NESTING ECOLOGY OF WEST AFRICAN DWARF CROCODILE IN THE CHIREHIN COMMUNITY LAND GHANA

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INTRODUCTION

West Africa is home to three species of crocodiles, the West African slender-snouted crocodile (*Mecistops cataphractus*), West African crocodile (*Crocodylus suchus*), and West African dwarf crocodile, currently assigned to *Osteoleamus tetraspis*, all of which are native to Ghana (Shirley *et al*., 2009). Unfortunately, crocodile research and conservation have not received much attention in West Africa (Shirley *et al*., 2009). As a result, the West African species are regarded as the least known crocodilians in the world (Shirley, 2007). Crocodiles of West Africa, are faced with threats ranging from hunting pressure, direct persecution to habitat destruction. Among the three species, *O. tetraspis* is the most heavily hunted crocodile in Ghana because locals perceive it to be less dangerous and easier to capture than the larger crocodiles.

Dwarf crocodiles are categorized as Vulnerable on the IUCN Red List (Crocodile Specialist Group, 1996) and all populations are on Appendix I of CITES checklist. However, an update of the Red List status may be necessary following the taxonomy revision by Eaton et al. (2009) that recognized three lineages in the genus Osteoleamus, namely, *O. osborni* restricted to the Congo Basin, *O. tetraspis* found in the Lower Guinea bioregion of west Central Africa and yet to be named *Osteolaemus sp. nov. cf. tetraspis* distributed in the Upper Guinea bioregion of West Africa. Among the three species, West African dwarf crocodile is considered the most threatened due to extensive hunting and habitat loss-related population declines (M. Shirley, pers. comm.). Despite this, the ecology remains poorly known (Eaton, 2010). The current study investigated the incubation temperature, nesting success, clutch size and hatching rate of the species in a traditionally protected stream in the Chirehin Community Land.

METHODS AND MATERIALS

Data Collection.

We thoroughly searched the banks of Nimprun Stream for *O. tetraspis* nests during the 2017 and 2018 nesting seasons (late March-August). Once an active nest was located, we carefully opened it. Eggs in-situ were marked on the dorsal surface and their original orientation was maintained as they were removed and counted (Platt and Thorbjarnarson, 2000). The viability of eggs was determined by the presence of a visible band and the date of oviposition was estimated based on the extent of banding (Ferguson, 1985). After taking the clutch data, Hobo tidbits® data logger programmed to record at 30 minutes was placed inside the egg chamber and nests were carefully covered to minimize disturbance (Charruau, 2012). At two of the nests (Nest 2 and 4), the ambient temperatures were recorded simultaneously with egg chamber temperatures. Nesting success is defined as the proportion of nests from which at least one egg hatched, following Platt and Thorbjarnarson (2000). Hatching dates were either obtained from camera traps or estimated from the temperature trend of data loggers placed inside the egg chamber.

Analyses

We performed descriptive statistics to determine the clutch size, incubation temperature, ambient temperature, and incubation days. We further calculated nesting success using the definition above. Spearman's rank correlation and Mann-Whitney U test were run to assess the relationship between natural nests and ambient temperature variations. Kruskal Wallis test was run to assess the differences in temperature variations among nests. Graphs of mean daily temperature variation trends were plotted using Microsoft Excel 2013. Values are expressed as mean, range and ± Standard Deviation.

RESULTS

Clutch Attributes, Hatching Success, Incubation Period and Nesting Success of West Africa Dwarf Crocodiles in Chirehin

For the two nesting seasons (2017 and 2018), we recorded 18 nests (but 16 were active), 8 and 10 in 2017 and 2018 respectively. Nest construction and oviposition began in late March and continued through early June and hatching occurred in mid-June through to late August. Estimated incubation period ranged from 89-110 days (mean=97 days, SD= ±5, n=15). We limited analyses on nesting success, egg viability, and hatching success to the 16 active nests. The average clutch size was 8 eggs (SD=±2, range 5-13, n=17). Out of the 16 active nests, 14 were successful and 2 failed to give a nest success rate of 87.5%. The nest failures were caused by predation (all eggs were eaten before we found the nest) and flood. The remaining 15 nests with eggs had a total of 116 eggs. The viability of the eggs as determined by the presence of a pigmented band was at 98.28% (n=116). Out of the 114 viable eggs, 104 hatched successfully giving a hatching success of 91.22%.

Dwarf crocodile incubation temperatures

The overall temperature variations for three nests had the following descriptive parameters; mean (30.56±SD=0.93°C), maximum (33.00°C), minimum (26.48°C). The individual mean temperature values were the same for nest 3 (31.06 ±SD=0.86) and nest 4 (31.06 ± SD=0.53) while nest 2 was lower (29.95 ±SD=0.76°C). Kruskal-Wallis test indicates significant differences among incubation temperatures of the three nests ($H=3957.554$; $P< 0.001$). There was a weak positive correlation between nest incubation temperatures and ambient temperature (NEST 2: $r=0.10$, $p<0.0001$; Nest 4: $r=0.13$, $p<0.0001$). There was significance difference between nest incubation temperatures and ambient temperature (nest2: $p<0.0001$, $Z= -68.167$, $U=13082E06$; nest4: $p<0.0001$, $Z=-54.145$, $U=99472$). Contrary to ambient temperature, nest incubation temperatures appeared well-buffered (Figure 1).

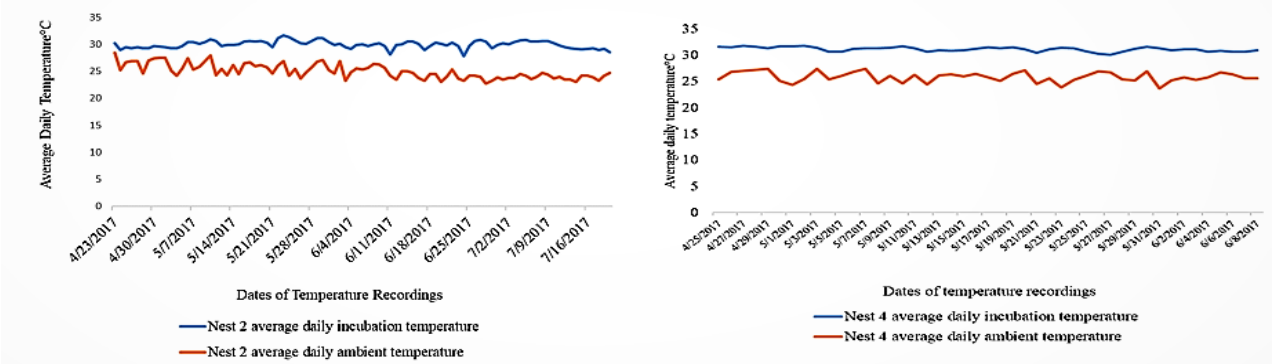


Figure 1. Variation trend of nest 2 and nest 4 average daily ambient and incubation temperature

DISCUSSION

West African Dwarf Crocodile Clutch Size and Nesting Success

In oviparous vertebrates, clutch size is regarded as an important life-history trait and is generally used as a measure of fecundity (Shanbhag et al. 2000). The mean clutch value of ~10 eggs of this study is consistent with data published by Waitkuwait (1989) on wild populations of West African dwarf crocodile. Nesting success of dwarf crocodile in the Chirehin Community Land appears to be high since 14 nests (~88%) of the 16 active nests successfully hatched. The destruction of two nests by flood and predator is consistent with previous reports which stated that flood and predation are the major causes of nest failure among mound nesting crocodilians (Platt et al. 2008; Allsteadt,1994). Developing a sustainable harvesting model for the species will require a thorough understanding of how the clutch size and other factors such as nesting success, hatchling survival interact to influence population dynamics.

Incubation Temperature Variations in Dwarf Crocodile Nests

Crocodilians have temperature-dependent sex determination (TDS) where incubation temperatures, particularly during a thermo-sensitive period (TSP), determines the sex of embryos (Piña et al. 2003; Webb et al. 1987). Crocodilians usually incubate their eggs above 27°C (Magnusson et al. 1990). The result from this study is consistent with previous studies as the mean incubation temperature for all the three nests (nest 2: ~30°C; nest 3: ~31°C; nest 4: ~31°C) were consistent with the reported value. Like other crocodilians, dwarf crocodiles have been successfully bred in captivity with various approaches to incubation temperature (Tryon, 1980; Becks, 1978). The result from this study provides the true picture of incubation temperature variation trend in natural nests thereby putting conservationists in a good position to replicate it in captivity for optimal results. This is very important because the species is currently threatened by hunting pressure and habitat disturbances making future captive breeding programmes imminent.

CONCLUSIONS

The study has provided the most comprehensive data on the nesting ecology of the wild population of West African dwarf crocodile to-date with 18 nests from two seasons. The findings from this study support earlier reports on dwarf crocodiles as the least fecund among the extant

crocodilians. However, it appears that the combination of high fertility, nesting success and good hatch success, offsets the low fecundity of this species and may be responsible for its continued survival across a wide range despite significant human disturbance and harvest for food. Nevertheless, there is evidence to suggest that in areas where hunting and habitat disturbances have been extreme, local populations have been seriously affected. The study has demonstrated that dwarf crocodile nest temperature fluctuates throughout the incubation period and this is not significantly influenced by the ambient temperature. Efforts should be made to repeat the study across the species' range for an improved understanding of its nesting ecology.

Literature Cited

Allsteadt J. 1994. Nesting ecology of *Caiman crocodilus* in Cano Negro, Costa Rica. Journal of Herpetology 28: 12-19.

Becks C. (1978) Breeding the West African Dwarf crocodile, *Osteolaemus tetraspis tetraspis*, at Memphis Zoo. International Zoo Year Book, 18: 89-91.

Charruau P. 2012. Microclimate of American crocodile nests in Banco Chinchorro Biosphere Reserve, Mexico: effect on incubation length, embryos survival and hatchlings sex. Journal of Thermal Biology 37(1): 6-14.

Eaton MJ, Martin A, Thorbjarnarson JB, Amato GD. 2009. Species-level diversification of African dwarf crocodiles (Genus *Osteolaemus*): a geographic and phylogenetic perspective. Mol. Phylogenet. Evol. 50: 496-506.

Eaton MJ. 2010. Dwarf crocodile *Osteolaemus tetraspis*. Crocodiles. Pp. 127-132. In: Status Survey and Conservation Action Plan. Editors, Manolis SC, Stevenson C. Crocodile Specialist Group, Darwin, Australia.

Magnusson WE, Lima AP, Hero JM, Sanaiotti TM, Yamakoshi M. 1990. *Paleosuchus trigonatus* nests: sources of heat and embryo sex ratios. Journal of Herpetology 24: 397-400.

Piña CI, Larriera A, Cabrera M. 2003. Effect of incubation temperature on incubation period, sex ratio, hatching success, and survivorship in *Caiman latirostris* (Crocodylia, Alligatoridae). Journal of Herpetology 37: 199-207.

Platt SG, Thorbjarnarson JB. 2000. Nesting ecology of the American crocodile in the coastal zone of Belize. Copeia 2000(3): 869-73.

Ross JP. 1998. Crocodiles: Status survey and conservation action plan. IUCN, Gland. SSC Crocodile Specialist Group.

Shanbhag BA, Radder RS, Saidapur SK. 2000. Maternal size determines clutch mass, whereas breeding timing influences clutch and egg sizes in the tropical lizard Calotes versicolor (Agamidae). Copeia 1062-1067.a description on parental behaviour. SSAR Contribution to Herpetology No.1

Shirley MH, Oduro W, Beibro HY. 2009. Conservation status of crocodiles in Ghana and Côte d'Ivoire, West Africa. Oryx 43(1): 136-145.

Shirley, M. 2007. Crocodile conservation in West Africa: Planning for the future. Report by Department of Wildlife Ecology and Conservation, University of Florida, 2.

Tryon, B.W. (1980) Observations on reproduction in the West African dwarf crocodile with a description of parental behavior. In *Reproductive Biology and Diseases of Captive Reptiles* (eds Murphy, J.B. & Collins, J.T.), 167-185. Society for the Study of Amphibians and Reptiles, Oxford, USA.

Waitkuwait WE. 1989. Present knowledge on the West African slender-snouted crocodile and West, *Crocodylus cataphractus* Cuvier 1824 and the West African dwarf crocodile, *Osteolaemus tetraspis* Cope 1861. Pp.259-275 In: Crocodiles: Their Ecology, Management and Conservation. Editors, Hall P, Bryant R. IUCN, Gland, Switzerland.

Webb GJW, Manolis SC, Whitehead PJ, Dempsey, K. 1987. The possible relationship between embryo orientation opaque banding and the dehydration of albumen in crocodile eggs. Copeia, 1, 252–2