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Breeding and rearing the Orinoco crocodile *Crocodylus intermedius* in Venezuela

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Intensive hunting in the first part of this century placed the Orinoco crocodile *Crocodylus intermedius* in immediate danger of extinction. We studied the potential for enhancing populations through captive rearing. In an area of 35 000 m^2 seven enclosures were developed with six earthen and eight concrete ponds. In two years' operation a hatching rate of 72·4% and a hatchling survival rate of 42% were obtained. In the first year males attained an average total length of 745 mm and females 620 mm. In the second year average total length was 1362 mm and 1111 mm, respectively. Seasonal changes in growth and the influence of climatic conditions in mortality are discussed. Captive breeding and rearing appears to be an appropriate conservation strategy for this species.

INTRODUCTION

At the present time, there are 22 species of crocodiles in the world, five of them inhabiting the Venezuelan wetlands — *Paleosuchus palpebrosus, P. trigonatus, Caiman crocodilus, Crocodylus acutus* and *C. intermedius.* The last two are considered endangered by the IUCN (Groombridge, 1986).

From a total population numbering thousands of individuals at the beginning of the century, only a few hundred Orinoco crocodiles *C. intermedius* now persist. Their distribution includes the Orinoco basin, from the Guaviare River in Colombia to the Amacuro Delta in Venezuela (Medem, 1981, 1983). The high commercial value of the skins supported intensive hunting in the first part of this century and the population of this species drastically diminished. Medem (1983) estimated that 900 000 skins were exported from Venezuela during the 1933–35 period, and in Colombia a minimum of 250 400 crocodiles were captured and only 280 individuals recorded (Medem, 1981). In a census conducted in 1978 in the Venezuelan Llanos, only 273 crocodiles were found (Godshalk & Sosa, 1978; Godshalk, 1982). Since then, two new populations have been discovered, one in the Caura River (nine crocodiles; Franz *et al.*, 1985) and another in the Tucupido river (19 crocodiles; Ramo & Busto, 1986).

Two main complementary strategies exist for the preservation of this species: (1) protection of the remaining wild populations; and (2) breeding and rearing crocodiles in captivity to avoid natural high losses of eggs and young due to predators, in order to rebuild wild populations (Blohm, 1973). A similar conservation programme in India has achieved satisfactory results, where after ten years of management, 2364 crocodiles of three species have been released, and 13 crocodilian sanctuaries created (de Vos, 1984; Singh *et al.*, 1986).

In Venezuela, Orinoco crocodiles breed successfully in captivity at three stations: Universidad Nacional Experimental de los Llanos Occcidentales Ezequiel Zamora (UNELLEZ, Portuguesa State), Hato Masagüaral (Guarico State) and Estación Biológica El Frío (Apure State). There are also four protected areas within the geographical range of this species: Parque Nacional Aguaro-

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Guariquito (Guarico State), Parque Nacional Cinaruco-Capanaparo (Apure State), Refugio de Fauna Estero de Chiriguare (Portuguesa State) and Refugio de Fauna Caño Guaritico (Apure State).

Although there is abundant literature about crocodilian husbandry (Blake, 1974; Blake & Loveridge, 1975; de Vos, 1982; Webb *et al.*, 1983 *a*; Whitaker & Whitaker, 1984; Joannen & McNease, 1986; Rodriguez & Robinson, 1986; Rodriguez, 1988, 1989), there is only one paper concerning the Orinoco crocodile (Blohm, 1982). The purpose of this article is to summarize our experience of crocodile breeding and rearing at the UNELLEZ station between 1987 and 1989.

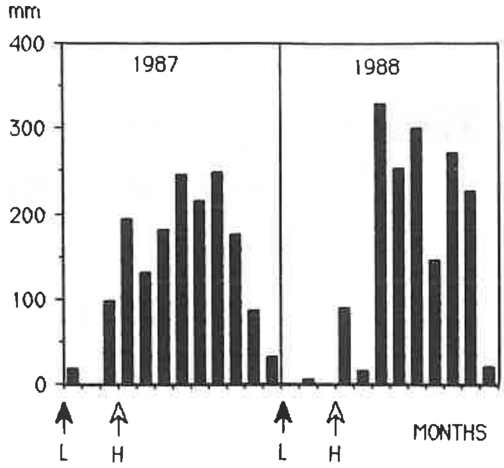

Fig. 1. Monthly rainfall, laying date (L) and hatching date (H) at UNELLEZ station, during two years.

METHODS

Rearing site

The UNELLEZ station is located near the village of Mesa de Cavacas in the Andean foothills at 255 m above sea level. During 1987–89, annual rainfall averaged 1641 mm, with a rainy and a dry season (Fig. 1). Temperatures were high, averaging 27·25°C, with little variation through the year. This site is located within the species' range although close to the altitudinal limit.

Pen design and stock densities

In an area of 35 000 m^2 we constructed seven enclosures to maintain crocodiles (Fig. 2). Pen 1 was a breeding area with two earthen ponds (20 × 10 × 1 m and 10 × 4 × 1 m) and two sand beaches for breeding purposes. In this pen we maintained a male (total length 3·48) and two females (female 1, 2·76 m and female 2, 2·56 m). Pen 2 was another breeding area with an earthen pond (30 × 10 × 2 m) and two sand beaches. This at first contained no crocodiles but because of fighting be-

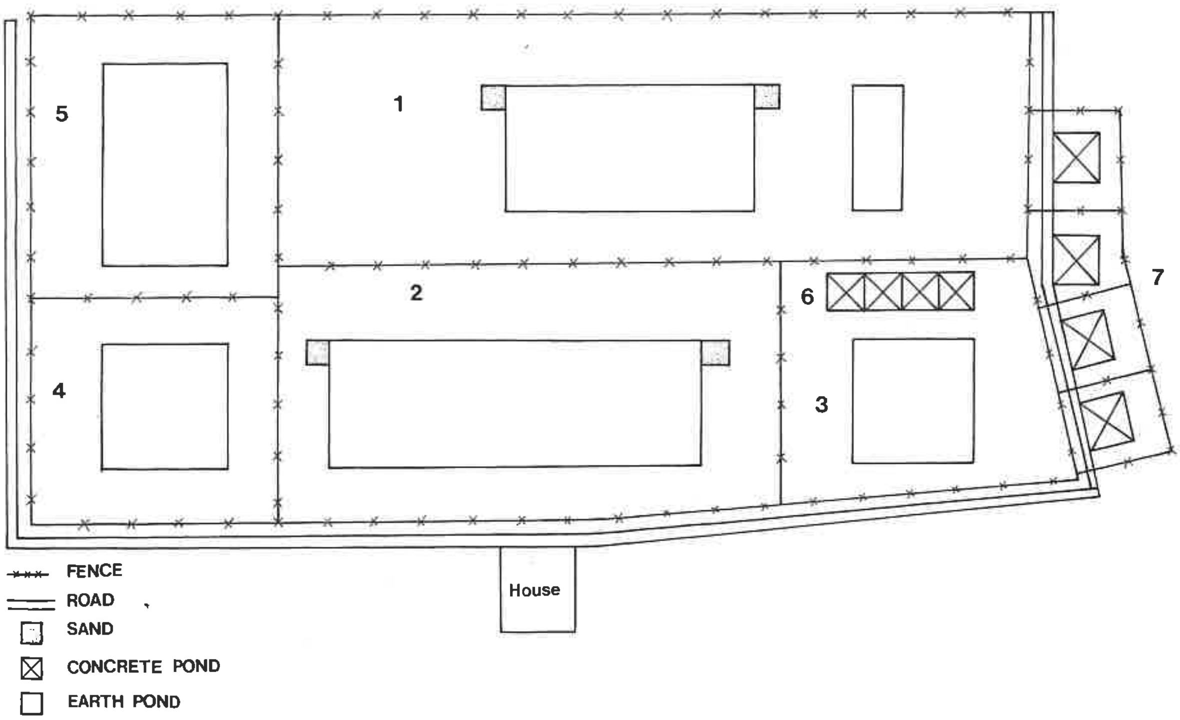

Fig. 2. Pen design at UNELLEZ station.

tween the two females in pen 1, and as the eggs of female 2 always failed, we decided to move her from pen 1 to pen 2. Pens 3 and 4 contained one earthen pond each (10 × 10 × 1·5 m) for rearing young, stock densities in these pens ranging between 0·11 and 0·27 individuals/m². Pen 5 contained an earthen pond of 16 × 10 × 2 m, where two subadults (male and female) were maintained. Pen 6 was an area with four concrete ponds (2 × 2 × 0·5 m) for hatchlings, with stock densities of 0·25–6 individuals/m². Pen 7 had four concrete ponds (4 × 4 × 1 m) for yearlings; stock densities 0·5–0·69 individuals/m².

Management of crocodiles

Nests were incubated under natural conditions. In 1987, 28 crocodiles were born; 26 were separated from the parents and moved to pen 5. In 1988, 26 of 27 hatchlings were moved. In addition 24 hatchlings were captured in the Cojedes River on 10 June 1987 and maintained at the station. We assigned to them the same age as that of the crocodiles born at the station in 1987, although they were probably several days younger.

The crocodiles were reclassified from time to time according to their size. For individual recognition, they were marked by cutting the tail scutes according to a prearranged code. Hatchlings were weighed and measured monthly. Total length (TL) and snout–vent length (SVL) were measured with a steel tape, head length (HL) with a vernier caliper, following Medem (1981). Body mass (BM) was determined with the aid of spring scales of different capacities. Crocodiles were sexed by manual probing of the cloaca (Brazaitis, 1969).

Diet

Hatchlings were fed *ad libitum* with sardines and liver chopped into small pieces, three times per week. We also placed a light on the ponds to attract nocturnal insects, and released small live fishes. Yearlings and two-year-old crocodiles were fed with fish (mostly sardines), poultry and offal from a cow slaughter-house, three times per week. The weekly rations were 10–30% body weight.

Condition index

The Stat View program (Feldman & Gagnon, 1986) was used to determine the regression equation describing the line of best fit with total length (TL) as the independent variable x, and body mass (BM) as the dependent variable y. Data of 30 surviving crocodiles (21 females and 9 males), measured monthly from hatching to two years, were utilized in the analysis ($n=187$ for males; $n=499$ for females). Body mass, as in other species of crocodiles (Webb *et al.*, 1983*b*; Montague, 1984), shows a clear positive allometry described by the following equation:

$$BM = b\ TL^{a}$$

where a is the allometric coefficient between BM and TL. For males $a=3{\cdot}2912$, $b=-6{\cdot}3007$, and $r^2=0{\cdot}9920$, and for females $a=3{\cdot}3046$, $b=-6{\cdot}3539$, and $r^2=0{\cdot}9909$.

Condition index (G) was calculated by the equation:

$$G = \frac{BM^{1/a}}{TL}$$

RESULTS

Breeding biology

Courtship and mating activity were observed from October to the beginning of December. Egg laying occurs at the end of December and the beginning of January, and corresponds to the start of the dry season. Hatching takes place at the end of March, with the onset of the rains (Fig. 1). Several days before nest construction, females excavated holes in the sand. On 7 January 1988 at 0845 h we observed female 1 on the sand beach laying eggs. There were already several eggs in the nest and we saw her laying four at intervals of 1 to 3 min. The hind feet were in the hole and the eggs were expelled directly into the nest—we could hear the noise of each egg laid striking the others. At 0918 h she began to bury the eggs, supported by her tail, and using her hind feet alternately. At 0942 h, female 2 approached the nest and bit female 1's tail, who escaped to the water. Several seconds later, this female came out of water several metres away from the nest and moved her hind feet in a characteristic egg-burying fashion.

In five nests observed, the first layer of eggs was at a depth of 25–30 cm and the last at 40–45 cm. The nest surface was 30–45 × 45–55 cm. The temperature inside two nests was 31–32°C (0940 h) and the incubation period ranged between 78 and 85 days. Clutch size varied between 37 and 52

Table 1. Reproductive data at UNELLEZ station

Female	Year	Clutch size	Hatching rate (%)	Incubation (days)	Eggs		
					n	Size (mm)	Mass (g)
1	1987	39	28 (71·8)	80–85	10	77·35 × 47·22	107·0
1	1988	37	27 (73·0)	78	10	77·49 × 47·55	105·6
1	1989	52	—	—	—	—	—
2	1987	49	0	—	10	75·58 × 56·78	102·8
2	1988	38	0	—	10	80·17 × 48·26	113·8
Mean		43	(72·4)	78–85	40	77·65 × 47·45	107·3

eggs (Table 1). Egg measurements are also presented in Table 1.

Both females protected their nests, but female 2 was more aggressive and frequently ejected female 1 from the beach.

Only female 1 laid fertile eggs, clutch size in 1989 being higher than in the preceding two years when she shared the pond with female 2. Hatching rate was 72·4% (Table 1). All crocodiles born at the station and surviving two years were females. We cannot verify the sex of dead hatchlings.

Mortality

During two study years a hatchling survival rate of 42% was obtained. The survival rate for crocodiles born in 1987 until the second year was 46·2% (Table 2). Individuals born in 1988 suffered high mortality (96·15%), only one surviving through the first year. Crocodiles brought from the Cojedes River (approximately two-months-old) suffered less mortality, with a 79·2% survival.

Accidents and escapes represented only 11·36% of the losses, one crocodile (2·27%) was a runt and died at 18 months old and 37 (86·36%) were in very bad condition on death. They had lost body mass and had empty stomachs, and probably died of starvation. Of these individuals, 67% were less than three months old, and 97% less than six months old. Mortality occurred in the early rainy season, when days were cloudy and temperatures fell (Table 3). Nocturnal observations of hatchlings revealed that they were feeding normally until heavy rains came; afterwards the crocodiles left most of the chopped sardines.

Table 2. Survival rates of hatchlings

Hatchlings	No.	Survival	
		1 year (%)	2 years (%)
Cojedes 1987	24	19 (79·2)	19 (79·2)
UNELLEZ 1987	26	13 (50·0)	12 (46·2)
UNELLEZ 1988	26	1 (3·9)	—
Total	76	33 (43·4)	31 (40·8)

Condition index

The condition index during the first months was very variable (Fig. 3). The highest value of *G* (0·0127) was at hatch, the differences with other months being significant (*t*-tests), except in October. This indicates that crocodiles were born in good condition, with sufficient yolk reserves to subsist for some time. *G* drastically diminished in the two subsequent months, reaching the lowest value in May (significantly different from other months, *t*-tests). From then the index increased, almost reaching the hatch value in October, but afterwards decreased, and showed little variation

Table 3. Monthly average temperature (°C) at UNELLEZ station and numbers of crocodiles dying from starvation each month

Month	UNELLEZ 1987		UNELLEZ 1988	
	Temperature °C	No. dead (%)	Temperature °C	No. dead (%)
January	26·7	—	27·2	—
February	28·5	—	28·1	—
March	29·0	Hatch	—	Hatch
April	28·5	0	29·1	0
May	26·6	1 (3·6)	29·2	0
June	26·4	10 (35·7)	26·5	3 (11·1)
July	26·3	0	26·3	11 (40·7)
August	26·4	0	26·1	8 (29·6)
September	26·9	1 (3·6)	26·5	2 (7·4)
October	27·3	0	26·9	1 (3·7)
November	27·4	0	26·4	0
December	27·4	0	—	0

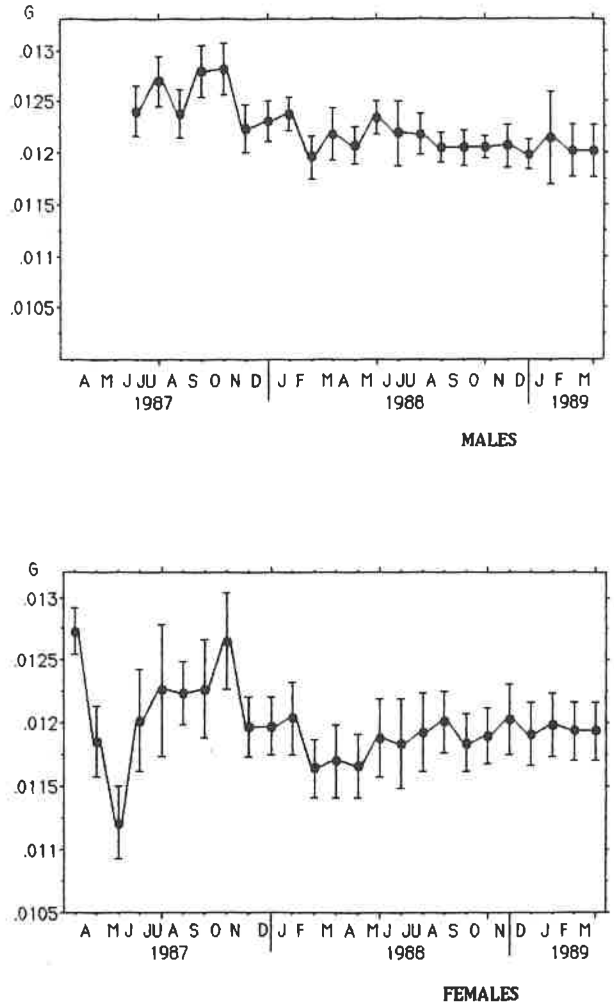

Fig. 3. Monthly average and standard deviation of *G* index males and females.

(at two years old, G=0·0119). In males we have data from three months old. Around October–November of the first year the G-index showed the maximum value—at two-year-old, G=0·0120.

The low condition in May (at two months old) could be associated with the beginning of the rains and decrease in temperatures. In their second year, the beginning of the rainy season in June had no influence on the condition of juveniles (Fig. 3).

For management purposes this curve is very important because it shows the critical period in early life when hatchlings are in the poorest condition and are most vulnerable. The maximum mortality was observed in July–August. Average G of dead hatchlings was 0·0102, significantly lower than the average of living males (G=0·0122, t=26·35, d.f.=26, p=0·0001) and females (G=0·0120, t=18·30, d.f.=26, p=0·0001).

Growth

At hatching, crocodiles are 270–300 mm in length (Table 4). Several growth models for crocodilians have been described (Webb *et al.* 1983*b*; Rodriguez, 1988; Jacobsen & Kushlan, 1989). In our case growth until two years is practically linear. Regression lines of *TL* plotted against age of nine males and 21 females are shown in Fig. 4. In the first year males attained an average *TL* of 745 mm, and females 620 mm and in the second year 1362 mm and 1111 mm, respectively (Table 4).

As in other crocodiles (Webb *et al.*, 1983*b*; Chabreck & Joanen, 1979) males grew significantly faster than females (analysis of covariance slopes of the regression line between age and total length, p<0·001). In the first year, males increased in *TL* by an average of 46·43 mm and females by 35·89 mm (t=3·29, 29 d.f., p<0·01). In the second year males grew 60·65 mm and females 48·09 mm (t=2·80, 27 d.f. p<0·01).

Wild females from the Cojedes River grew at the same rate as females hatched at the station (first-year females 39·17 mm vs 33·15 mm respectively, t=1·69, 20 d.f., p>0·1; second-year females 44·77 mm vs 50·57 mm, t=–1·14, 19 d.f., p>0·2).

Monthly growth was not constant throughout the year (Fig. 5). Considering data of 1988 to obviate the effect of poor condition and mortality in the first months, we found a positive correlation

Table 4. Measurements (in mm and g) of hatchlings, one-year-old and two-year-old crocodiles

	N	Total length	SD	Range	Body mass	SD	Range
Hatchlings 1987[a]	25	280·68	5·17	270–290	67·64	2·41	62–70
Hatchlings 1988[b]	20	288·65	8·66	282–300	71·80	1·96	68–75
One-year males	9	745·33	62·47	666–838	1 472·22	489·97	950–2 300
One-year females	21	619·61	101·09	376–789	783·04	374·72	125–1 900
Two-year males	9	1 362·12	144·28	1 142–1 591	10 437·50	4 068·59	5 300–17 500
Two-year females	21	1 111·10	182·98	804–1 503	5 620·00	3 077·44	1 750–15 200

[a] 6 days old.
[b] 3 days old.

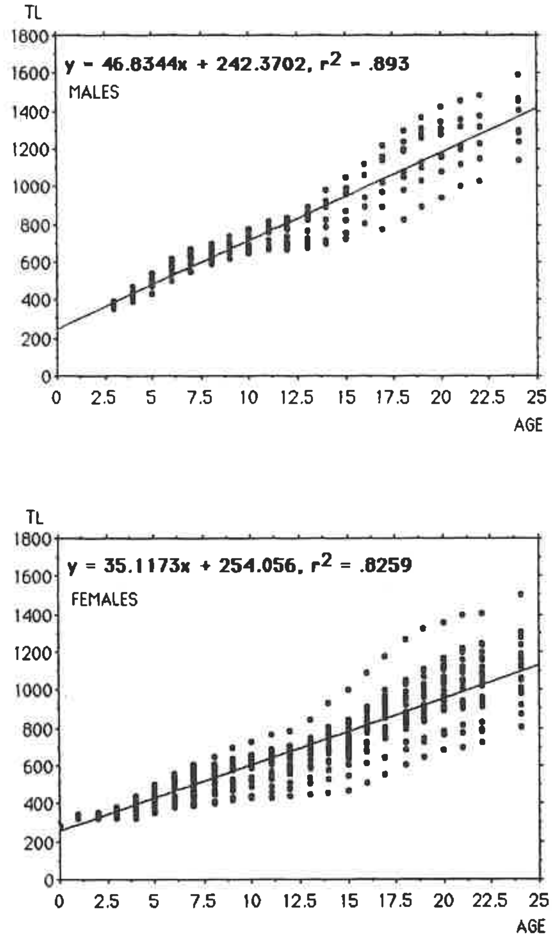

Fig. 4. Scattergrams of total length (*TL*) in mm plotted against age in months of males and females.

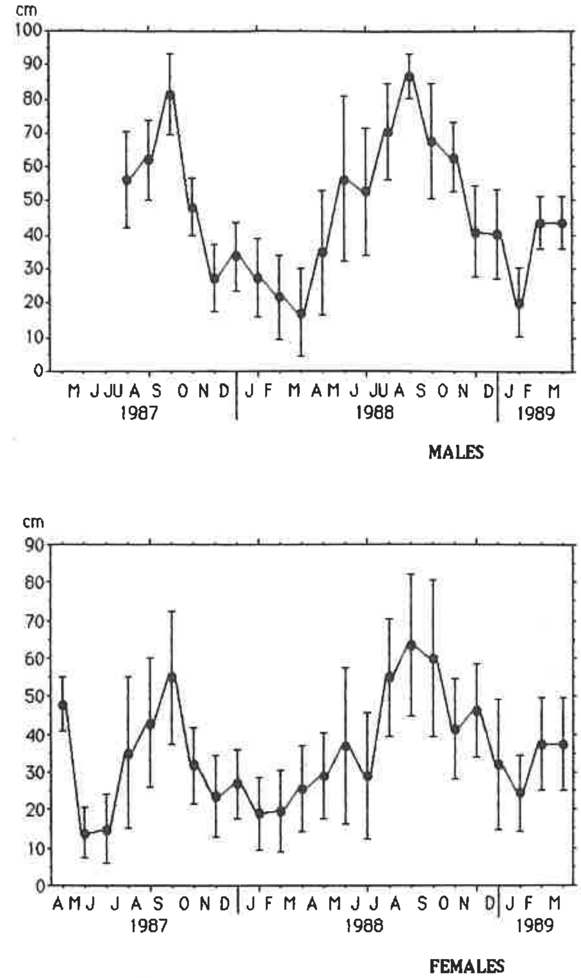

Fig. 5. Monthly growth rate in cm and standard deviation in males and females.

between monthly growth and rainfall for both males (r_s=0·63, n=98, p=0·0001), and females (r_s=0·48, n=256, p=0·0001). A negative correlation between growth and stocking densities was also found for both males (r_s=–0·60, n=98, p=0·0001) and females (r_s=–0·44, n=256, p=0·0001).

DISCUSSION

In other Venezuelan localities, the breeding season tends to occur later than in UNELLEZ, egg laying taking place in February, and hatching in April–May (Morillo 1980; T Blohm, pers comm.). In the Andean foothills the rains come earlier than in the Llanos and as breeding chronology is closely related with rain cycles, this fact could cause the advance of the breeding season at UNELLEZ.

In other crocodile species the hatching rate of wild eggs artificially incubated was higher than ours (72·4%), for example in *Crocodylus niloticus* it is 80–95% (Hutton & van Jaarsveldt, 1986), in *Caiman crocodilus* 90% (Rodriguez & Robinson, 1986), and in *Alligator mississippiensis* 91% (Joanen & McNease, 1986). However the hatching success of eggs laid by captive adults was lower: 40–60% in *C. porosus* (Suvanakorn & Youngprapakorn, 1986), 27·4 and 54% for *A. mississippiensis* fed with fish and nutria *Myocastor coypus*, respectively (Joanen & McNease, 1986), and 56·5–83·6% for *C. crocodilus* (Rodriguez, 1989).

The main cause of mortality (86·36%) appears to be starvation caused by loss of appetite. Appetite appears to be linked to temperature (Lang, 1979; 1986) and in other rearing stations low temperatures are reported to suppress appetite, causing mortality in hatchlings (Blake & Loveridge, 1975; Child, 1986; Foggin, 1986; Hutton & van Jaarsveldt, 1986; Whitaker, 1986). Under laboratory conditions *Alligator mississippiensis* did not initiate feeding activities at temperatures below 22°C (Couldson *et al.*, 1973). At UNELLEZ minimum temperatures between June and September ranged from 21°C to 21·9°C.

Table 5. Annual growth rate (cm) of captive Orinoco crocodiles, with number of crocodiles measured in parentheses

Source of information	Total length		
	<1·5 m	1·5–2·5m	>2·5 m
Blohm (1973)	22·8 (2)	10·5 (2)	—
Medem (1981)	22·9 (4)	33·5 (4)	8·1
Ayarzagüena (1984)	29·5 (1)	—	—
This paper	45·0 (30)	—	—

Crocodiles at UNELLEZ were provided with food throughout the year and ponds were maintained with sufficient water. Nonetheless, the rainy season in the wild—the time of feeding and growth (Gorzula, 1978; Webb *et al.*, 1983*b*)—appears to be the main factor affecting monthly growth.

There is little information about growth rates (Table 5) and size of sexual maturity in *C. intermedius*. Medem (1981) reported that a male reached sexual activity at 13 years old and 2·65 m total length. According to the regression lines, our crocodiles could attain this length much sooner, at about five years old. In other localities, captive crocodiles maintained under ideal husbandry conditions grew and reached sexual maturity faster than in natural conditions (Bustard & Singh, 1981; Joanen & McNease, 1986).

Crocodiles 1 m long can be released into the wild (Blake & Loveridge, 1975; Singh *et al.*, 1986); under our rearing conditions therefore we could liberate *C. intermedius* at two years old.

At UNELLEZ, as in other rearing centres, mortality in the first year is important to a captive-release programme. Survival rates could be improved with controlled environmental chambers, as used by Joanen and McNease (1986), at least during the first six months of life. These workers recorded a survival rate of 95% in alligators raised in chambers from hatching to three years old. Finally, in order to minimize disturbance to the adults, we recommend moving the eggs to artificial sand nests (de Vos, 1982) instead of allowing the eggs to hatch and then separating hatchlings from parents.

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REFERENCES

Ayarzagüena, J. (1984). Primeros datos de crecimiento de *Crocodylus intermedius* en semilibertad. *Mem. Soc. Cienc. Nat. la Salle*, **122**, 149–50.

Blake, D. K. (1974). The rearing of crocodiles for commercial and conservation purposes in Rhodesia. *Rhodesia Sci. News*, **8**, 315–24.

Blake, D. K. & Loveridge, J. P. (1975). The role of commercial crocodile farming in crocodile conservation. *Biol. Conserv.*, **8**, 261–72.

Blohm, T. (1973). Conveniencia de criar crocodilidos en Venezuela con fines económicos y para prevenir su extinción. *Simp. Int. Sobre Fauna. Silvestre y Pesca Fluvial y Lacustre Amazónica*, Manaus.

Blohm, T. (1982). Husbandry of Orinoco crocodiles *Crocodylus intermedius* in Venezuela. *Proc. Work Mtg, CSG, SSC, IUCN*, 5th, 264–82.

Brazaitis, P. (1969). The determination of sex in living crocodiles. *Brit. J. Herpetol.*, **3**, 54–8.

Bustard, H. R. & Singh, L. A. K. (1981). Age at onset of sexual maturity in male Indian Mugger. *Crocodylus palustris*, Lesson reared under ideal husbandry conditions in captivity. *J. Bombay Nat. Hist. Soc.*, **3**, 607–10.

Chabreck, R. H. & Joanen, T. (1979). Growth rates of American alligators in Louisiana. *Herpetologica*, **35**, 51–7.

Child, G. (1986). The management of crocodiles in Zimbabwe. In *Wildlife Management: Crocodiles and Alligators*, ed. G. J. W. Webb., S. C. Manolis & P. J. Whitehead. Surrey Beatty, Chipping Norton, NSW, pp. 49–62.

Couldson, T. D., Couldson, R. A. & Hernandez, T. (1973). Some observations on the growth of captive alligators. *Zoologica*, **58**, 45–52.

De Vos, A. (1982). A manual on crocodile conservation and management in India. FAO, Project IND/82/003, 69 pp.

De Vos, A. (1984). Crocodile conservation in India. *Biol. Conserv.*, **29**, 183–9.

Feldman, D. S. & Gagnon, J. (1986). *Stat View*. BrainPower Inc., Calabasas.

Foggin, C. M. (1986). Disease and disease control on crocodile farms in Zimbabwe. In *Wildlife Management: Crocodiles and Alligators*, ed. G. J. W. Webb, S. C. Manolis & P. J. Whitehead. Surrey Beatty, Chipping Norton, NSW, pp. 351–62.

Franz, R., Reid, S. & Pucket, C. (1985). Discovery of a population of Orinoco crocodile *Crocodylus intermedius* in southern Venezuela. *Biol. Conserv.*, **32**, 137–47.

Godshalk, R. & Sosa, E. (1978). El Caimán del Orinoco, *Crocodylus intermedius*, en los Llanos occidentales Venezolanos, con observaciones sobre su distribución en Venezuela y recomendaciones para su conservación. FUDENA, WWF, Caracas.

Godshalk, R. (1982). Status and conservation of *Crocodylus intermedius* in southern Venezuela. *Proc. Work Mtg, CSG, SSC, IUCN*, 5th, 39–53.

Gorzula, S. (1978). An ecological study of *Caiman crocodilus crocodilus* inhabiting savanna lagoons in the Venezuelan Guayana. *Oecologia, Berl.*, **35**, 21–34.
Groombridge, B. (1986). The distribution and status of world crocodilians. In *Wildlife Management: Crocodiles and Alligators*, ed. G. J. W. Webb, S. C. Manolis and P. J. Whitehead. Surrey Beatty, Chipping Norton, NSW, pp. 9–21.
Hutton, J. M., van Jaarsveldt, K. R. (1986). Crocodile farming in Zimbabwe. In *Wildlife Management: Crocodiles and Alligators*, ed. G. J. Webb, S. C. Manolis & P. J. Whitehead. Surrey Beatty, Chipping Norton, NSW, pp. 323–7.
Jacobsen, T. & Kushlan, J. A. (1989). Growth dynamics in the American alligator *Alligator mississippiensis. J. Zool., Lond.*, **219**, 309–28.
Joanen, T. & McNease, L. (1986). Alligator farming research in Louisiana, USA. In *Wildlife Management: Crocodiles and Alligators*, ed. G. J. W. Webb, S. C. Manolis & P. J. Whitehead. Surrey Beatty, Chipping Norton, NSW, pp. 329–40.
Lang, J. W. (1979). Thermophilic response of the American alligator and the American crocodile to feeding. *Copeia*, **1**, 48–59.
Lang, J. W. (1986). Crocodilian thermal selection. In *Wildlife Management: Crocodiles and Alligators*, ed. G. J. W. Webb, S. C. Manolis & P. J. Whitehead. Surrey Beatty, Chipping Norton, NSW, pp. 301–17.
Medem, F. (1981). *Los Crocodylia de Suramérica. Vol. I. Los Crocodylia de Colombia*. Colciencias, Bogota.
Medem, F. (1983). *Los Crocodylia de Suramérica. Vol. II. Venezuela, Trinidad, Tobago, Guyana, Suriname, Guyana Francesa, Ecuador, Perú, Bolivia, Brasil, Paraguay, Argentina, Uruguay*. Colciencias, Bogotá.
Montague, J. J. (1984). Morphometric analysis of *Crocodylus novaeguineae* from the Fly River Drainage, Papua New Guinea. *Aust. Wildl. Res.*, **11**, 395–414.
Morillo Prieto, C. M. (1982). Observaciones sobre el mantenimiento y cría del *Crocodylus intermedius. Act. Cong. Latinoamer. Zool.*, VIII Tomo II, ed P. Salinas, pp. 1443–4.
Ramo, C. & Busto, B. (1986). Censo aéreo de caimanes *Crocodylus intermedius* con observaciones sobre su actividad de soleamiento. *Proc. Work. Mtg. Crocodile Specialist Group of the Species Survival Commission of the IUCN*, 7th, Caracas, pp. 109–19.
Rodriguez, M. A. (1988). El crecimiento de neonatos y juveniles de *Caiman sclerops fuscus* Cope 1868 (Crocodylia: Alligatoridae). *Lozania*, **55**, 1–88.
Rodriguez, M. A. (1989). Crocodile farming in Colombia: Pizano S. A.'s Project in the North Coast. American Alligator Farmer's Association Crocodilian Congress, 'Production and Marketing Strategies for the 1990s'.
Rodriguez Arvelo, G. & Robinson, M. D. (1986). Estudio del crecimiento en cautiverio de la baba, *Caiman crocodilus*, durante sus primeros meses de vida. *Proc. Work. Mtg Crocodile Specialist Group of the Species Survival Commission of the IUCN*, 7th, Caracas, pp. 62–79.
Singh, L. A. K., Kar, S. & Choudhury, B. C. (1986). Indian crocodilians: a 10-year review of management. *Proc. Work. Mtg Crocodile Specialist Group of the Species Survival Commission of the IUCN*, 7th, Caracas, pp. 362–71.
Suvanakorn, P. & Youngprapakorn, C. (1986). Crocodile farming in Thailand. In *Wildlife Management: Crocodiles and Alligators*, ed. G. J. W. Webb, S. C. Manolis & P. J. Whitehead. Surrey Beatty, Chipping Norton, NSW, pp. 341–3.
Webb, G. J. W., Buckworth, R. & Manolis, S. C. (1983*a*). *Crocodylus johnstoni* in a controlled-environment chamber: a raising trial. *Aust. Wildl. Res.*, **10**, 421–32.
Webb, J. W., Buckworth, R. & Manolis, C. (1983*b*). *Crocodylus johnstoni* in the McKinlay river area, NT, III. Growth, movement and the population age structure. *Aust. Wild. Res.*, **10**, 383–401.
Whitaker, R. (1986). The management of crocodilians in India. In *Wildlife Management: Crocodiles and Alligators*, ed. G. J. W. Webb, S. C. Manolis and P. J. Whitehead. Surrey Beatty, Chipping Norton, NSW, pp. 63–72.
Whitaker, R. & Whitaker, Z. (1984). Reproductive biology of the mugger *Crocodylus palustris. J. Bombay Nat. Hist. Soc.*, **2**, 297–316.