | 914 | 0.039 | — |
| 492 | M | 47.5 | I | — | 92.8 | II | 2,500 | 45.3 | — | 914 | 0.050 | — |
| 493 | M | 53.0 | I | 410 | 84.8 | II | 1,050 | 31.8 | — | 914 | 0.035 | 0.700 |
| 498 | M | 50.5 | I | — | 91.2 | II | 960 | 40.7 | — | 914 | 0.045 | — |
| 517 | F | 53.5 | I | — | 93.4 | II | 870 | 39.9 | — | 914 | 0.044 | — |
| 521 | F | 59.5 | I | — | 86.4 | II | 1,000 | 26.9 | — | 914 | 0.029 | — |
| 525 | M | 52.0 | I | — | 84.0 | II | 950 | 32.0 | — | 914 | 0.035 | — |
| 454 | F | 50.0 | I | — | 124.4 | III | 2,750 | 74.4 | — | 913 | 0.081 | — |
| 485 | M | 52.0 | I | 440 | 75.5 | II | 650 | 23.5 | 210 | 800 | 0.029 | 2E-04 |
| 598 | F | 42.8 | I | 360 | 76.6 | II | 580 | 33.8 | 220 | 667 | 0.051 | 0.330 |
| 599 | M | 53.0 | I | 375 | 73.5 | II | 580 | 20.5 | 205 | 667 | 0.031 | 0.307 |
| 552 | M | 48.0 | I | — | 84.0 | II | 1,000 | 36.0 | — | 549 | 0.066 | — |
| 694 | M | 53.5 | I | — | 67.6 | II | 720 | 14.1 | — | 498 | 0.028 | — |
| 540 | M | 51.0 | I | — | 97.0 | II | 930 | 46.0 | — | 403 | 0.114 | — |
| 561 | M | 48.0 | I | — | 89.5 | II | 900 | 41.5 | — | 365 | 0.114 | — |
| 562 | F | 54.0 | I | 410 | 89.0 | II | 1,150 | 35.0 | 740 | 365 | 0.096 | 2.027 |
| 696 | M | 52.5 | I | — | 89.0 | II | 1,050 | 36.5 | — | 365 | 0.100 | — |
| 569 | M | 48.0 | I | 380 | 88.1 | II | 1,050 | 40.1 | 670 | 311 | 0.129 | 2.154 |
| 668 | M | 54.0 | I | 405 | 70.0 | II | 680 | 16.0 | 275 | 292 | 0.055 | 0.941 |
| 678 | M | 42.0 | I | 320 | 71.0 | II | 610 | 29.0 | 290 | 292 | 0.099 | 0.993 |
| 702 | M | 51.0 | I | 395 | 80.0 | II | 760 | 29.0 | 365 | 292 | 0.099 | 1.250 |
| 705 | M | 43.0 | I | 335 | 88.4 | II | 800 | 45.4 | 465 | 292 | 0.155 | 1.592 |
| 628 | F | 54.5 | I | — | 72.1 | II | 730 | 17.6 | — | 287 | 0.061 | — |
| 682 | M | 46.5 | I | — | 61.8 | II | 600 | 15.3 | — | 254 | 0.060 | — |
| 690 | M | 46.0 | I | — | 61.6 | II | 600 | 15.6 | — | 254 | 0.061 | — |
| 686 | M | 55.0 | I | 490 | 55.4 | I | 520 | 0.4 | 30 | 184 | 0.002 | 0.163 |
| 688 | M | 52.0 | I | — | 62.4 | II | 750 | 10.4 | — | 184 | 0.057 | — |
| 632 | M | 56.0 | I | 495 | 56.8 | I | 520 | 0.8 | 25 | 96 | 0.008 | 0.260 |
| 963 | M | 104.8 | II | 3,100 | 105.6 | II | 3,350 | 0.8 | 250 | 87 | 0.009 | 2.873 |
| 677 | M | 49.0 | I | — | 68.9 | II | 900 | 19.9 | — | 70 | 0.284 | — |

1978; Webb et al.1983; Rootes et al. 1991; Rebêlo et al. 1997; Andrews 2000; Wang et al. 2006). This was also observed in our study, where crocodiles of class I and I had higher growth rates in length with a mean of 0.056 cm/d, and then growth rates decreased in crocodiles of class III (juveniles) with mean of 0.038 cm/d. In addition, mean growth rate of *C. acutus* in the Yucatan Peninsula was obtained from individuals of all size class (class I to V; Charruau et al. 2010), whereas in Jalisco it was obtained from crocodiles of class I only (Cupul-Magaña et al. 2004). Thus, the mean growth rate obtained in Jalisco would be expected to be higher than that obtained in the Yucatan Peninsula. Growth rates obtained in our study are from individuals of size classes I to III only and appear intermediate compared to those studies from Jalisco and the Yucatan Peninsula. Furthermore, growth rates found herein agree with those found in other studies on this species (Thorbjarnarson 1989; Moler 1991; Schubert et al. 1996; Mazzotti 1999; Mazzotti et al. 2007).

Currently, few data exist on growth rates based on body weight of wild *C. acutus*. Only Charruau et al. (2010) and Mazzotti (1999) present some data for the Yucatan Peninsula and Florida, obtaining mean growth rates of 9.65 ± 18.35 g/d (range: 0.00–60.00 g/d, n = 20)

rates in crocodilians are temperature of egg incubation (Joanen et al. 1987), environmental temperature (Webb and Manolis 1998), food quality and availability (Rootes et al. 1991), seasons (Magnusson and Taylor 1981), salinity (Magnusson and Taylor 1981; Dunson 1982; Mazzotti et al. 1986), and clutch of origin (Garnett and Murray 1986). Furthermore, different growth dynamics between sexes have been observed in various crocodilian species, with males tending to grow faster and reaching larger size than females (Webb et al. 1978, 1983; Rootes et al. 1991; Tucker et al. 2006; Platt et al. 2009). *Crocodylus acutus* show sexual dimorphism, with males

and 5.39 ± 5.39 g/d (range: -0.45–17.54 g/d, n = 16), respectively. Mean growth rate in weight of 1.092 ± 0.470 g/d (range: 0.0002–2.8730 g/d, n =16) obtained in La Ventanilla is much lower than those found in other studies. As for growth rates in length, our results can be explained through the weight growth dynamic of crocodilians and the size of individuals studied. In crocodilians, the dynamic of growth in weight differs from the dynamic of growth in length (Charruau et al.

2010). While young individuals (classes I to III) and adults (class V) show low rates, sub-adults (class IV) show much higher rates (Charruau et al. 2010). Thus, as individuals of this study are from classes I to III, it appears normal to obtain a mean growth rate lower than those obtained by Charruau et al. (2010) and Mazzotti (1999), where individuals of all size classes were used. Furthermore, growth rates in weight found in this study agree with mean growth rates of young individuals from the Yucatan Peninsula (0.93 and 1.33 g/d) and from Florida (1.7 g/d; Mazzotti 1999; Charruau et al. 2010). Other factors, such as genes, environment, and social aspects factors can explain regional differences in mean growth rates of *C. acutus* (Garnett and Murray 1986; Wilkinson and Rhodes 1997; Tucker et al. 2006). Among factors that have been identified to affect growth being larger than females (Álvarez del Toro 1974; Platt et al. 2011). Thus, males and females of this species could have different growth rates and it is generally better to construct a model of von Bertalanffy for each sex (Hutton 1987). In this study, data were insufficient to analyze the effect of sex in growth of *C. acutus* in Oaxaca´s coast, due primarily to the low number of females captured compared to males. The latter reflects the male-biased sex ratio reported in the study area (García-Grajales et al. 2007a). For the same reason, no significant linear regression between growth rates and mean size of individuals could be obtained for each sex.

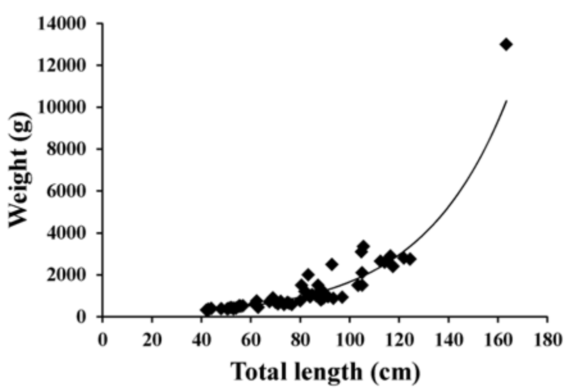


**FIGURE 2.** Relationship between weight and total length of *Crocodylus acutus* captured in La Ventanilla, Oaxaca, Mexico.

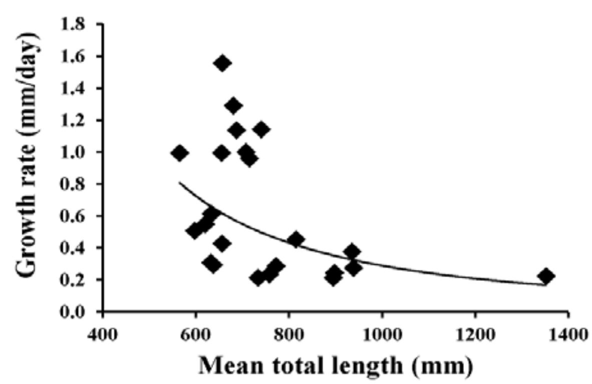


**FIGURE 3.** Relationship between growth rate of total length and mean total length between capture and recapture of 23 *Crocodylus acutus* from La Ventanilla, Oaxaca, Mexico.

**TABLE 2.** Age estimate (in years) of *Crocodylus acutus* from La Ventanilla, Banco Chinchorro, and Puerto Vallarta, based on their total length (TL in mm).

| This study La Ventanilla | | Charruau (2011) Banco Chinchorro | | Cupul-Magaña (2002) Puerto Vallarta | |
|---|---|---|---|---|---|
| TL | Age | TL | Age | TL | Age |
| 280 | 0.02 | 280 | 0.12 | 280 | 0.00 |
| 300 | 0.07 | 300 | 0.21 | 300 | 0.10 |
| 320 | 0.12 | 320 | 0.30 | 320 | 0.19 |
| 340 | 0.17 | 340 | 0.39 | 340 | 0.29 |
| 360 | 0.23 | 360 | 0.48 | 360 | 0.39 |
| 380 | 0.28 | 380 | 0.57 | 380 | 0.49 |
| 400 | 0.33 | 400 | 0.67 | 400 | 0.59 |
| 420 | 0.39 | 420 | 0.76 | 420 | 0.69 |
| 440 | 0.44 | 440 | 0.86 | 440 | 0.79 |
| 460 | 0.50 | 460 | 0.95 | 460 | 0.89 |
| 480 | 0.56 | 480 | 1.05 | 480 | 0.99 |
| 500 | 0.62 | 500 | 1.14 | 500 | 1.09 |
| 520 | 0.68 | 520 | 1.24 | 520 | 1.19 |
| 540 | 0.74 | 540 | 1.34 | 540 | 1.29 |
| 560 | 0.81 | 560 | 1.43 | 560 | 1.40 |
| 580 | 0.87 | 580 | 1.53 | 580 | 1.50 |
| 600 | 0.94 | 600 | 1.63 | 600 | 1.60 |
| 620 | 1.01 | 620 | 1.73 | 620 | 1.71 |
| 640 | 1.08 | 640 | 1.84 | 640 | 1.81 |
| 660 | 1.15 | 660 | 1.94 | 660 | 1.91 |
| 680 | 1.23 | 680 | 2.04 | 680 | 2.02 |
| 700 | 1.30 | 700 | 2.14 | 700 | 2.12 |
| 720 | 1.38 | 720 | 2.25 | 720 | 2.23 |
| 740 | 1.46 | 740 | 2.35 | 740 | 2.34 |
| 760 | 1.55 | 760 | 2.46 | 760 | 2.44 |
| 780 | 1.63 | 780 | 2.57 | 780 | 2.55 |
| 800 | 1.72 | 800 | 2.67 | 800 | 2.66 |
| 820 | 1.81 | 820 | 2.78 | 820 | 2.77 |
| 840 | 1.91 | 840 | 2.89 | 840 | 2.87 |
| 860 | 2.01 | 860 | 3.00 | 860 | 2.98 |
| 880 | 2.11 | 880 | 3.11 | 880 | 3.09 |
| 900 | 2.21 | 900 | 3.22 | 900 | 3.20 |
| 920 | 2.32 | 920 | 3.34 | 920 | 3.31 |
| 940 | 2.44 | 940 | 3.45 | 940 | 3.42 |
| 960 | 2.56 | 960 | 3.57 | 960 | 3.54 |
| 980 | 2.68 | 980 | 3.68 | 980 | 3.65 |
| 1,000 | 2.82 | 1,000 | 3.80 | 1,000 | 3.76 |
| 1,050 | 3.17 | 1,050 | 4.09 | 1,050 | 4.04 |
| 1,100 | 3.59 | 1,100 | 4.40 | 1,100 | 4.33 |
| 1,150 | 4.08 | 1,150 | 4.71 | 1,150 | 4.62 |
| 1,200 | 4.67 | 1,200 | 5.02 | 1,200 | 4.91 |

***Age estimate***.—In crocodiles, mean growth rates in relation to an individual's size change around 4–5 y of age. Thus, if there are enough data are available, it is recommended to make two models of von Bertalanffy, one for young and one for older crocodiles (Hutton 1987). Mean size range between capture and recapture of the 23 crocodiles used for the von Bertalanffy model was 700–1,352 mm. Moreover, the asymptotic TL obtained (TLA = 1,406.8 mm) cannot be considered as the maximum length that crocodiles can reach in the study area, as the largest crocodile captured in La Ventanilla measured 3,086 mm (García-Grajales 2005). Thus, the model obtained in this study can be considered as a model for young (i.e., small) crocodiles (< 1,200 mm). For this reason, we estimated the age of crocodiles between 280 and 1,200 mm TL, which ranged from just older than a hatchling to almost five years of age. Compared with results of other studies on the same species, crocodiles of La Ventanilla reach greater sizes than crocodiles of the same age from Banco Chinchorro and from Puerto Vallarta (Table 2). For example, at one year old, crocodiles from La Ventanilla measure 620 mm, whereas those of Banco Chinchorro and Puerto Vallarta measure 480 mm (Table 2).

***Conclusions.***—Growth rates of *C. acutus* found in this study, the first reported for the species in Oaxaca, agree with patterns found in other regions for this species. However, it is necessary to evaluate the factors influencing growth of *C. acutus* in Oaxaca's coast, especially salinity, environmental temperature variations, and precipitation. In the future, it will be important to capture larger individuals and of both sexes to construct von Bertalanffy models for older crocodiles and for each sex. Current programs or studies on *C. acutus* in Mexico should implement mark-recapture techniques, which in the long term will provide knowledge on population age structure, specific mortality tables, survival rates, life expectancy, and individual and population growth rates (Cupul-Magaña 2003). This information may then be used to inform optimal management strategies for the species.

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