

## DIET RECORDS FOR *CROCODYLUS CATAPHRACTUS* (REPTILIA: CROCODYLIDAE) AT LAKE DIVANGUI, OGOOUÉ-MARITIME PROVINCE, SOUTHWESTERN GABON

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**ABSTRACT.**— A population of *Crocodylus cataphractus* was discovered at Lake Divangui, south-western Gabon. Data on stomach contents (fish and gastroliths) of this species are provided. A first, very preliminary list of fish species inhabiting the lake includes 10 species (1 Characidae, 2 Aplocheilidae, 1 Claroteidae, 3 Cichlidae, 1 Distichodontidae, 1 Clariidae, and 1 Hepsetidae).

**KEYWORDS.**— Reptilia, *Crocodylus cataphractus*, Pisces, diet, gastrolith, Lac Divangui, Ogooué-Maritime, Gabon.

### INTRODUCTION

Lake Divangui is situated in Ogooué-Maritime Province, south-western Gabon. It belongs to the Echira River system to which it is connected through a small stream. Its diameter is ca. 1 km, its altitude 22 m a.s.l. The depth is ca. 80 m, which makes it the deepest lake of Gabon. It has a peculiar geological history, and is probably the surface expression of a salt diapir which was eroded about 300,000 years before present (Anselmetti et al., 1997, 1999; Ariztegui et al., 1998, 1999). The surrounding human population density is low, although there is limited subsistence fishing activity. In the course of an aquatic vertebrate survey as part of the Gamba Complex Biodiversity Project (Smithsonian Institution/Shell Gabon), we made preliminary investigations on the fish and herpetofauna of the lake. In the present report, which constitutes the first zoological study ever provided for this lake, we

report observations on the diet of the slender-snouted crocodile, *Crocodylus cataphractus* Cuvier, 1825 collected with nets by fishermen in the lake, as well as a very preliminary list of fish species for the lake.

### MATERIAL AND METHODS

The survey was undertaken during the dry season (20-21 July 2002), and focused on the western bank of the lake (GPS coordinates 01° 56' 28.4''S, 09° 59' 19.9''E). Fishes were caught with nets and by angling, using locally collected earthworms as bait. On the first morning, we examined six drowned specimens of *Crocodylus cataphractus* accidentally caught by local fishermen's nets designed to catch fish. The two nets were about 30 m long by 2 m high, suspended by floats, and placed a few meters from, and perpendicularly to, the bank. The whole crocodile stomach contents were extracted and transferred to

**TABLE 1:** Description of the gastroliths sets found in three *Crocodylus cataphractus* stomachs at Lake Divangui, south-western Gabon.

Crocodile n°	Crocodile total length (cm)	Number of gastroliths	Nature of gastroliths	Total dry weight of gastroliths (g)	Mean weight of gastroliths (g)	Maximal diameter of smallest gastrolith (mm)	Maximal diameter of largest gastrolith (mm)
2	216	38	Limonite	44.99	1.18 ± 1.23	3.1	34.1
3	212	17	Limonite + quartz	30.45	1.79 ± 1.28	2.5	27.0
6	201	34	Limonite	58.63	1.72 ± 1.75	5.0	29.6

10% formalin until identification the following day. Stomach contents were not preserved, but voucher specimens for the fish species that we caught in the lake will be deposited in the collections of the Muséum National d'Histoire Naturelle in Paris, the Smithsonian Institution in Washington, D.C., the Smithsonian Institution Biodiversity Center in Gamba, and the Institut Royal des Sciences Naturelles de Belgique in Brussels. The dry weight of the gastroliths was obtained with a Ohaus Adventurer balance (precision  $10^{-3}$ g) after the gastroliths had been washed through a 200 microns Retsch screen, and dried in a W.C. Heraeus Hanau oven at 110° C for 28 h and then cooled to 20° C in a dessicator with synthesis gel. The size of gastroliths was measured with a Tajima Dial-15 caliper (precision 0.1 mm).

## RESULTS

Local people claim that the density of crocodiles in the lake is extremely high. A five minutes overview from a single point of the lake bank (01° 56' 28.4''S, 09° 59' 19.9''E) with binoculars on 20 July 2002 at 17.30 h allowed us to detect five individuals of *Crocodylus cataphractus* swimming at the surface of the lake; another visual survey on 21 July at 11.00 h revealed 24 active specimens. Because of the vegetation along the banks, only a small part of the lake was in view. The six crocodiles drowned in the fishermen nets measured respectively (snout-vent length + tail length, in cm), from the longest to the shortest, 137 + 96, 126 + 90, 123 + 89, 119 + 85, 117 + 84, and 115 + 86. The stomach of the largest contained nothing but a few gastroliths (not collected). The five others had eaten, respectively: 1 *Chrysichthys* sp. (Claroteidae); 2

*Distichodus notospilus* Günther, 1867 (Distichodontidae) + 1 *Chrysichthys* sp.; 1 Cichlidae sp.; 1 Cichlidae sp. + 1 *Tilapia* sp. (Cichlidae) + 3 *Nannopetersius ansorgii* (Boulenger, 1910) (Characidae); and 1 *Tilapia rendalli* (Boulenger, 1897) (Cichlidae). No nematodes or other macroscopic parasites were detected in the stomachs nor in the abdominal cavity, and all crocodiles seemed very healthy. The gastroliths of three of the crocodiles were studied (see Table 1). All gastroliths are composed of limonite, except one (weight 3.50 g, maximum diameter 18.8 mm) in crocodile 3 which is a quartz.

The fish species collected in the lake include: *Nannopetersius ansorgii* (Characidae), *Aphyosemion* sp. and *Epiplatys sexfasciatus* Gill, 1862 (Aplocheilidae), *Chrysichthys auratus* (Geoffroy Saint-Hilaire, 1808-1809) (Claroteidae), *Oreochromis schwebischi* (Sauvage, 1884), *Tilapia cabrae* Boulenger, 1899 and *Tilapia rendalli* (Boulenger, 1897) (Cichlidae), *Distichodus notospilus* Günther, 1867 (Distichodontidae), *Clarias* sp. (Clariidae) and *Hepsetus odoe* (Bloch, 1794) (Hepsetidae). The *Chrysichthys* sp. found in the crocodiles stomachs may be *C. auratus*, but their partly digested condition prevented positive identification.

## DISCUSSION

*Crocodylus cataphractus* has previously been recorded from the Gamba Complex (Bourobou Bourobou, 1999: 12; Camara Gakou, 1992: 23). Blaney et al. (1997: 43) mentioned that the species is collected by nets in the Gamba Complex, Canton Basse Nyanga; the same authors observed the species in the "rivière Mougouambi,

tronçon Mayonami-Moulondo”(loc. cit.: 67) and provided a unambiguous picture of a specimen collected by net at Mbouda. Outside of the Gamba Complex, *C. cataphractus* occurs in several protected areas of Gabon, notably that of Ipassa, Ogooué-Ivindo Province (Steel, 1994: 4), and Lopé-Okanda Reserve (Blanc and Frétey, 2000). Human predation on *C. cataphractus* in Gabon is widespread and heavy, and has been reported from Moyen-Ogooué Province, Ogooué-Ivindo Province and Ogooué-Lolo Province (Abercrombie, 1978; Gramentz, 1999; Knoepffler, 1974; Pauwels et al., 2002). Steel (1994: 39) moreover reported the species as being sold as food on the Port Gentil markets. The species is easily caught and drowned by fishnets (Lawson, 1993; Fleury and Gautier, unpubl. obs.; present obs.) and is hence especially vulnerable. Due to intensive hunting in Gabon and adjacent countries, the species is listed in CITES Appendix 1. Despite this very few studies have been made on its biology, which remains poorly known (Spawls et al., 2002).

Fishermen in Diangui, Ogooué-Lolo Province, reported that the aquatic colubrid snake *Grayia ornata* was part of the diet of *Crocodylus cataphractus* (Pauwels et al., 2002: 138). Lang *in*: Schmidt (1919) recorded a wide range of prey in the stomachs of Congo *C. cataphractus*: “shrimps (Palaemonidae), crabs (Thelphusidae), batrachians, water-snakes, fish and even grasshoppers had been eaten by young”. However, no specific details or identifications were given. In support to the food eclecticism of *C. cataphractus*, we here report observations made by Fleury and Gautier (pers. comm., Dec. 2002) at the Station de Recherche de la Makandé (00° 40' 54''S, 11° 54' 42''E) in the Forêt des Abeilles (Lopé Department, Ogooué-Ivindo Province, Gabon), on the stomach contents of a specimen found drowned in a fisherman's net on 6 August 1995. The crocodile's total length was 256 cm (SVL 142 cm), its weight 52.5 kg. Its stomach contained the remains of a young Water Chevrotain (*Artiodactyla*: *Tragulidae*: *Hyemoschus aquaticus*) consisting of the legs, omoplates, three hooves, bones, and a 2396 sq.

cm fragment of skin. At that place, the depth of the Makandé River was about 60 to 80 cm.

Although their predation range is certainly much wider, our observations on the crocodiles stomach contents at Lake Divangui allow us to conclude that they prey on at least five fish taxa, of which three could be identified at the specific level. Among the other fish species that we recorded from the lake, several probably enter in the crocodiles diet, as well as other yet unrecorded species. Considering their lengths, the crocodiles examined by us were all subadults or adults; the diet of juveniles must include much smaller prey.

Limonite and quartz are naturally present in environments like a tropical African lake (Deliens, pers. comm. Sept. 2002). All the presently studied gastroliths have an irregular but smooth surface, maybe because they have been brought to the lake by a stream. The role of gastroliths has currently not yet been elucidated (see for example the recent work of Platt et al., 2002), but the prevalent hypotheses are that they could help in the digestion by an easier breakdown of the ingested prey, or may serve as ballast for buoyancy control. As the weight of the gastrolith sets in each stomach was between 30 and 60 gm (Table 1) and we estimated these crocodiles to weigh around 40 kg each, it seems unlikely that the gastroliths can exert any significant effect on buoyancy. Our specimens were completely devoided of visible parasites, and it is possible, as suggested by Lang *in*: Schmidt (1919: 430), that the gastroliths play a role in this. The present gastroliths have been deposited in collections (IRSNB 16626-8, from crocodiles 2, 3, 6 respectively) and remain available for further studies.

#### CONCLUSIONS

These new records constitute an important contribution to knowledge of the diet of *Crocodylus cataphractus*, for which little biological data are available. It allows a better understanding of its importance in the local trophic chain. It is evident that the population of *C. cataphractus* in Lake Divangui remains large. Due to its remoteness and the low human density and predation pres-

sure, the lake could form an important protected sanctuary for this endangered species. Additional studies on this peculiar and remote lake are required. Due to its great depth and unique geological history it may harbour possible fish endemics. The herpetofauna is also poorly studied, and the presence of chelonians, including trionychids and pelomedusids, as well as aquatic snakes requires confirmation. Their presence would enhance the value of the lake for conservation.

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#### LITERATURE CITED

- ABERCROMBIE, C. L. 1978. Notes on West African crocodylians (Reptilia, Crocodylia). *J. Herpetol.* 12(2): 260-262.
- ANSELMETTI, F. S., D. ARIZTEGUI, J. MALEY, R. OSLISLY & M. FONTUGNE. 1999. Linking palaeoenvironmental changes and human settlement history in Equatorial rainforest: evidence from the sedimentary record of lakes Divangui and Kamalété, Gabon. *In: INQUA XV International Congress, Durban, South Africa, 3-11 Aug. 1999.* p. 9.
- \_\_\_\_\_, \_\_\_\_\_, G. von Salis, J. Maley & R. Oslisly. 1997. The Lac Divangui (Gabon) Sedimentary Record: reconstructing tropical environmental changes in Equatorial Africa. p. 51. *In: American Geophysical Union Annual Meeting, San Francisco, U.S.A., 8-12 Dec. 1997. Trans. AGU 78 (46).*
- ARIZTEGUI, D., F. S. ANSELMETTI, R. OSLISLY, J. MALEY & M. FONTUGNE. 1999. Linking palaeoenvironmental changes and human settlement history in Equatorial rainforest: Evidence from the sedimentary record of lakes Divangui and Kamalété, Gabon. *In: Abstracts. COL Symposium "Looking into the sediment subsurfaces of lakes", Zürich. 7-8 Oct. 1999.* pp: 3-4.
- \_\_\_\_\_, \_\_\_\_\_, G. von Salis, J. Maley & R. Oslisly. 1998. Palaeoenvironmental changes in African Equatorial rainforest: the Lac Divangui (Gabon) Sedimentary Record. *In: Abstracts. "Past global changes and their significance for the future", IGBP PAGES Open Science Meeting, London.* p. 40.
- BLANC, C. P. & T. FRÉTEY. 2000. Les reptiles de la Réserve de Faune de la Lopé et de la Forêt des Abeilles (Gabon). *Bull. Soc. Zool., France* 125(4): 281-292.
- BLANEY, S., S. MBOUITY, J.-M. NKOMBÉ & M. THIBAUT. 1997. Complexe d'Aires Protégées de Gamba. Caractéristiques socio-économiques des populations des départements de la Basse-Banio et de la Mougoutsi (Mouenda). Unpublished report presented to the "WWF-Programme pour le Gabon", Libreville. i-vi + 1-75 + annexes + map + plates.

- BOUROBOU BOUROBOU, H. P. 1999. Gamba entre la réserve et les intérêts des populations autochtones. Projet sur la Biodiversité dans le Développement, IRET/CENAREST, Libreville. 1-21 + figs.
- CAMARA GAKOU, F. 1992. Project [sic] de programme d'éducation et de formation à l'environnement des ruraux au Gabon. Unpublished report presented to the "WWF - Programme pour le Gabon", Libreville. 33 pp.
- GRAMENTZ, D. 1999. Schwere Zeiten für Reptilien in Gabun. *Elaphe* 7(2): 57-61.
- KNOEPFFLER, L.-P. 1974. Faune du Gabon (Amphibiens et Reptiles). II. - Crocodiles, chéloniens et sauriens de l'Ogooué-Ivindo et du Woleu N'tem. *Vie Milieu* 24(1), ser. C: 111-128.
- LAWSON, D. P. 1993. The reptiles and amphibians of the Korup National Park Project, Cameroon. *Herpetol. nat. Hist.* 1(2): 27-90.
- PAUWELS, O. S. G., A. KAMDEM TOHAM & C. CHIMSUNCHART. 2002. Recherches sur l'herpétofaune du Massif du Chaillu, Gabon. *Bull. l'Inst. Royal Sci. nat. Belgique, Biol.* 72: 47-57.
- \_\_\_\_\_, \_\_\_\_\_ & V. Mamonekene. 2002. Ethnozoology of the *Dibomina* (Serpentes: Colubridae: *Grayia ornata*) in the Massif du Chaillu, Gabon. *Hamadryad* 27(1): 136-141.
- PLATT, S. G., T. R. RAINWATER & S. T. McMURRY. 2002. Diet, gastrolith acquisition and initiation of feeding among hatchling Morelet's crocodiles in Belize. *Herpetol. J.* 12: 81-84.
- SCHMIDT, K. P. 1919. Contributions to the herpetology of the Belgian Congo based on the collection of the American Museum Congo Expedition, 1909-1915. Part I. Turtles, crocodiles, lizards, and chameleons. *Bull. American Mus. nat. Hist.* 39: 385-624.
- SPAWLS, S., K. HOWELL, R. DREWES & J. ASHE. 2002. A field guide to the reptiles of East Africa. Academic Press, London & San Diego. 543 pp.
- STEEL, E. A. 1994. Etude sur le volume et la valeur du commerce de la viande de brousse au Gabon. Unpublished report presented to the "WWF - Programme pour le Gabon", Libreville. i-v + 1-84 pp.

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