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**Observations of vertebrate and invertebrate predation on Gabonese Clawed Frogs,  
*Xenopus mellotropicalis* Evans et al., 2015 (Amphibia: Anura)**

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The predator-prey relationship is a major biotic interaction in nature and a better knowledge of this relationship enables a better understanding of animal populations and community dynamics. Predation events are, however, rarely observed in situ, even in rich ecosystems such as tropical areas. For example, Nordberg et al. (2018) reported only nine instances of predation by vertebrates or invertebrates during 500 hours of visual observation in north-east Australia.

A variety of vertebrate and invertebrate predators feed on eggs, embryos, tadpoles, and adult amphibians. In small freshwater ecosystems, arachnids and aquatic hemipteran insects are important predators of amphibian larvae (McCormick and Polis, 1982;

Duellman and Trueb, 1994; Toledo, 2003; Ohba, 2019). Dragonfly larvae, together with aquatic hemipterans and beetles, are among the most well-known insects preying on amphibians. Spiders have also been observed preying on small frogs and tadpoles in the Neotropical and Afrotropical regions (Menin et al., 2005; Babangenge et al., 2019). Crustaceans such as crayfish are known to consume amphibian eggs and larvae (Wilson and Williams, 2014). Among vertebrate predators, examples of predation on amphibians in water by fishes, turtles, and crocodilians are numerous, while snakes, birds, and mammals are predators both in water and on land (Duellman and Trueb, 1994). Finally, cross-predation, which refers to the predation of amphibians by other amphibians of the same or other species, plays important roles in amphibian ecology, especially in shaping amphibian communities (McCormick and Polis, 1982).

The Gabonese clawed frog, *Xenopus mellotropicalis* Evans et al., 2015, is widespread in Central Africa and is common in Gabon (Christy et al., 2008; Frétey et al., 2011). However, the life history traits of *X. mellotropicalis* are not well known. It has been reported from forest ponds, partly in syntopy with the Upland Clawed Frog, *Xenopus parafraseri* Evans et al., 2015, but also from more open aquatic ecosystems, pristine or disturbed (Evans et al., 2015). *Xenopus mellotropicalis* adults are medium-sized frogs measuring around 45 mm from snout to vent (SVL) and weighing about 10 g (unpubl. data). The diagnostic characters used to distinguish *X. mellotropicalis* from other *Xenopus* species found in Central Africa are mainly genetic and behavioural. *Xenopus mellotropicalis* are tetraploids with  $2N=4X=40$ , and the males sing with a specific trill-call (Evans et al., 2015; Knytl et al., 2017). Without genetic or acoustic data analysis, the identification of *X. mellotropicalis* from sympatric *Xenopus* is mostly based on the presence of spicules on the skin, and the homogeneous pale abdominal skin (Fig. 1.1).

Like most Xenopodinae, *X. mellotropicalis* lay thousands of eggs, generating thousands of tadpoles that represent an important biomass in small aquatic ecosystems (unpubl. data, Fig. 1.2).

Reports of predation in situ on *X. mellotropicalis* frogs are scarce in the literature. Recently, Babangenge et al. (2019) summarized cases of frog-eating spiders and mentioned observations of *X. mellotropicalis* preyed upon by pisaurid spiders. It is also known that *Xenopus* are widely used as food in Central Africa (Gonwouo and Rödel, 2008; Mohnke et al., 2010). While writing up this study, we became aware of *X. mellotropicalis* frogs being sold for human consumption on the market near Mondah forest (O. Pauwels, pers. comm.) and also near Bongoville in Gabon (unpubl. data). Here, we document five observations of predation events on *X. mellotropicalis* tadpoles and adults.

**Observation 1.** We observed the predation of an adult male *X. mellotropicalis* by a freshwater crab on 13 November 2017 in the Mont de Cristal National Park, Gabon (Fig. 1.3). The observation happened during a rainy night at 22:00 h in the rainforest (0.5231°N, 10.2925°E, WGS84 datum). Upon exploring a dense fern and bush area bordering a shallow pond (water depth ca. 20 cm) next to a road, we spotted the crab holding a male *X. mellotropicalis*. The crab was holding the frog, which was still alive, with one of his claws grasping the hindleg at the level of the knee. The black nuptial pads on the ventral side of the frog's forelimbs were clearly visible and identified it as a male. The other hindleg of the frog was damaged at the level of the knee. The prey and its predator were of very similar size, about 40 mm SVL. The crab escaped with the frog while we recorded a short video of the end of a predation sequence (video <https://zenodo.org/record/7113490/files/PB131783.m4v?download=1>). This observation

occurred near a larger pond that housed numerous frogs and where a dwarf crocodile *Osteolaemus tetraspis* Cope, 1861, was spotted a few days later. Other anurans, such as reed frogs, *Hyperolius* spp., and Leonard's wot-wot, *Hylambates leonardi* Boulenger, 1906, were present and actively calling during the event, and the area was found to be an important breeding site.

Later the same night, we observed numerous other active *X. mellotropicalis*, both males and females, around the same shallow pond. We identified all these *Xenopus* as being *X. mellotropicalis* through morphological examination and genetic analysis of a 578 bp segment of the mitochondrial cytochrome oxidase 1 (CO1) gene fragment (European Nucleotide Archive accession numbers OX344825–344828). We also observed other freshwater crabs during the same night and obtained one specimen (Fig. 1.4). We obtained a DNA sample from this individual and sequenced a portion of the CO1 gene region for specific identification (European Nucleotide Archive accession number OX344824). This sequence proved to be nearly identical (98% similarity) to *Sudanonautes floweri*, and it grouped with other *S. floweri* sequences in a phylogenetic tree (not shown). This genetic identification, together with the overall morphological characters, led us to identify this crab as *S. floweri*, which is known to occur in Gabon (Cumberlidge et al., 2008).

**Observation 2.** We witnessed an adult water scorpion (Nepidae: *Laccotrephes*) predating a *X. mellotropicalis* froglet on 8 April 2017 at 22:30 h near Libreville in the Arboretum Raponda Walker (pond of the Ecole Nationale des Eaux et Forêts; 0.6103°N, 9.3197°E). The predation event occurred on the edge of the pond, at about 10 cm water depth and about 2 m from the grassy shore (Fig. 1.5; video file <https://zenodo.org/record/7113490/files/P4081158.m4v?download=1>). This pond was

located in an anthropized setting, within the settlement of the Ecole Nationale des Eaux et Forêts, surrounded by housings and trails and regularly used by humans for various purposes. The pond measured about 20 x 5 m, with gentle slopes leading to shallow borders, and a maximum depth of about 1 m. We observed several tens of thousands *X. mellotropicalis* tadpoles spanning different stages of development from premetamorphic individuals to froglets, but adults were not encountered. They were identified morphologically and genetically (European Nucleotide Archive accession numbers OX344829–344833). Several other aquatic insect species were also present in the pond, including backswimmers (Notonectidae: Notonecta), Dyticae and giant water bugs (Belostomidae). We filmed the end of a predation sequence on a ca. 20 mm SVL froglet. The Nepidae held the froglet immobile by grasping the right hindlimb of its prey with one of its front legs, with its rostrum inserted into the frog's thigh ventrally. The bug was not moving while sucking its meal.

**Observation 3.** We observed the predation of *X. mellotropicalis* tadpoles by a great egret, *Ardea alba*, on 10 April 2017 at 16:30 h in the same pond as Observation 2 (Fig. 1.6). We counted 19 predation events over a 6-minute interval. The egret was immobile over a school of tadpoles which were visible as a swirl on the water surface. Predation occurred in bursts of about five minutes, followed by a pause during which time the bird moved slowly toward the next hunting area. The feeding event lasted about 30 minutes, after which the bird was disturbed and flew away. We noticed that only the largest tadpoles in the pond, i.e., those about 50 mm or larger, were preyed upon.

**Observation 4.** We observed a giant water bug *Hydrocyrius* sp. nymph (Heteroptera: Belostomatidae) predating a *X. mellotropicalis* tadpole. We observed this predation at night while sorting tadpoles that we had caught in the same pond as where predation

events 2 and 3 were observed. The *Hydrocyrius* sp. nymph remained immobile and caught the tadpole as it swam past (video files <https://zenodo.org/record/7113490/files/PB121016.m4v?download=1>; <https://zenodo.org/record/7113490/files/PB121023.m4v?download=1>; <https://zenodo.org/record/7113490/files/PB121030.m4v?download=1>; Fig. 1.7). The tadpole was grasped at midbody and the *Hydrocyrius* nymph inserted its rostrum just behind the tail base and sucked on its prey for several minutes.

**Observation 5.** While examining an adult African tiger frog *Hoplobatrachus occipitalis* sold as food on 20 November 2017 in Port-Gentil, we noticed the clawed foot of an adult *X. mellotropicalis* protruding from the *Hoplobatrachus*' mouth (Fig. 1.8). We inferred that it was a *X. mellotropicalis* due to the presence of speckles on the skin. *Hoplobatrachus occipitalis* is known to predate other adult amphibians (Hirschfeld and Rödel, 2011; Tohé et al., 2014).

We report here five instances of predation on *X. mellotropicalis*, two involving vertebrate predators and three involving arthropods. These observations are complementary to the predation of a *X. mellotropicalis* tadpole by a spider (Araneae: Pisauridae) (Babangenge et al., 2019) since they document predations by different predator species. These observations exemplify the different interactions in which *Xenopus* are involved with other taxa in Central Africa. Among the general biological interest to document such observations, the knowledge of predator-prey relationships may also be important for the study of parasitism. This is especially true regarding anurans since they are intermediate hosts for many parasitic taxa while there is currently a dearth of information on this topic in Africa (Imasuen et al., 2012).

All *Xenopus* secrete a white toxic mucous from their granular skin glands upon acute stress (Benson and Hadley, 1969). Among other peptides, proteins, steroids and alkaloids, these secretions contain toxic compounds, such as indolealkylamines that are chemical derivatives of the monoamine neurotransmitter serotonin and thereby are expected to have neuroleptic properties (Anastasi et al., 1970; Bennett et al., 1982; Goedert et al., 1984; Conlon et al., 2012). Indeed, *Xenopus laevis* mucus elicits dyskinetic yawning and gaping movements in some snake species, which enables the adult frog to escape its predator (Barthalmus, 1989). Yet the skin of *Xenopus* tadpoles does not secrete toxic mucous and therefore they may constitute a preferred meal for vertebrates. Also, predators that directly ingurgitate adult frogs may escape the toxin's effects. This defence mechanism can be effective in some vertebrate predators but is likely to be ineffective in arthropods, which will not respond to these toxins. This may explain the efficiency with which crabs and other large arthropods can prey on *Xenopus*, provided the latter are not too large. In their natural environment, aquatic hemipterans are likely to be one of the main predators of young post-metamorphic *Xenopus*.

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241

## Figure Legend

**Figure 1.** Observed predation events on *Xenopus mellotropicalis* frogs and tadpoles. 1. *X. mellotropicalis* adult. 2. *X. mellotropicalis* tadpole. 3. *X. mellotropicalis* froglet being preyed upon by a freshwater crab. 4. Sampled specimen of *Sudanonautes floweri*. 5. *X. mellotropicalis* froglet being preyed upon by a water scorpion (Nepidae). 6. Great egret *Ardea alba* predation events on *X. mellotropicalis* tadpoles. 7. *X. mellotropicalis* tadpole being preyed upon by a giant water bug nymph (Belostomatidae). 8. African tiger frog, *Hoplobatrachus occipitalis*, with its unfinished *X. mellotropicalis* meal.



