MEDWIN PUBLISHERS
Committed to Create Value for Researchers

International Journal of Zoology and Animal Biology
ISSN: 2639-216X

Modeling the Growth of the Black Iguana *Ctenosaura pectinata* in a Tropical Deciduous Forest Climate

Arcos-García JL* and Machorro-Sámano S

Universidad del Mar, campus Puerto Escondido, Mexico

***Corresponding author:** José Luis Arcos-García, Universidad del Mar, campus Puerto Escondido, Km 3.5 carretera Puerto Escondido-Sola de Vega, Mixtepec, Juquila, Colonia Universidad C.P. 71980. Puerto Escondido, Oaxaca, México

Research Article

Volume 9 Issue 4

Received Date: July 29, 2026

Published Date: August 19, 2026

DOI: 10.23880/izab-16000691

Abstract

In order to implement effective management programs for both wild and human-managed populations of the black iguana (*Ctenosaura pectinata*), modeling the growth pattern of the species is essential. The goal of this study was precisely to model the growth pattern of black iguanas in a tropical deciduous forest climate. A total of 2,300 iguanas were used, distributed across three age categories: hatchlings, juveniles, and adults. Newborn iguanas were classified as hatchlings until they reached 12 months of age, when they were reclassified as juveniles, leading up until the start of the reproductive stage, when they were finally categorized as adults. The variables were recorded and analyzed from the day of hatching up to 180 months of age. Measurements of weight (g) and snout-vent and head lengths (cm) were taken consistently. Three growth models were evaluated for both males and females: a three-parameter model with an inflection point, a four-parameter model with an inflection point, and the Richards model. The growth models for weight, snout-vent length, and head length proved to be a good fit (r^2>0.96, P<0.001) in both sexes. The conclusion reached was that the most suitable model for establishing management programs in a tropical deciduous forest climate was the four-parameter models with an inflection point, which accurately describes the growth of the head in *Ctenosaura pectinata*.

Keywords: Captivity; Equations; Management; Programs; Production

Introduction

Growth is a biological phenomenon that concludes when an animal attains its species-specific morphology and reaches sexual maturity; it can be interpreted through mathematical models and applied for various purposes such as management programs, productivity assessment, growth pattern prediction, determination of age at puberty, and conservation and utilization efforts [1-3]. In the black iguana (*Ctenosaura pectinata*), growth has been described as continuing throughout the animal's entire lifespan [4-6] a pattern which differs from that of domestic animals [7] but is similar to that of other reptiles [8-10]. Models must be specific to the animals in question, as growth characteristics vary by species, breed, and sex [11]. Growth studies on *C. pectinata* have been conducted across hatchling, juvenile, and adult stages [4-6,12,13]. However, there is a need to develop a specific model for *C. pectinata* rather than relying on standard models (such as Von Bertalanffy, Gompertz, or logistic models) [14], as the use of inappropriate

growth models can lead to erroneous estimates [15]. Thus, additional data is needed for more accurate growth predictions. Furthermore, growth modeling in this species is particularly important because it is classified as threatened under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) [16] and is endemic to Mexico [17]. Consequently, it is necessary to formulate management plans for the species, covering both captive and wild populations [18]. Key indicators of physical condition in these iguanas include weight, snout-vent length, and head length [19]. Therefore, the hypothesis is proposed that suitable models can be identified to describe the growth of *C. pectinata* in a tropical forest climate, later serving as a solid foundation for the establishment of management plans. Therefore, the objective of this research was to model the growth of the black iguana (*C. pectinata*) in a tropical deciduous forest climate.

Materials and Methods

Study Area

This study was conducted at the Iguana Conservation and Breeding Center of the Universidad del Mar (CECOREI-UMAR), located at kilometer 128.1 of Federal Highway No. 200 (Pinotepa Nacional–Puerto Escondido, Oaxaca, Mexico) at coordinates 15°55'34'' N and 97°09'02'' W, and at an elevation of 9 meters above sea level (Garmin GPS 73). The prevailing climate was A(w) warm sub-humid with summer rains characterized by annual precipitation ranging from 731.9 to 2,054 mm, average temperatures between 24 and 26°C, and temperature in the coldest month exceeding 18°C [20]. The facility holds a management permit (code: INE/CITES/DGVS-CR-IN-0668-OAX./00) and an Environmental Registration Number (CCRSY2006711). This study was endorsed by the Institute of Ecology at the Universidad del Mar under program code 2II1306.

Study Animals

A total of 2,300 black iguanas (*C. pectinata*) were evaluated. The study began using the breeding stock from CECOREI-UMAR. Subsequently, all hatchlings and juveniles born in later years were included. Data collection continued until the breeding females reached 180 months of age. This approach was adopted because, under human management, iguanas continue to grow beyond 180 months of age [5] and remain reproductively active [21].

Housing and Maintenance

Newly hatched individuals were housed in groups of 20 to 30 for the first twelve months. Each group's enclosure measured 0.45 x 0.45 x 0.45 m (width, length, and height) and was constructed with a wooden frame entirely covered in wire mesh, except for the top; the top section was covered half by a wooden board and half by wire mesh [23]. The enclosures were equipped with water and food containers at all times. As the hatchlings grew, they were sorted by weight and size and regrouped to prevent fighting.

Although under human care, the iguanas were kept in the region's natural environmental conditions, similar to those experienced by wild iguanas. They were exposed to temperature, humidity, wind, rain, light levels, hurricanes, and other diurnal and nocturnal weather fluctuations. As ectotherms [24], the iguanas could freely choose between basking in the sun, staying in the shade, or seeking shelter among the trees and nesting areas. This management of the enclosures and the animals themselves prevented predation [25].

Diet

The nutritional requirements of adult iguanas [26], as well as those of hatchlings and juveniles [27], were met. The diet consisted of a variety of food items: a) insects: 1) *Tenebrio molitor* mealworm, 2) *Notonecta unifasciata* backswimmer larvae, 3) *Nasutitermes* spp. termites, and 4) other insects that entered the cages, such as crickets, spiders, and myriapods; b) flowers and leaves: 1) *Hibiscus* spp., 2) *Desmodium infortum*, 3) *Tulipa gesneriana*, 4) *Solanum lycopersicum*, 5) *Lactuca sativa*, and 6) *Guazuma ulmifolia*; and c) commercial feeds for: 1) rabbits, 2) laying hens, 3) turkeys, and 4) broiler chickens. Food and water were provided daily starting at 08:00 h.

Iguana Handling and Care

The handling and care for the black iguana specimens were in complete accordance with the plan authorized in the registry INE/CITES/DGVS-CR-IN-0668-OAX./00 and CCRSY2006711. The well-being of the iguanas was ensured with dignified and respectful treatment.

Variables Evaluated

Black iguana specimens were weighed using a precision balance (capacity: 20 ± 0.001 kg; model MFQ-40, TORREY brand, Mexico) and a digital scale (pocket scale, model 10053; capacity: 210 ± 0.01 g). Snout-vent length (SVL, cm) and head length (HL, cm) were measured using a tape measure (precision: 0.1 cm) and a digital caliper (Sure Bilt brand, "Caliper Black" model; scale: 150 ± 0.2 mm). Twenty-two measurements were taken at irregular intervals, starting from hatching and continuing until the adult iguanas reached 180 months of age. At each measurement interval, only the average value was recorded for use in fitting the models [1,6].

Copyright© Arcos-García JL and Machorro-Sámano S.

Analysis

Three growth models were evaluated for males and females:

1) Three parameters with an inflection point (3PWIP) [6,12]:

$$y=1/(A+Be^{(-KE)})$$

Where y = estimated weight or length (g or cm), A = reciprocal of asymptotic weight or length (g or cm) as age approaches infinity, B = reciprocal of the difference between the reciprocals of asymptotic weight or length and weight or length at birth, e = reciprocal of the exponent, K = reciprocal of the change in growth rate, and E = reciprocal of age (months).

2) Four parameters with an inflection point (4PWIP) [6,12]:

$$y=(A-B[\![exp]\!]^{(-KE)})/(2(1-Ce^{(-KE)}))$$

Where y = estimated weight or length (g or cm), A = asymptotic weight or length (g or cm) as age approaches infinity, B = difference between asymptotic weight or length and weight or length at birth, e = inverse of the exponent, K = growth rate change, E = age (months), and C = inverse of the weight or length adjustment (g or cm) at the point of an age-related change.

3) Richards Growth Model (RS) [7]:

$$y=A[\![(1-Be^{(-KE)})]\!]^{C}$$

Where A = asymptotic weight or length (g or cm) as age approaches infinity, B = weight or length at birth (g or cm), e = exponent, K = change in growth rate, E = age (months), and C = adjustment to weight or length (g or cm) when age undergoes a change. All models were analyzed using a statistical package [28].

Results

Weight Growth Model

The best-fitting models for males were the Richards model ($r^2 > 0.97$, $P < 0.0001$) and the 3PWIP model ($r^2 > 0.95$, $P < 0.0001$); however, both models overestimate iguana weight from birth to 22 months of age (Table 1, Figure 1a). The 4PWIP model was the least accurate ($r^2 > 0.84$, $P < 0.0001$). The same pattern was observed for females: RS ($r^2 > 0.92$, $P < 0.0001$), 3PWIP ($r^2 > 0.90$, $P < 0.0001$), and 4PCP ($r^2 > 0.84$, $P < 0.0001$). The models may over or under-estimate the weights of female hatchlings during the first few months of age (Table 1, Figure 1b).

Sex/Model	Parameters				Asymptote	AIP	R2
	A	B	K	C			
Males							
3PWIP	0.000456	0.00566	0.029		2193	86.9	0.953
SEM	0.000037	0.005141	0.00398				
4PWIP	4153.3	4153.2	0.000062	0.9958	2076.7	---	0.84
SEM	12.2059	--	0.00741	0.5061			
RS	2465.4	0.00567	0.0165	573.45	2465.4	71.5	0.971
SEM	236.3	0.000493	0.0024	---			
Females							
3PWIP	0.000717	0.00642	0.0225		1394.7	97.4	0.903
SEM	0.00012	0.0017	0.00467				
4PWIP	2194	2194.4	0.00006	0.9974	1097	---	0.838
SEM	61.0529	--	0.00842	0.3904			
RS	1519.6	0.00572	0.0134	480	1519.6	75.4	0.922
SEM	300.8	0.00057	0.0035	---			

3PWIP: Three parameters with an inflection point. 4PWIP: Four parameters with an inflection point. RS: Richards model. SEM: Standard error of the mean. AIP: Age at inflection point (months). ($P<0.0001$).

Table 1: Weight (g) models for *C. pectinata* from birth to 180 months of age.

Copyright© Arcos-García JL and Machorro-Sámano S.

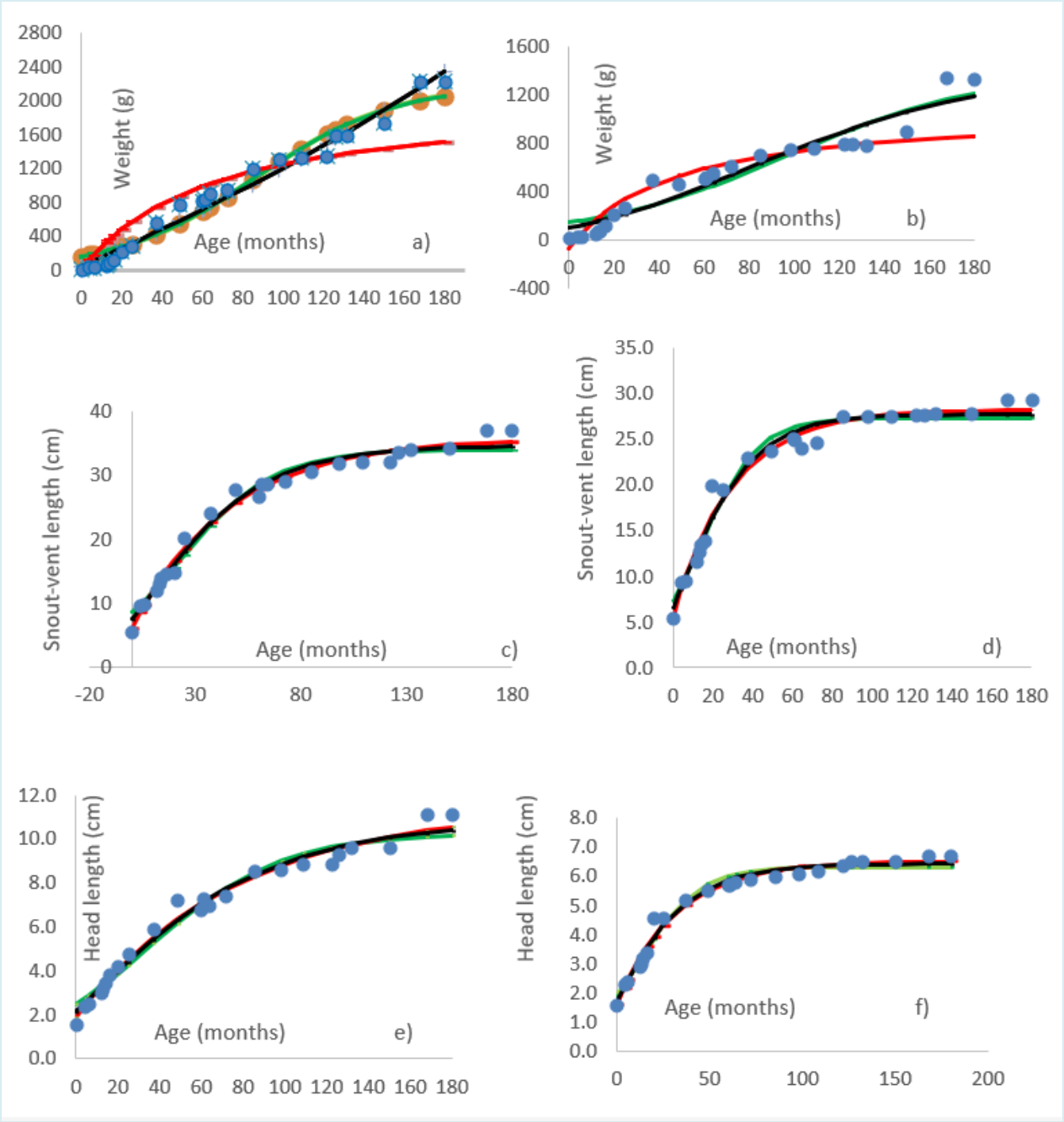


Figure 1: Fitted curves for weight of males (a) and females (b); snout-vent length (SVL) of males (c) and females (d); and head length (HL) of males (d) and females (e) at different ages, in a tropical deciduous forest climate. Three parameters with an inflection point: green line. Four parameters with an inflection point: red line. Richards model: black line.

Snout-Vent Length Growth Model

Table 2, Figure 1c and 1d show that the three LHC models for *C. pectinata* prove a good fit ($r^2 > 0.97$) for both males and females. However, the best predictor was the 4PWIP model ($r^2 > 0.99$, $P < 0.0001$), with asymptotic values of 38.5 cm for males and 28.8 cm for females; no inflection point was recorded.

Copyright© Arcos-García JL and Machorro-Sámano S.

Sex/Model	Parameters				Asymptote	AIP	R2
	A	B	K	C			
Males							
3PWIP	0.0294	0.0869	0.0459		34	24	0.97
SEM	0.00057	0.0088	0.0042				
4PWIP	76.9823	72.575	0.0101	-0.59	38.5	---	0.99
SEM	6.9315	11.556	0.0099	0.412			
RS	34.6783	0.1198	0.0327	12	34.7	11	0.98
SEM	0.626	0.0058	0.0027	--			
Females							
3PWIP	0.0366	0.1	0.0705		27.3	14	0.97
SEM	0.0006	0.0135	0.0085				
4PWIP	57.6305	51.264	0.0238	0.379	28.8	---	0.98
SEM	1.6232	5.355	0.0097	0.326			
RS	27.7543	0.1389	0.0484	9.6	27.75	5.9	0.97
SEM	0.433	0.0093	0.0048				

3PWIP: Three-parameter model with an inflection point. 4PWIP: Four-parameter model with an inflection point. RS: Richards model. SEM: Standard Error of the Mean. AIP: Age at inflection point (months). (P<0.0001).

Table 2: Longitudinal models of snout-to-vent length in male and female *C. pectinata* from birth to 180 months of age.

Head Length Growth Model

The three head-growth models for male and female *C. pectinata* yielded adequate coefficients of determination; however, the 4PWIP model provided the best fit (r^2 = 0.98, P < 0.0001) (Table 3, Figure 1e, f). Among the three models, those based on head length are the most precise for both males and females; snout-vent length measurements are prone to error because iguanas are highly flexible and arch their spines, and weight is highly variable.

Sex/Model	Parameters				Asymptote	AIP	R^2
	A	B	K	C			
Males							
3PWIP	0.0977	0.302	0.0317		10.2	35.6	0.967
SEM	0.00299	0.0314	0.0032				
4PWIP	30.1238	30.1235	1.1E-06	-0.9999	15.1	---	0.984
SEM	1.6054	1.6054	1.67E-07	---			
RS	10.8098	0.4165	0.0191	3	10.81	11.7	0.979
SEM	0.3694	0.0154	0.00196	--			
Females							
3PWIP	0.1585	0.3612	0.0634		6.3	13	0.971
SEM	0.00231	0.0388	0.0067				
4PWIP	13.2775	11.4835	0.0223	-0.3927	6.6	---	0.984
SEM	0.3408	1.2748	0.00855	0.2933			
RS	6.431	0.4387	0.0403	2.3	6.4	0.2	0.981
SEM	0.0866	0.0192	0.00339				

4PWIP: Four parameters with an inflection point. RS: Richards model. SEM: Standard Error of the Mean. AIP: Age at inflection point (months). (P<0.0001).

Table 3: Head models for male and female *C. pectinata*. 3PWIP: Three parameters with an inflection point.

Copyright© Arcos-García JL and Machorro-Sámano S.

Discussion

Weight Growth Model

Weight models for male and female iguanas present certain limitations. This is likely due to several factors: 1) during the annual breeding season, both sexes stop eating and lose muscle and body fat [28-30]; 2) hatchlings, juveniles, and adults in the non-reproductive stage accumulate reserves [21,23]; 3) environmental factors affecting weight gain or loss [30,31]; 4) the availability of high- or low-quality food [32,33]; and 5) [other factors]. Adult specimens older than 150 months did not exhibit reproductive behavior.

Weight-based models—including birth weight—do not provide useful information for determining sex at 12 months of age. However, they could be complemented by the three-parameter logistic growth model proposed [12] for *C. pectinata* up to 25 months of age. The birth weight range for *C. pectinata* offspring is similar whether they are raised under human care (with or without environmental control) or in the wild [12,21,29]. Differences in offspring size and weight at birth are attributable to environmental and nutritional conditions, as well as parental genetic factors (such as size, clutch size, and number of clutches), which influence embryonic growth [21,25].

Black iguana hatchlings exhibit high mortality rates [29], which can be prevented through proper management, nutrition [12,13], and ambient temperatures above 35°C [12,13,23,27]. High levels of metabolizable energy and high-quality nutrients are required during this stage. Before dying, the hatchlings shift from their characteristic bright green color to a yellowish hue, lose weight, become immobile, and their skin turns rough.

In *C. pectinata* hatchlings, the type of diet consumed influences the ontogenetic shift [27]; however, it has been shown that changes in feeding habits during ontogeny do not correlate with physiological adaptations [33]. Hatchlings are defined as individuals ranging from newly hatched up to 12 months of age, at which point they are classified as juveniles [34,35], with weights of 133.6 ± 45.6 g for males and 114.1 ± 42.1 g for females [12]. During the course of this study, juvenile iguanas and occasionally the heavier six-month-old hatchlings-exhibited behaviors similar to those of reproductive adults [29]: males displayed reproductive movements, females remained attentive to the males' activities, and both sexes ceased feeding.

Ctenosaura pectinata reaches adulthood at the onset of the reproductive stage between two and three years of age in the wild [29], or three and a half years under human care in a climate similar to that of wild iguanas [21]. The inflection point in weight models does not coincide with the age of peak reproductive fitness [22], possibly due to the species' natural variation in fat storage. Therefore, it is not a reliable indicator of the onset of the reproductive stage. However, it suggests that a decrease in growth rate may signal a shift in reproductive efficiency, involving the reallocation of nutrients toward reproductive functions rather than weight gain.

Snout-Vent Length Growth Model

In the proposed models, the snout-vent length (SVL) of *C. pectinata* at birth is observed to be similar to that found in studies conducted under human management without climate modification [23,33] and in the wild [29]. In C. pectinata hatchlings kept under human management at a constant temperature (35°C), SVL growth exceeds the estimated value by more than 33%, possibly because the iguana's metabolism is favored at that temperature [4,12,13]. Regardless of the conditions whether the climate is modified or not—under which black iguana hatchlings or juveniles develop, weight gain or loss is recorded, whereas SVL remains constant or increases [4,12,13,23,29,31]. Ambient temperature is the factor influencing growth—and consequently, food intake and ontogenetic changes [27,36]-which are linked to diet and changes in the size and function of the digestive tract. The best-fit model shows no inflection point, indicating no significant deceleration in the rate of SVL growth; the iguanas do not reach a maximum size, and growth likely continues [5,6].

Inbreeding may be occurring in the study area, potentially giving rise to heavier or larger individuals in the most recent measurements, or this could simply be due to continued growth at varying rates depending on food availability [37]. This contrasts with the suggestion that a specific growth endpoint exists in sauropsids a hypothesis based on the bone microstructure of the outermost cortex of long bones in organisms that have reached skeletal maturity [38].

Age classification for *C. pectinata* based on snout-vent length categorizes individuals as hatchlings (5.2-15.8 cm), juveniles (15.9-18.0 cm), and adults (18.1-36.4 cm) [12,13,38,39]. This information is valuable, as the models provide sufficient data to determine growth stages and the timing of sexual differentiation at 12 months of age [12]. These data can be complemented by the logistic growth model [4] derived for *C. pectinata* from birth up to 25 months of age.

Sexual differentiation between males and females based on snout-vent length is not evident until 21 months of age under captive management conditions and constant temperatures above 35°C. However, differentiation is

Copyright© Arcos-García JL and Machorro-Sámano S.

apparent through other characteristics, such as femoral pore size and dorsal crest size [12]. In the wild, sexual differentiation based on snout-vent length begins at 25 months of age, coinciding with the onset of the reproductive stage [29].

Evaluations revealed that males with greater snout-vent length are heavier, more aggressive, and have higher survival rates [29] than smaller males. However, males that mate with the most females are not necessarily the largest ones. Females did not exhibit territorial aggression; however, smaller females showed lower survival rates-particularly during the egg-laying season-due to difficulties with oviposition. As adults age, they begin to lose their climbing ability and may become more vulnerable to predation. Regardless, *Ctenosaura pectinata* juveniles and adults raised in human care demonstrate the same capacity for adaptation when released into deciduous forest areas or agroforestry ecosystems [40].

Head Length Growth Model

The head-length models align with the head size of newborn *C. pectinata* offspring-both those from parents raised under human management (without environmental modification or accounting for sex [21]) and those from the wild [12,13].

Head length alone does not allow for the distinction between male and female black iguana hatchlings during their first six months of life, as measurements are very similar-a finding consistent with other studies. Previously, it was only possible to determine the sex of *C. pectinata* in fast-growing iguanas up to twelve months of age [12] when males possess larger heads than females-a point that coincides with the species' ontogenetic shift [27,36]. However, certain morphometric characteristics have been established to identify the sex of neonates with successful results [41].

Environmental conditions such as temperature, humidity, and diet influence growth by altering the iguanas metabolic rate [31]. Arcos García, et al. [13] report that weight gain in black iguana hatchlings is greater at ambient temperatures above 35°C. In this same species, head length is unaffected by changes in body energy storage or utilization resulting from food scarcity; therefore, it serves as a reliable indicator of growth. Adult males and females of *C. pectinata* possess heads that are lightweight yet powerful [42]; this trait may influence the species' demography by regulating population structure through cannibalism [43] and by determining the consumption of various vertebrates and invertebrates [26,27,30]. Additionally, males use their heads during the reproductive phase to defend territory and mate with multiple females [29] with the latter likely being the primary driver behind this head development.

Regarding age, adult iguanas in the wild can live between 108 and 120 months [29]. One specimen observed in the present study was between 220 and 228 months old; however, it was excluded from the count because its exact age was unknown, and it was blind, unable to climb, and excessively obese. Despite the age *C. pectinata* can attain, few individuals reach adulthood in the wild [29], as over 90% die within the first year. Subsequently, the primary threat they face is hunting for human consumption; however, it should be stated that many of the captured iguanas are juveniles which have not yet reached reproductive age [44] and thus leave no offspring.

It is suggested that diets be formulated to maximize growth while controlling body temperature the primary factor to manage in ectothermic animals [45] though heat or cold stress must be avoided. This implies that climate change may not affect weight gain or loss in iguanas [31]. In the wild, the ambient temperature where *C. pectinata* lives ranges from 27 to 36.9°C, while substrate temperatures range from 28 to 37.6°C across tropical deciduous, semi-deciduous, and mixed forests [45]. However, iguanas exhibit their most efficient metabolic activity at a temperature of 36°C [46,47], resulting in superior growth and weight gain [13]. Iguanas engage in behaviors such as seeking out sunlight, shade, or materials that help maintain body heat, thereby supporting both their own metabolism and that of their intestinal flora. [13,29,30,31,45,47].

Another factor influencing growth is nutrition, categorized by developmental stage: 1) carnivores or selective feeders of concentrated food, 2) omnivores or intermediate consumers, and 3) herbivores or forage consumers. *Ctenosaura pectinata* meets its nutritional needs for maintenance, growth, and reproduction by employing all three of these strategies [23,26,27,29,31]. Growth and body condition in *C. pectinata* are important for understanding the evolution of age and size at sexual maturity, biological fitness, and developmental timing under various ecological or genetic scenarios [10,32]. The optimal diet of the adult black iguana must maintain a total protein content of 25.3% and 2.7 megacalories kg^{-1} of metabolizable energy [26].

Nutritional and reproductive management based on growth curves could be structured in stages: a) hatchlings (birth to eight months): high-quality feed; b) young juveniles (9 to 25 months): medium-quality feed; c) older juveniles/pre-pubescent (26 to 36 months): medium-quality feed, transitioning toward a forage-based diet; and d) reproductive adults (36 months and older): primarily forage-based diet, adjusted to ensure reproductive success. Breeding iguanas should be selected based on performance from the second

Copyright© Arcos-García JL and Machorro-Sámano S.

breeding cycle onwards, with less efficient individuals being replaced. Management strategies may include the exchange and release of iguanas into the wild; this allows unproductive adult individuals to integrate into the food web while wild populations survive and maintain genetic diversity, all while released hatchlings acquire the skills needed for survival. The primary factor influencing the continuous growth and development of *C. pectinata* is body temperature rather than ambient temperature as it directly affects feed intake, digestion, and metabolism, driving continuous yet decelerated growth in adults.

Conclusion

Given the conditions under which the study was conducted, it is concluded that four-parameter models of head growth are the most suitable for application to both males and females of the species *Ctenosaura pectinata*. These models can support the establishment of management programs in various facilities under human care as well as for free-ranging populations in tropical deciduous forest environments. Our suggested approach incorporates nutritional and reproductive management practices applicable to the black iguana across four growth stages: hatchlings, hatchling-juveniles, juvenile-prepubescents, and reproductive adults.

Acknowledgments: To the Universidad del Mar for the support received for the project titled “Growth Modeling in Iguanas,” project code: 2II1306.

Conflicts of interest: The authors declare that they have no conflicts of interest.

References

1. Pereda-Solís ME, González MSS, Arjona SE, Bueno AG, Mendoza MGD (2005) Ajuste de modelos de crecimiento y cálculo de requerimientos nutricionales para bovinos Brahman en Tamaulipas, México. Agrociencia 39(1): 19-27.

2. Ramírez EJ, Cerón MMF, Herrera AC, Vergara OD, Arboleda EM, et al. (2009) Crecimiento de hembras cruzadas en el trópico Colombiano. Rev Colom Cienc Pecua 22(4): 642-647.

3. Sariyel V, Aygun A, Keskin I (2017) Comparison of growth curve models in partridge. Poult Sci 96(6):1635-1640.

4. Arcos-García JL, Cobos PMA, Reynoso RVH, Mendoza MGD, Ortega CME, et al. (2002) Caracterización del crecimiento de la iguana negra (*Ctenosaura pectinata*) en cautiverio. Rev Vet Méx 33(4): 409-419.

5. Machorro SS, Herrera MM, Arcos-García JL, López-Pozos R, Mendoza MGD, et al. (2009) Aplicación de la regresión polinomial en el modelado de crecimiento hocico-cloaca en relación con el peso en iguana negra *Ctenosaura pectinata* (Reptilia: Squamata: Iguanidae). Rev Cienc Mar 8: 23-30.

6. Machorro-Sámano S, Gómez-Carreto S, López-Pozos R, Mendoza-Martínez GD, Arcos-García JL (2022) Modelado de crecimiento del índice Masa corporal-longitud total en machos de iguana Negra *Ctenosaura pectinata* (Sauropsida: Squamata, Iguanidae). Rev Cienc Mar 26(77): 3-13.

7. Wen Y, Liu K, Liu H, Cao H, Mao H, et al. (2019) Comparison of nine growth curve models to describe growth of partridges (Alectoris chukar). J App Anim Res 47(1): 195-200.

8. Valecantos S, Lobo F, Martínez V (2007) Estimación de edades, tamaño corporal y adquisición de madurez sexual en dos especies de Liolaemus (Iguania: Liolaemidae). Cuadernos de Herpetol 21(1): 31-44.

9. Burghardt GM, Rand AS (1982) Iguanas of the world: They Behaviour. Ecology and Conservation. Garland Pres. New Jersey, USA.

10. Zamora-Abrego JG, Zúñiga-Vega JJ, Ortega-León AM (2012) Ecología del crecimiento de una lagartija del género Xenosaurus Peters 1861 (Squamata: Xenosauridae) en la Reserva de la Biósfera, Sierra Gorda, Querétaro, México. Rev Chil Hist Nat 85(3): 321-333.

11. Agudelo-Gómez DA, Cerón MMF, Restrepo LLF (2007) Modelación de funciones de crecimiento aplicadas a la producción animal. Rev Col Cienc Pec 20(2): 157-173.

12. Arcos-García JL, Reynoso RVH, Mendoza MGD, Hernández SD (2005) Identificación del sexo y medición del crecimiento en iguana negra (*Ctenosaura pectinata*) en las etapas de cría y juvenil. Rev Vet Méx 36(1): 53-62.

13. Arcos-García JL, Reynoso VH, Mendoza MGD, Clemente SF, Tarango ALA, et al. (2005) Efecto del tipo de dieta y temperatura sobre el crecimiento y eficiencia alimenticia de iguana negra (*Ctenosaura pectinata*). Rev Cient LUZ 15(4): 338-344.

14. Karkach AS (2006) Trajectories and models of individual growth. Dem Res 15(12): 347-400.

15. Katsanevakis S (2006) Modelling fish growth: model selection, multi-model inference and model selection uncertainty. Fish Res 81(2): 229-235.

16. CITES (2021) Convention on International Trade in Endangered Species of Wild Fauna and Flora. Appendices

Copyright© Arcos-García JL and Machorro-Sámano S.

I, II y III. Ginebra, Suiza: an online referencia.

17. CDHCU (2021) Cámara de Diputados del H Congreso de la Unión. Ley General de Vida Silvestre 2000. Última reforma publicada DOF 20-05-2021. México.

18. Reynoso VH, Vázquez-Cruz M, Rivera-Arroyo RC, Zarza-Franco E, Grant TD (2020) *Ctenosaura pectinata*, Guerreran Spiny-tailed Iguana. The IUCN Red List of Threatened Species 2020: e.T174478A1414553.

19. Judson J, Knapp C, Welch M (2018) Age-dependent, negative heterozygosity-fitness correlations and local effects in an endangered Caribbean reptile, Iguana delicatissima. Ecol Evol 8(4): 2088-2096.

20. García E (1988) Modificaciones al Sistema de Clasificación Climática de Köppen. Universidad Nacional Autónoma de México.

21. López ROA, Arcos-García JL, Mendoza-Martínez GD, López-Pozos R, López-Garrido SJ, et al. (2012) Parámetros reproductivos de las hembras de iguana negra (*Ctenosaura pectinata*) en condiciones intensivas. Rev Cient LUZ 22(1): 65-71.

22. Pinacho SB, Arcos-García JL, López PR, Mendoza MGD, Plata PFX (2010) Parámetros reproductivos de la iguana verde (*Iguana iguana*) en condiciones de cautiverio en Oaxaca, México. Rev Cient LUZ 20 (5): 467-472.

23. Ortíz GJJ, Arcos-García JL, Mendoza MGD, Plata PFX, Fuentes MG, et al. (2013) Effect of lysine addition on growth of black iguana (*Ctenosaura pectinata*). Zoo Biol 32(3): 277-280.

24. Ortega CJE, Guerrero BJ, Cabanzo HR, Marchant S (2022) Thermal gradient for tigmothermic lizards using a water circulation system. Herpetol Rev 53(1): 39-42.

25. Castro-Franco R, Bustos-Zagal MG, Méndez-De la Cruz FR (2011) Variation in parental investment and relative clutch mass of the spiny-tail iguana, *Ctenosaura pectinata* (Squamata: Iguanidae) in central México. Rev Mex Biodiv 82(1): 199-204.

26. Zurita-Carmona ME, Aguilar VB, González EA, Mendoza M GD, Arcos-García JL (2009) Composición de la dieta, consumo de proteína y energía en iguana negra, *Ctenosaura pectinata* Wiegmann, 1834, y densidad poblacional en Santos Reyes Nopala, Oaxaca. Univ Ciencia, tróp húm 25(1): 103-109.

27. Durtsche RD (2004) Ontogenic variation in digestion by the herbivorous lizard *Ctenosaura pectinata*. Physiol Biochem Zool 77(3): 459-470.

28. SAS (2010) SAS Education Analytical Suite for Windows (Release 9.2). Cary NC, SAS Inst Inc Order number 582235, USA.

29. Suazo OI, Alvarado DJ (1994) Iguana Negra. Notas sobre su historia natural. Universidad Michoacana de San Nicolás de Hidalgo en colaboración con el Fish and Wildlife Service y Ecotonia AC México.

30. Méndez-Sánchez CG, López-Pozos R, Santiago-Romero H, Machorro SS, García-Grajales J, et al. (2022) Uso de diferentes niveles de proteína cruda en la dieta de crias de *Ctenosaura pectinata* (Sauropsida: Squamata, Iguanidae) en cautiverio. Rev Ciencia Mar 26(78): 3-14.

31. Sánchez MCG, López PR, Santiago RH, Martínez GJA, Mendoza MGD, et al. (2024) Alteraciones morfométricas en hembras juveniles de iguana negra (*Ctenosaura pectinata*) cuando varía el consumo de proteína y energía. Vet Méx AO 11: 1-18.

32. Arcos-García JL, Núñez OJ, García GJ, Rueda ZR del P, Romero HS, et al. (2020) Body condition index in breeding black iguana females (*Ctenosaura pectinata*) in captivity. Rev Fac Cienc Agrar 52(2): 349-359.

33. Rueda-Zozaya P, Mendoza GD, Crosby MM, González G, Reynoso VH (2011) Effect of Feed Type and Sex on Digestibility and Feed Efficiency Utilization in Black Spiny-Tailed Iguana (*Ctenosaura pectinata*). Zoo Biol 30: 349-354.

34. Henderson RW (1974) Aspects of the ecology of the juvenile common iguana (*Iguana iguana*). Herpetol 30(4): 327-332.

35. Penilla-Juárez Á, Cruz-Sáenz D, Lazcano D (2013) Notes on the Herpetofauna of Western Mexico 9: Current status of Green Iguanas (*Iguana iguana*) and Western Spiny-tailed Iguanas (*Ctenosaura pectinata*) in the Natural Protected Area "Estero El Salado" in Puerto Vallarta, Jalisco, México. Bull Chicago Herp Soc 48(7): 92-96.

36. Cooper WEJ, Lemos-Espinal JA (2001) Coordinated Ontogeny of Food Preference and Responses to Chemical Food Stimuli by a Lizard *Ctenosaura pectinata* (Reptilia: Iguanidae). Ethol 107: 639-653.

37. Rueda-Zozaya P, Plasman M, Reynoso VH (2021) Good alimentation can overcome the negative effects of climate change on growth in reptiles. Biol J Linn Soc 133: 81-92.

38. Woodward HN, Horner JR, Farlow JO (2011) Osteohistological Evidence for Determinate Growth in the American Alligator. J Herpetol 45(3): 339-342.

39. Casas-Andreu G, Valanzuela-López G (1984)

Copyright© Arcos-García JL and Machorro-Sámano S.

Observaciones sobre los ciclos reproductivos de *Ctenosaura pectinata* e *Iguana iguana* (Reptilia:Iguanidae) en Chamela, Jalisco. An Inst Biol 55(2): 253-262.

40. Ruiz-García N, Arcos-García JL, Villa-Hernández JM, López-Pozos R, Santiago RH, et al. (2024) Monitoring the release of black iguana from a management unit into two ecosystems. Int J Zool Anim Biol 7(5): 1-10.

41. Castro-Franco R, Bustos-Zagal MG, Castro-Bustos D, Trujillo-Jiménez P, Mena-Maldonado FE (2024) Variation in the morphology of hatchlings of black iguanas *Ctenosaura pectinata* (Wiegmann, 1834) (Squamata: Iguanidae). Acta Zool Mex 40: 1-11.

42. Oelrich TM (1956) The Anatomy of the Head of *Ctenosaura pectinata* (Iguanidae). Museum of zoology, University of Michigan, Ann Arbor.

43. Sánchez-Hernández AS, Rosas-Espinoza VC, Rodríguez ZFA (2017) Canibalismo en *Ctenosaura pectinata* (Squamata: Iguanidae) en el Parque Nacional Isla Isabel, Nayarit, México. Acta Zool Mex 33(2): 386-388.

44. Oviedo-Hernández E, Andrade-Soto G, Hernández-Gallegos O (2022) Explotación de *Ctenosaura pectinata* (iguanidae) en la parte centro de su distribución en México. Rev Latinoam herpetol 5(4): 104-107.

45. Gómez-Mora A, Suazo-Ortuño I, Alvarado-Díaz J (2012) Distribución, abundancia y uso de hábitat de la iguana negra (*Ctenosaura pectinata*) y la iguana verde (Iguana iguana) en el municipio de Buenavista, Michoacán. Biol 14(2): 67-74.

46. Arcos GJL, López PR (2009) La iguana negra. Fundamentos de reproducción, nutrición y manejo. 1ra Edición. Editorial Optime Impresos. Oaxaca, México.

47. Vélez-Hernández L, Cobos-Peralta MA, Arcos-García JL (2012) Contenido de alimento y metabolismo ceco-cólico en el tracto digestivo de poblaciones silvestres de iguana negra (*Ctenosaura pectinata*) en Morelos, México. Arch Med Vet 44(3): 217-224.

Copyright© Arcos-García JL and Machorro-Sámano S.