Dwarf Crocodile *Osteolaemus tetraspis*

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Common Names: African dwarf crocodile, broad-nosed crocodile; crocodile nain (French), cocodrilo chico (Spanish), Stumpfkrokodil (German)

Taxonomic Revisions: *Ostelaemus tetraspis, Osteolaemus* cf *tetraspis*, *Osteolaemus osborni*: The taxonomy of the African dwarf crocodile has been under debate for almost 80 years. *Osteolaemus tetraspis* was first described in 1860 from Gabon (Cope 1860). A second morphological form, discovered in the upper Congo River Basin, was described as a new genus (*Osteoblepharon osborni*, Schmidt 1919). This new genus was subsequently considered to be unwarranted, resulting first in *osborni* being relegated as species of *Osteolaemus* (Werner 1933; Mertens 1943; Inger 1948) and then to a subspecies, *Osteolaemus tetraspis osborni* (Wermuth 1953). Some authorities have even suggested that sub-species status may not be merited (Huchzermeyer 1993; Ross 2006).

A recent morphological study, however, has confirmed fixed differences between *tetraspis* and *osborni* (Brochu 2007), suggesting that each should be resurrected as a distinct taxon. Additionally, a recent molecular phylogenetic analysis of samples collected from the Republic of Congo, Gabon, Ivory Coast and Ghana supports the evolutionary distinctiveness of dwarf crocodiles in the Congo Basin (*osborni*) from those further west (Eaton *et al*. 2009). This same investigation also revealed that the nominal form of *O. tetraspis* from Gabon's Ogooué Basin is genetically distinct from dwarf crocodiles in West Africa, suggesting that at least one new morphologically cryptic species exists in the latter region.

One of the obstacles in verifying the taxonomic status of dwarf crocodiles has been limited sampling across the range of the genus and the lack of specimens from known localities from either side of purported taxonomic divides (see Priority Actions for a prioritization of sampling sites that will aid in further elucidating the geographic ranges and evolutionary relationships within this group).

Range:
Osteolaemus tetraspis (Cope 1860): Angola, Cameroon, Central African Republic, Chad (unconfirmed), Democratic Republic of Congo (coastal?), Equatorial Guinea, Gabon, Nigeria(?), Republic of Congo (coastal?)

Osteolaemus cf. *tetrapsis* (sp. nov.; West African dwarf crocodile): Benin, Burkina Faso, Côté d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Nigeria(?), Senegal, Sierra Leone, Togo

Osteolaemus osborni (Schmidt 1919; Osborn's dwarf crocodile): Democratic Republic of Congo, Republic of Congo, Central African Republic (?), Uganda (historic)

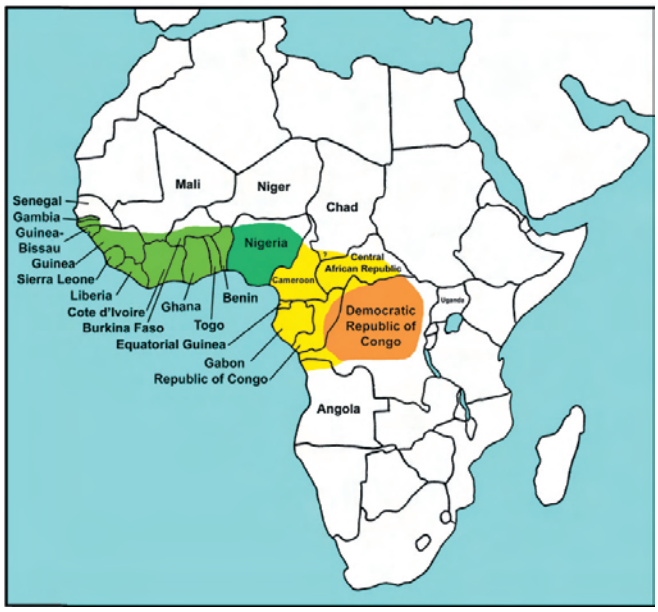

Figure 1. Distribution of the genus *Osteolaemus*: *O. tetraspis* (yellow), *O.* cf. *tetraspis* (light green), *O. osborni* (brown), *O. tetraspis* (?)/*O. cf. tetraspis* (?) (dark green).

Conservation Overview

CITES: Appendix I

CSG Action Plan:
Availability of survey data: Very poor in most regions
Need for wild population recovery: Moderate
Potential for sustainable management: Unknown

2009 IUCN Red List: VU (Vulnerable A2cd. High risk of extinction in the near-term, caused by habitat reduction and overexploitation; IUCN 2009) (last assessed in 1996).

Eaton, M.J. (2010). Dwarf Crocodile *Osteolaemus tetraspis*. Pp. 127-132 *in* Crocodiles. Status Survey and Conservation Action Plan. Third Edition, ed. by S.C. Manolis and C. Stevenson. Crocodile Specialist Group: Darwin.

Principal threats: Widespread and intensive subsistence hunting and the commercial bushmeat trade, habitat loss.

Figure 2. Juvenile *O. tetraspis*. Photograph: Mitchell Eaton.

Ecology and Natural History

The African dwarf crocodile historically ranged throughout the lowland regions of West and western Central Africa, from Senegal and The Gambia in the west to the eastern border of the Congo Basin in the Democratic Republic of Congo and Uganda. Northern Nigeria and Cabinda Province (Angola) are considered to be the northern and southern extents of the genus, respectively. The Central and West African dwarf crocodile (*O. tetraspis*) is now distinguished from Osborn's dwarf crocodile (*O. osborni*), and new research suggests that populations further west are significantly differentiated from lineages in Central Africa and the Congo Basin and warrant a unique species designation (*Osteolaemus* cf. *tetraspis*) (Eaton *et al*. 2009).

Osteolaemus tetraspis: Originally described from Gabon's Ogooué Basin, this lineage of dwarf crocodile appears to range from the western border of the Congo Basin to the coast, extending south into Angola (Cabinda) and north from the edge of the Congo Basin into Central African Republic. Pooley (1982) reported a population of dwarf crocodiles in the Lake Chad watershed of northern Central African Republic, although it is unknown if populations extend into southern Chad. The species boundary between *O. tetraspis* and the West African dwarf crocodile (*O.* cf. *tetraspis*) remains unclear. Candidate barriers to dispersal, which may have contributed to the evolution of independent dwarf crocodile lineages, include the Cameroonian Highlands and the arid Dahomey Gap in Togo and Benin. Directed sample collection in Nigeria will contribute to our understanding of the phylogeography of these two species.

Osteolaemus osborni: Described by Schmidt (1919) from the Ituri Forest of eastern Democratic Republic of Congo (DRC), Osborn's dwarf crocodile is presumed to be limited to the basin formed by an ancient lake drained by major tributaries of the Congo River (Giresse 2005). The majority of the basin lies in the DRC but extends into parts of the Republic of Congo (RoC), Cameroon, Angola, Zambia, Tanzania and Central African Republic. The presence of dwarf crocodiles in Uganda, discovered near Lake George in western Uganda (eg Temple Perkins 1951; Pitman 1952) has not been reconfirmed in recent years and their continued existence at the eastern limit of their range is questioned.

Osteolaemus cf. *tetraspis*: The West African dwarf crocodile was long believed to be *O. tetraspis*, but recent molecular phylogenetic evidence has revealed at least one lineage from this region to be highly differentiated from the nominal form (Eaton *et al*. 2009). It is possible that multiple species of dwarf crocodile exist in West Africa, but this will not be confirmed until more extensive sampling is completed. The boundary between this newly recognized species and the Central African *O. tetraspis* is unclear (see above) and additional genetic or morphological sampling is required to understand the evolutionary history of crocodiles in West Africa.

Very little is known about the ecology and natural history of the dwarf crocodile. Insufficient data have been collected from any region to describe the ecology of a particular species, so only general information on the genus *Osteolaemus* is provided here. As its name implies, the dwarf crocodile is a diminutive species, with a maximum size rarely exceeding 2.0 m. Its small size and generally dark coloration are presumably evolutionary adaptations allowing the dwarf crocodile to reside in small, cool streams under closed-canopy rainforest. In contrast to the broadly sympatric Nile (*Crocodylus niloticus*) and Slender-snouted crocodiles (*C. cataphractus*), dwarf crocodiles occupy dense swamps and flooded forests (Waitkuwait 1989; Luiselli *et al*. 1999; Riley and Huchzermeyer 1999; Eaton 2006). Dwarf crocodiles have also been observed using isolated savanna pools, small pools in perennial forest streams, larger open-canopy rivers, forest lakes and coastal lagoons (Waitkuwait 1989; Kofron 1992; Thorbjarnarson and Eaton 2004; Eaton and Barr 2005; Eaton 2006; Shirley 2007; Shirley *et al*. 2009).

Figure 3. Juvenile *O. tetraspis*. Photograph: Mitchell Eaton.

It is believed that dwarf crocodiles are one of the more terrestrial crocodilian species, and make extensive nocturnal terrestrial forays, especially following rains (Waitkuwait

1989) but this fact has been poorly substantiated. The dwarf crocodile is, however, a largely nocturnal predator, spending most daylight hours hidden in small pools or in deep burrows.

Diet consists primarily of invertebrates, with a smaller representation of vertebrates. In one study, nearly 55% of the diet was comprised of gastropods and crabs, with frogs and fish making up an additional 40% (Luiselli *et al*. 1999). Minor differences in diet were also seen between adult males, adult females and juveniles. Pauwels *et al*. (2007) reported invertebrates (insects, millipedes and crustaceans) making up 79.1% of the diet at one site, with bony fishes adding 8.7% and amphibians and mammals a combined 11.1%. At a second site, crustaceans comprised nearly 100% of the diet in a sample of 8 crocodiles (Pauwels *et al*. 2007). Riley and Huchzermeyer (2000), reporting on the stomach contents of 16 wild dwarf crocodiles sampled in the field and in local bushmeat markets, revealed a wide range of invertebrate and vertebrate prey including insects, gastropods, spiders, birds, snakes, mammals, amphibians and fish.

Figure 4. Juvenile *O. teraspis* feeding on a crab. Photograph: Mitchell Eaton.

Dwarf crocodiles are mound nesters, scraping together dead leaves and debris against the base of a tree to lay a clutch of approximately 10-14 eggs (Waitkuwait 1989; Eaton 2004). Nesting is thought to begin in the early wet season, but interviews with hunters have suggested nesting may be regionally asynchronous and multiple clutches may be possible in a single year (Eaton 2004). Breeding physiology is described by Kofron and Steiner (1994).

Conservation and Status

Information on the population and conservation status of dwarf crocodiles across West and Central Africa has been gleaned largely from anecdotal reports and a limited number of targeted surveys. Although the species is widespread and locally abundant in many areas, marginal populations at the perceived extent of its range (ie The Gambia, Senegal, Uganda) may be extinct or nearly extinct. Early reports (Temple Perkins 1951; Pitman 1952) of individual specimens of *O. osborni* found at the eastern limit of the genus, near Lake George in western Uganda, have not been confirmed in recent years.

Recent surveys and status reports are available from Ivory Coast (Waitkuwait 1989), Gabon, Republic of Congo and the Central African Republic (Behra 1987; Behra and Lippai 1994), Nigeria (Dore 1996), The Gambia, Senegal and Guinea Bissau (Jones 1991), and Liberia (Kofron 1992). Since the publication of the previous CSG Status Survey and Action Plan (1998), more detailed information on the status and relative abundance of dwarf crocodile populations has come from the Ivory Coast and Ghana (Shirley 2007; Shirley *et al*. 2009), Gabon and the Republic of Congo (Riley and Huchzermeyer 1999; Pauwels *et al*. 2004; Thorbjarnarson and Eaton 2004; Eaton and Barr 2005; Eaton 2006; Pauwels 2006; Pauwels *et al*. 2006), Cameroon (Wild 2000) and Nigeria (Akani *et al*. 1998; Luiselli *et al*. 2000; Eniang and Luiselli 2002). A West and Central Africa CSG sub-regional meeting was held in Tapoa, Niger, in 2007, bringing together researchers and conservationists for updates on the status of crocodilians across the region and to discuss conservation priorities for the near future (Crocodile Specialist Group 2007). A second regional meeting is planned to take place in Burkina Faso in late 2009 (Webb 2009).

Countries believed to contain significant populations of dwarf crocodiles include Ghana (throughout the forested south and southwest of Kumasi), Cote d'Ivoire (forested south and west), Nigeria (Niger and Benue Rivers), Gabon (many National Parks, Ogooué River and Delta), Republic of Congo (Likouala swamps), and Democratic Republic of Congo (Congo and Ubangi Rivers), but current and detailed information is lacking for the majority of the species range.

Harvesting for subsistence consumption and the widespread bushmeat trade is likely the most serious threat to the long-term viability of this genus (Kofron 1992; Thorbjarnarson and Eaton 2004). Habitat destruction in the form of commercial logging and degradation of wetland habitats are likely secondary threats, especially in West Africa (eg Kofron 1992). Rapid human population growth, high levels of urbanization and increased transportation infrastructure (roads, river and air travel) have shifted the use of crocodiles and other bushmeat species from local, subsistence consumption to commercial exploitation for regional and even global bushmeat markets (Thorbjarnarson and Eaton 2004; Milius 2005).

Dwarf crocodiles are of particular importance in the commercialization of African wildlife, as they are one of the few species capable of being transported live over long distances without the need for refrigeration (Thorbjarnarson and Eaton 2004). As a result, it is estimated that tens of thousands of dwarf crocodiles are shipped annually from remote forests to urban centers to feed a growing demand for wild meat (Hutton 1991; Behra 1993a,b; Efoakondza 1993). Harvest rates of this magnitude may now be limited to Central Africa, as populations in West Africa are likely already below

economically viable levels (Shirley *et al*. 2009). Dwarf crocodiles are now being sold in illegal markets in Europe and the United States (Milius 2005), a trade ostensibly fueled by the demand from a growing expatriated African population. Some skins are used for the local production of leather goods (Huchzermeyer 1998; Eaton, pers. obs.), but the market for these poor quality products is unlikely to be significant.

Despite the difficulties of managing a widespread and often surreptitious trade in dwarf crocodiles, creative management alternatives are needed to mitigate unsustainable harvesting as currently practiced. Because crocodiles and other bushmeat species serve as an important subsistence resource for rural inhabitants, context-appropriate management guidelines are needed, in addition to reducing illegal commercial harvest through enforcement, to ensure dwarf crocodiles remain viable in Central and West African forests. Several countries permit legalized harvest of dwarf crocodiles for local consumption (eg Gabon, Republic of Congo), but this is rarely part of a well-considered management plan and almost never backed by quantitative estimates of population size or harvest rates. Legalized international trade in live dwarf crocodiles for the zoo industry is permitted by CITES but has principally involved trade in captive-bred animals among developed nations (eg 18 live dwarf crocodiles traded in 2007 from Spain to Thailand, www.cites.org). Export permits of manufactured leather products over the last decade have declined from 27 in 1997 to 0 in 2007. Plans for captive breeding programs for conservation, tourism and possible meat production (Togo, Cameroon, Nigeria, Ghana) seem to have been stalled, though there has been recent discussion of a breeding program in The Gambia that holds promise.

Figure 5. Juvenile *O. tetraspis*. Photograph: Mitchell Eaton.

Priority Projects

High Priority

1. **Surveys of status and distribution throughout West and Central Africa**: Despite increased interest and additional surveys in many parts of the range of the dwarf crocodiles, there is still inadequate information on any of the three species to do more than speculate on their actual status. Although their poor quality skin reduces the international commercial incentive that has been important for the conservation of many crocodilian species, the important economic and protein benefits of dwarf crocodiles throughout Africa's forest blocks provides sufficient incentive to Governments and local residents to develop sustainable harvest programs (within Africa *Acacia* tanned leather products made of dwarf crocodile skins are widely used). Regional CSG meetings have been organized to address these and other conservation issues.

   Such management programs are essential for continued survival of the species and the food security of the region, but will first require more detailed information on abundance, life history and current levels of exploitation. Although dwarf crocodiles use somewhat different habitat types than the other African crocodiles, surveys to determine crocodile abundance and status can be designed to efficiently gather information on all species. Surveys need to be conducted on a country-by-country basis throughout West and Central Africa. Priority regions may include Senegal (Cassamance), southern Chad, Guinea-Bissau, Sierra Leone, Liberia, Cote d'Ivoire (National Parks throughout, forested coastal river drainages), Ghana (Western Region), Nigeria (throughout), Gabon, Republic of Congo, Democratic Republic of Congo, Angola (forested areas in the north) and Uganda (dense swamps on the southern border of Lake George).

   An important part of the focus of surveys should be sampling of genetic and morphologic material for resolution of species limits and distribution. Key regions for this priority are the Cameroon Highlands (and bordering regions), Nigeria, either side of the Dahomey Gap, Senegal, and southern Central African Republic.

2. **Evaluation of harvest sustainability in Gabon and the Congos**: As possible strongholds of populations of *O. tetraspis* and *O. osborni*, evaluation of current levels of harvest and the economic and social context of wildlife use should remain a priority for the conservation of these species with the ultimate goal of ensuring biological, ecological and economic sustainability.

Medium Priority

3. **Captive breeding potential**: An assessment should be undertaken for the economic and biological potential of captive breeding programs for dwarf crocodiles. Assessment should include viability of captive-breeding populations to serve as a substitute for bushmeat hunting of wild animals and as a source for the re-establishment of wild populations in protected areas in West Africa.

4. **Basic ecology studies on movement and population demography**: While management and conservation programs cannot wait for additional data to be gathered, detailed information on the life history and ecology of dwarf crocodiles will result in better understanding of

the impacts of current and future harvest pressure on population viability. Because of their unique habitat use and calm temperament, the dwarf crocodile represents an ideal subject for conservation programs aimed at increasing attention on understudied flooded forests and swamps, in addition to training African biologists in methods of ecology and population biology.

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