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## NOTES ON THE ECOLOGY AND GROWTH OF AMAZONIAN CAIMANS (CROCODYLIA, ALLIGATORIDAE)

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### ABSTRACT

*Data are presented on habitat preferences, stomach contents and the relationship between body weight and some length parameters of Caiman crocodilus and Paleosuchus trigonatus collected in the Rio Japurá from October to December 1977.*

### INTRODUCTION

In the months of October to December, 1977, the boats "Lindolpho R. Guimarães" and "Garbe", of the Expedição Permanente da Amazônia (EPA), presently supported by this Museum, by the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) and by the Instituto Nacional de Pesquisas da Amazônia (INPA), worked on the Rio Japurá, from its mouth on the Solimões at 03°08'S, 64°46'W, to the mouth of the Apaporis, on the Brasil-Colombia border, at 01°23'S, 69°25'W. This is the whole length (some 720 km) of the Japurá under this name; in Colombia it is called the Caquetá.

Among the objectives of the trip were the collection of natural history data on chelonians and crocodylians. In the present paper we report on the latter.

### GENERAL DATA

The Japurá is a curious river in that it does not meander, but just the same touches very few stretches of "terra firme" (land above seasonal flood level) as it runs through a broad floodplain. It is not an easy river to work, and does not have many beaches, even in the dry season. The year of 1977 was a poor one for collecting caimans, turtles and fish, as the level of the water did not lower as usual: the turtles had few beaches on which to lay, and the caimans and fish remained dispersed in the spacious swamps of the region. Even

so, two species of caiman, *Caiman crocodilus* (L., 1758) (called all over Brasil "jacarétinga" or simply "tinga") and *Paleosuchus trigonatus* (Schneider, 1801) (locally "jacarépaguá" or "paguá"; other names elsewhere) were quite common and easy to obtain.

Collecting was done at night, from a canoe, slowly paddled up or down the middle of small rivers (10-30 m wide), starting at the Japurá. The banks (forested, shallowly flooded) were swept by the beams of head lamps and the animals discovered by eye shine, which permitted to distinguish between the two species; that of the tinga was an angry red, like a cigar coal, while the paguá showed a rosier shade and sort of a berry-like texture. These features are well known to the local people and those working with us made no mistakes of identification, even at first sight.

Since the animals were plentiful and easy to approach, an attempt was made at obtaining an adequate spread of body sizes of the two species, many specimens of intermediate size being spared. However, it was not possible to obtain large *C. crocodilus* nor infantile *P. trigonatus*. It is possible that the two species breed at different times, but we could not obtain reliable information on this point. Once spotted, the animals were cautiously approached and, the vegetation permitting, noosed; otherwise harpooned. A noose was then slipped over the snout and the four feet tied on the back. The beast being thus rendered helpless, hunting was continued. Next morning the specimens were killed, measured and weighed; the smaller ones were injected, the larger autopsied and only the head preserved. Additional specimens were bought from local inhabitants and identically processed.

For each specimen the following data were recorded: (i) total length, from the tip of the snout to the tip of tail; (ii) body length, from the tip of the snout to the posterior end of the vent; (iii) tail length, from the latter point to the tip.

Weights were taken with the help of four spring balances: to 100 g (precision 1 g); to 500 g (5 g); to 10 kg (50 g); to 100 kg (0.5 kg).

Stomach contents were washed in a bucket; all items not too badly decomposed and all gastroliths were preserved.

In some cases one of us (PEV) forgot to record the sex of the autopsied specimens. The injected specimens were not sexed.

#### HABITAT PREFERENCES

Until very recently (e.g., H. W. Campbell, 1972) it was accepted, at least tacitly, that caimans were consistent in their habitat preferences, and that Medem's (e.g. 1971) scheme of ecological isolation, arrived at in Colombian Amazonia, and especially involving *Caiman crocodilus* and the two species of *Paleosuchus*, had broad geographic validity. In Medem's (1971:153) own words: "... the ecological niche for the Spectacled caiman consists principally of quiet waters, and, therefore, it is not found near rapids and water-falls but prefers the bends of large rivers, lakes and swamps. By contrast, the Smooth-fronted and Dwarf caimans are both found in another well-defined niche which consists — in general terms — of swift running waters in tropical rain forests". Recently it has become evident, however,

that these statements are not universally valid. For instance, K. E. Campbell (1973) found *P. trigonatus* in a small spring-fed stream running through a pasture in the Madre de Dios, Peru. Dixon & Soini (1977), on the basis of Soini's extensive experience, preferred to define very broadly the habitat of *C. crocodilus* (rivers, ponds, oxbow lakes, lower areas of forest streams and flooded forests) and associated the two species of *Paleosuchus* to closed canopy forest streams.

Before the present trip we had some incidental information on habitats that did not conform to previous ideas. For instance, and restricting ourselves to recorded observations, our *C. crocodilus* MZUSP 2014 was caught at the tail end of the last of the rapids of the Madeira (cachoeira de Santo Antonio, a few kilometers above Porto Velho, Rondonia). It was clearly a resident, not a washed-down specimen, as we saw him twice during the day, before going after him at night. And it was not a sickly and displaced specimen; it was a healthy male 167 cm long, that put up quite a struggle before two experienced men could board and hogtie him. The place was rocky and the water very swift. Our specimen MZUSP 2115 was collected at Igarapé Jaramacaru, a fast-flowing creek on the edge of a "savanna" clearing in northern Pará, in a place where the bed was bare sandstone.

On the other hand, our *Paleosuchus palpebrosus* MZUSP 2181 was collected on the beach of the broad Trombetas, at the very city of Oriximiná, Pará. Several specimens of the same species, among which MZUSP 2179 and 2180, were collected in the Negro at about 65°W — not a fast small river and certainly not a closed-canopy one.

In all these cases we were matter-of-factly assured by the local inhabitants that the animals were not behaving exceptionally, and that they were not rare.

It is clear then that stereotyped preferences cannot be attributed to these species, and that local situations must be individually studied. The broad range of variability encompassed by so few direct observations shows that these local studies should be rewarding. They are, however, not easy to make. One first difficulty is that, in caiman collecting, one usually does not survey all possible sites, but stops looking as soon as a good place is found. Large swamps with their attending cohorts of mosquitos, narrow jungle rivers full of fallen trees, and other difficult environments, are understandably passed by, although they might conceivably be very rewarding.

On the other hand, the pressure of commercial hunting has already deformed beyond hope of recovery the natural setting along all navigable rivers and lakes of Amazonia. It should be noted that this is a differential pressure: *Melanosuchus niger* was the only species bought at first, and is still the most sought after; later it was discovered how to tan the skin of *Caiman*, which were then slaughtered; to date *Paleosuchus* has very little market value.

It would be wrong, however, to say that, since the pristine relationships are irrecoverable, studies of habitat preference and coadaptation are not important. On the contrary, they are essential to programs of recuperation of numbers and conservation. Brasil has had for some years a full ban on all professional hunting. Since some of the neighboring countries haven't, the prohibition is ineffectual within smuggling distance of the respective borders, which covers a

lot of ground in Amazonia. Surprisingly enough to skeptics, elsewhere protection is functioning well and rapidly. In fact, *Caiman crocodilus* is coming back so fast that it is predictable that controlled hunting will have to be permitted in the not too distant future. It will never be a really dangerous or destructive animal, but will certainly become again a harassing one, and there will be a pressure to allow impecunious local populations to make use of a traditional resource in the process of recuperation. If other South American countries come to adopt the ban, and especially if some of the developed countries forbid the importation of wild skins, the need for population control will very possibly become acute. It seems to us that the acquisition of natural history data on caimans is an urgent matter; in fact it is to us the main rationale of synecological studies of caimans.

Our present data are as follows (see the Appendix). At Serrinha (01°35'S, 69°27'W, on the Colombian border) we collected on a stretch of flood plain river a little less than 1 km long. As said, the Japurá had not gone down in 1977, and the water was still in the woods. We obtained 2 *crocodilus* and 10 *trigonatus*. A very similar environment was explored at the Paraná da Jacitara (01°57'S, 65°10'W, on the flood plain of the Solimões), where we obtained 3 *crocodilus* and 6 *trigonatus*. At 4 other localities, 6 *crocodilus* and 2 *trigonatus* were brought in. In the areas where we collected, the two species seemed to be randomly mixed, and it is clearly impossible to assume any form of habitat segregation. This is also the opinion of the local inhabitants, who assert, on the other hand, that *Melanosuchus niger* is to be found only in the lakes. We saw at Serrinha a very large *Palaeosuchus* (perhaps 2 meters long) lying on the bank of the Japurá proper. Our harpooner failed, but we are sure of the identification.

#### FOOD HABITS

We examined three stomachs of *C. crocodilus* and 12 of *P. trigonatus*. One *crocodilus* stomach (MZUSP 2219, 95 cm total length) was empty. As to the others:

MZUSP 2220, 85 cm, 2350 g: elytra of Coleoptera; one lepidopteran larva, 4 cm; one crab shell, 3 cm (probably *Trichodactylus (Valdivia) peruvianus*).

MZUSP 2221, 103 cm, 3600 g: bird shin bone 10 cm long.

Among *P. trigonatus*, MZUSP 2207 (103 cm), 2205 (130 cm) and 2214 (147 cm) had no food remains; the former two had gastroliths.

As to the other specimens:

MZUSP 2213, 91 cm, 2750 g: remains of a rat-sized mammal with a bushy tail tip; gastroliths.

MZUSP 2216, 93 cm, 2650 g: 5 seeds, with respectively 4.2, 7.2, 10.1, 23.5 and 28.7 cubic centimeters, weighing a total of 9 grams.

MZUSP 2218, 112 cm, 5.1 kg: one fish (*Hoplias malabaricus*, Erythrinidae) weighing about 1 kg; the opercle of a large gastropod (*Pomacea* sp.); gastroliths.

MZUSP 2211, 105 cm, 4.9 kg: fragments of crab shell (probably *Trichodactylus peruvianus*); gastroliths.

- MZUSP 2214, 108 cm, 6.0 kg: one small gastropod (young of *Pomacea* sp.); tree bark; gastroliths.  
 MZUSP 2204, 128 cm, 7.0 kg: three fur balls; gastroliths.  
 MZUSP 2206, 141 cm, 12.5 kg: the heart and lungs of a large mammal (size of a pig or a goat; undoubtedly offal); gastroliths.  
 MZUSP 2209, 147 cm, 14.5 kg: 3-4 fur balls; gastroliths.

This list confirms (if confirmation were needed) that caimans are catholic, opportunistic feeders. Gastroliths were not found in the 3 *crocodilus* stomachs, and were present in 10 out of 12 *trigonatus*. The seeds found in MZUSP 2216 may also be considered as gastroliths, as by Staton & Dixon (1977); in fact they are very hard and too diversified to have been swallowed accidentally, or as food.

Gastroliths are an interesting item of crocodilian behavior. Brazaitis (1969) has a brief review of the literature, that may be complemented, in what concerns South America, by the citation of the following papers: Wied (1825), Schmidt (1928), Banks (1931), Medem (1952, 1953), Carvalho (1955), K. E. Campbell (1973), Chirivi-Gallego (1973), Staton & Dixon (1977). With regard to function, Cott (1961:237) in his classic monograph on the Nile crocodile, found a remarkable statistical dependence between weight of gastroliths and weight of the individual, and concluded that the stones have the function of increasing the density of the submerged animal. We weighed the gastroliths of the following specimens:

- MZUSP 2216 (seeds): weight of the animal 2650 g, of the seeds (dry) 9 g (0.4%)  
 MZUSP 2213: 2750 g, 9 g (0.3%)  
 MZUSP 2218: 5.1 kg, 32 g (0.6%)  
 MZUSP 2214: 6.0 kg, 1 g (0.02%)  
 MZUSP 2211: 4.9 kg, 11 g (0.2%)

There is no apparent relationship between gastrolith weight and animal weight, but the values are in good agreement with Cott's (1961) Table 8, relating stone weight to body weight over a much larger range of sizes and indicating that the relative weight of the gastroliths increases with crocodile size, and reaches saturation at about 1%, which Cott thinks is effective in increasing the density of the submerged animal. It must be considered, however, that *P. trigonatus* will never grow to the size at which gastroliths can be effective as ballast. It would seem then that habit of swallowing stones may have ended by having a hydrostatic function in large crocodiles, but was initially acquired for some other purpose. The best candidate is of course the mechanical function of trituration. Without going in detail into Cott's argument against this, it should be remembered that crabs and gastropods are a sizable part of the caiman's diet, and that their remains are found thoroughly crushed in the stomach. That the opercula of large gastropods survive the crushing of the shells is not so surprising as Cott thought, because they are very flexible.

## BODY WEIGHT

The biometrical study of body weight is relevant from several viewpoints: intrinsically as a growth parameter, as a means of exploring interpopulational differences, and as a means of estimating biomass.

Crocodylians are aquatic animals: the preponderance of swimming as a method of locomotion makes total length the most logical body size parameter. However, other variables are also desirable. For instance, animals with small or even medium amputations of the tip of the tail will weigh practically the same as intact ones, but, if total length is taken as the independent variable, the specimens will be unusable or, if the mutilation goes undetected, plotted to the left of their correct position on the graph, thus introducing a bias. It is obviously necessary to consider variables (such as body length and head length) less subject to injury. Incidentally, no obviously mutilated tails were observed in our materials, which would indicate low rates of predation and intra-specific aggression.

Otherwise, the tail deserves individual attention; for instance, it would be interesting to compare habitat and ethological data with the relative amount of tail muscle — devoted to swimming, display, combat and predation. Tail weight can be directly studied by amputation at the root, but the resulting wastage of specimens is unpleasant, and this method should be resorted to only when sufficient evidence exists that the results will be worth while. Indirect methods, more advisable to begin with, consist in studying the regression of tail length on body length and of weight on body length; if interspecific differences appear in these respects, it will be interesting to further explore the problem.

Finally, another variable that must be considered, especially for the purpose of biomass estimation, is head length. It is not always easy to take large balances to the work area, but skulls are easy to bring back or to measure in the field. If the regression of body weight on head length has a good fit, an adequate approximation can be had for individual weights, and combined with specimen counts to afford an estimate of biomass. We studied this relationship and, as a check, also the regression of the head length on the length of the trunk, i. e., body length minus head length (body length itself cannot be used as the independent variable because regression of a part on the whole includes a strong bias).

As it was to be expected (Dodson, 1975), the regressions of length on length were found to be isometric with very high correlations. The weight on length correlations also proved excellent.

## WEIGHT ON TOTAL LENGTH (W x L)

The regression being obviously curvilinear, the two usual anamorphoses were tried, cubic root of weight on length, and double logarithmic. The former was not successful, but the latter afforded an excellent fit (Table 1), resulting into straight lines with coefficients of determination of 0.994 (*crocodilus*) and 0.972 (*trigonatus*).

The ranges of body size for the two species differ: no large *crocodilus* were found, nor infantile *trigonatus*, so that a satisfactory

comparison cannot be made; however, in the region of overlap the agreement between the two species is so close that it is highly probable that the two regressions do not differ. In fact, a joint regression afforded a coefficient of determination of 0.992 (Table 1, Graph 1). The equation of the curve is

$$\log W = 3.51539 \log L - 3.50789$$

or, alternatively,

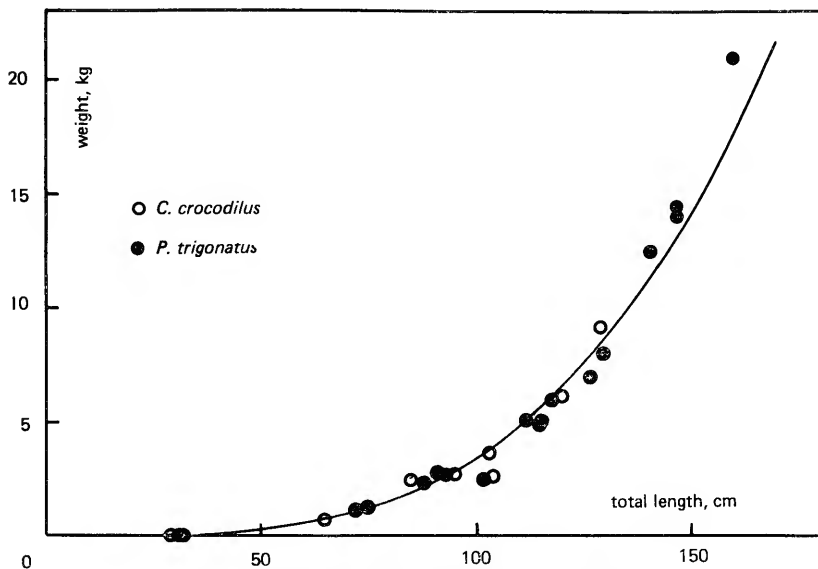
$$W = 3.220 L^{3.5154} \cdot 10^{-4}$$

We do not consider this curve completely adequate yet for the practical estimation of weight, as we had no really large specimens. It is, however, reasonable for the range sampled; principally, it demonstrates the feasibility of the estimation, which is additionally

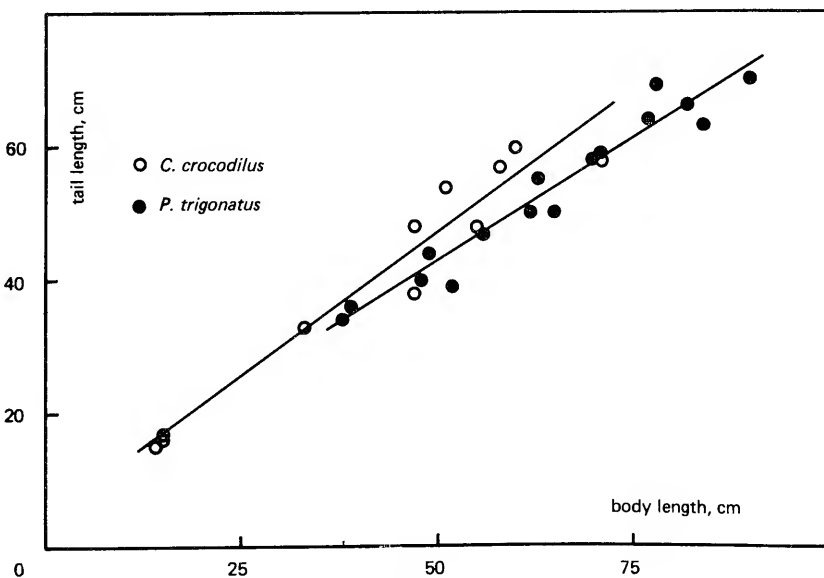
TABLE 1 — DATA ON REGRESSIONS

	N	R	b	s <sub>b</sub>	a	t <sub>a</sub>	r <sup>2</sup>
<b>log weight x log total length</b>							
tinga	11	29 — 129	3.46151	.092343	- 3.42215	19.749***	.994
paguá	16	72 — 160	3.50708	.15826	- 3.47806	10.681***	.972
joint	27	29 — 160	3.51539	.064921	- 3.50789	27.209***	.992
<b>tail length x body length</b>							
tinga	11	14 — 71	.852	.0710	4.27	1.292 ns	.941
paguá	16	38 — 90	.727	.04590	6.26	2.019 ns	.945
<b>log weight x log body length</b>							
tinga	11	14 — 71	3.27004	.051532	- 2.09426	25.467***	.998
paguá	16	38 — 90	3.32147	.16607	- 2.22753	7.469***	.966
joint	27	14 — 90	3.22957	.057669	- 2.05013	20.754***	.992
<b>cubic root of weight x body length</b>							
tinga	11	14 — 71	.305	.00808	- .834	2.220 ns	.994
paguá	16	38 — 90	.324	.0151	- 2.553	2.569*	.971
joint	27	14 — 90	.306	.00800	- 1.162	2.475*	.983
<b>head length x trunk length</b>							
tinga	11	246 — 1115	.149	.00753	8.281	1.411 ns	.978
paguá	16	603 — 1341	.167	.01219	16.228	1.314 ns	.930
<b>log weight x log head length</b>							
tinga	11	44 — 175	3.70937	.078487	- 4.43362	27.938***	.996
paguá	16	117 — 259	3.76671	.23377	- 4.73402	9.008***	.949
joint	27	44 — 259	3.47168	.10189	- 4.02440	18.297***	.979

N, specimens in sample; R, range of the independent variable; b, coefficient of regression; s<sub>b</sub>, its standard deviation; a, regression constant; t<sub>a</sub>, Student's; r<sup>2</sup>, coefficient of determination; \*, significant at the 5% level; \*\*\*, significant at the .1% level; ns, not significant.



Graph 1. Regression of weight on total length.



Graph 2. Regression of tail length on body length.



borne out by the fact that a plot of Banks' (1931) measurements of *Crocodylus porosus* shows that double logarithmic linearity extends comfortably to 3.66 meters total length and the corresponding 136.2 kilos body weight.

#### WEIGHT ON BODY LENGTH (W x SVL)

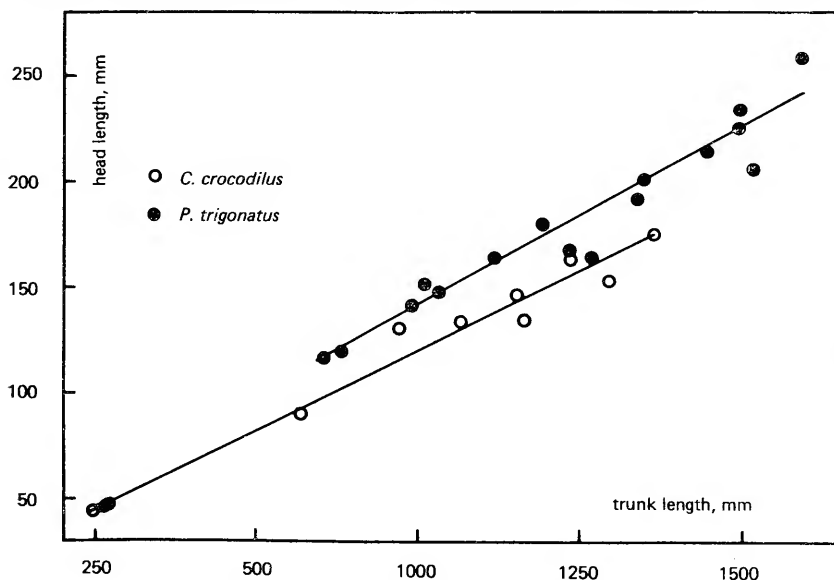
The regression of tail length on body length is impressively good for either species (Table 1). This confirms that there are no noticeably mutilated tails in our sample. In both species tails are on the average a little shorter than the body, but *crocodylus* tends towards larger tails (Graph 2). The difference between the coefficients of regression is not significant:  $t$  (Student) is 1.537 for 23 degrees of freedom. On the other hand, the difference between the constants of regression is significant at the 5% level ( $t = 2.746$  with 24 degrees of freedom). This difference is compensated, in some unknown way, because the regression of weight on body length is the same for the two species, the joint regression affording a coefficient of determination of 0.992. The equation of prediction (with the same caveats applied to that on total length) is

$$\log W = 3.22957 \log SVL - 2.05013$$

or

$$W = 0.00891 SVL^{3.2296}$$

The regression of the cubic root of the weight on body length also showed a very good fit (Table 1). This relationship has been plotted by Staton & Dixon (1977) for *C. crocodylus* of the Venezuelan llanos. Since they do not present the original values or a fitted



Graph 3. Regression of head length on trunk length.

equation, an adequate comparison is not possible, but a rough plot of our line on their graph indicates at least very close coincidence.

#### WEIGHT ON HEAD LENGTH (W x H)

We took as head length the distance between the tip of the snout and the hind edge of the skull table; it is a measurement that can be equally taken in live specimens or cleaned skulls.

The regression of head length on trunk length is linear for either species, and very good (Table 1, Graph 3); as in the case of tail length, the coefficients of regression do not differ significantly ( $t = 1.215$  with 23 degrees of freedom) but the constants of regressions differ at the .1% level ( $t = 5.240$  with 24 degrees of freedom). *P. trigonatus* has a proportionally longer head than *C. crocodilus*.

Again as in the case of tail length, the joint regression of weight on head length (Table 1) is surprisingly good ( $r^2 = 0.979$ ); the respective equations are

$$\log W = 3.47168 \log H - 4.02440$$

and

$$W = 0.945 H^{3.4717} \cdot 10^{-4}$$

Head length may thus be said to afford a very accurate and practical means of estimating body weight.

#### CONCLUSIONS

The study of 11 *Caiman crocodilus* (jacaré tinga) and 16 *Paleosuchus trigonatus* (jacaré paguá) collected between October and December 1977 on the Rio Japurá permits the following preliminary conclusions:

Habitat preferences of individual species of Amazonian caimans seem to vary geographically, as do the patterns of coadaptation between the two species.

Food preferences of both species are catholic and opportunistic. Gastroliths were found in a large proportion of *P. trigonatus*, and it is thought that in this species they do not have a hydrostatic function. The fact that in small crocodylians the weight of the gastroliths is insufficient as ballast indicates that the mechanical function must have preceded, phylogenetically, the hydrostatic one.

The two species differ in relative tail length and in relative head length, but the weight-length relationships (weight on total, on body and on head length) are apparently the same, and the joint regressions show excellent fits. All three length measurements afford good estimates of weight, and better materials should permit the construction of accurate predictive tables, with narrow confidence intervals.

The ecological and behavioral meaning of these paradoxically contrasting differences and resemblances remains to be investigated.

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## APPENDIX - RAW DATA

		Length				
		SVL	T	H	Weight	
<i>Caiman crocodilus</i>						
2195	Maraã, 1° 52', 63° 35'	♀	71	58	175	9050 g
2196	"	♀	33	33	90	700 g
2197	"	♂	60	60	153	6050 g
2198	Vila Bitencourt, 1° 23', 69° 25'	—	14	15	44	44 g
2199	"	—	15	16	46	58 g
2200	"	—	15	17	47	58 g
2201	Serrinha, 1° 35', 69° 27'	—	51	54	134	2550 g
2202	"	—	58	57	163	4950 g
2219	Paraná da Jacitara, 1° 57', 65° 10'	♀	47	48	133	2700 g
2220	"	♀	47	38	130	2350 g
2221	"	♂	55	48	146	3600 g
<i>Paleosuchus trigonatus</i>						
2203	Serrinha, 1° 35', 69° 27'	—	82	66	235	14.0 kg
2204	"	—	70	58	192	6950 g
2205	"	—	71	59	202	8000 g
2206	"	—	77	64	215	12.5 kg
2207	"	—	56	47	164	2500 g
2208	"	—	39	36	120	1300 g
2209	"	—	78	69	226	14.5 kg
2210	"	—	48	40	142	2350 g
2211	Lago Mapará, 1° 54', 66° 59'	—	65	50	168	4850 g
2212	Costa da Altamira, 1° 47', 66° 32'	—	84	63	206	14.0 kg
2213	Paraná da Jacitara, 1° 57', 65° 10'	♀	52	39	152	2750 g
2214	"	♂	63	55	164	6000 g
2215	"	♂	49	44	148	2650 g
2216	"	♀	62	50	180	5100 g
2217	"	♂	38	34	117	1200 g
2218	"	♀	90	70	259	21.0 kg

All latitudes South, all longitudes West. Snout-to-vent and tail length in centimeters, head length in millimeters. Weight in grams or kilograms, according to the balance used.

## REFERENCES

- Banks, E., 1931. Some measurements of the Estuary Crocodile (*Crocodilus porosus*) from Sarawak. *J. Bombay Nat. Hist. Soc.* 34 (4): 1086-1088.
- Brazaitis, P., 1969. The occurrence and ingestion of gastroliths in two captive crocodilians. *Herpetologica* 25 (1): 63-64.
- Campbell, H. W., 1972. Ecological or phylogenetic interpretation of crocodilian nesting habits. *Nature* 238 (5364): 404-405.
- Campbell, K. E., jr, 1973. Habitat notes on *Paleosuchus trigonatus* (Schneider) in Peru. *J. Herp.* 7 (3): 318-320.
- Carvalho, A. L., 1951. Os jacarés do Brasil. *Arq. Mus. Nac., Rio de Janeiro*, 42: 127-152.
- Chirivi-Gallego, H., 1973. Contribución al conocimiento de la Babilla o Yacaré tinga (*Caiman crocodilus*) con notas acerca de su manejo y de otras especies de Crocodylia neotropicales, in: Instituto Interamericano de Ciencias Agrícolas da OEA e Ministério da Agricultura do Brasil, Relatório do Simpósio Internacional sobre fauna silvestre e pesca fluvial e lacustre amazônica (Mimeographed). Vol 2, art. VIII-G, 126 pp., pls.
- Cott, H., 1961. Scientific results of an inquiry into the ecology and economic status of the Nile Crocodile (*Crocodilus niloticus*) in Uganda and Northern Rhodesia. *Trans. Zool. Soc. London* 29: 211-337, pls.
- Dixon, J. R. & P. Soini, 1977. The reptiles of the Upper Amazon basin, Iquitos region, Peru. II. Crocodilians, turtles and snakes. *Mihwaukeee Publ. Mus. Contrib. Biol. Geol.* 12: 91 pp.
- Dodson, P., 1975. Functional and ecological significance of relative growth in *Alligator*. *J. Zool., London*, 175 (3): 315-355.
- Medem, F., 1952. *Paleosuchus trigonatus* (Schneider) en Colombia (Nota preliminar). *Lozania (Acta Zool. Colomb.)* 5: 1-112.
- Medem, F., 1953. Contribuciones a la taxonomía y distribución del Yacaré Negro, *Paleosuchus palpebrosus* (Cuvier) en Colombia. *Rev. Colomb. Antropol.* 1 (1): 409-419, pls.
- Medem, F., 1971. Biological insolation of sympatric species in South American Crocodylia, pp. 152-158 in: Crocodiles, Proceedings of the First Working Meeting of Crocodile Specialists ... New York ... March 1971. *IUCN Publications New Series Suppl. Paper* 32 (1).
- Schmidt, K. P., 1928. Notes on South American caimans. *Publ. Field Mus. Nat. Hist. (Zool Ser.)* 12 (17): 205-231, pls.
- Staton, M. A. & J. R. Dixon, 1977. Studies in the dry season biology of *Caiman crocodilus crocodilus* from the Venezuelan llanos. *Mem. Soc. Ci. Nat. La Salle, Caracas*, 35 (101): 237-265.
- Wied-Neuwied, Maximilian, Prinz zu, 1825. Beiträge zur Naturgeschichte von Brasilien. Vol. 1: xxii + 614 pp. Weimar: Gr. H. S. priv. Landes-Industrie-Comptoirs.