The Spectacled Caiman (*Caiman crocodilus*) as a cave dweller in the Upper Paraguay karst, mid-western Brazil

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Most non-avian reptiles (henceforth reptiles) spend their lives in epigean (surface) habitats and information on species inhabiting caves and other hypogean (underground) cavities are scarce, usually based on the occasional finding of a few living individuals or carcasses, mostly of Squamata (e.g., Trajano et al., 1987; Wilson, 1987; Nuñeza & Galorio, 2015; Turbanov et al., 2019; Santos et al., 2022; Fraga et al., 2023). Although no obligate cave-dwellers have been reported among living reptiles so far, higher proportions of species that occasionally use caves can be found in selected karst systems (e.g., Esmaeili-Rineh et al., 2016; Maglangit et al., 2021; Santos et al., 2022).

Among crocodilians, individuals of at least six species, on four continents, have been encountered using caves or small subterranean habitats as diurnal

or seasonal shelters, in search of water and food sources, and as protection against hunters or other adverse conditions, particularly during periods of drought (Table 1). In Brazil, the presence of crocodilians in caves is poorly (Reis et al., 2013; Santos et al., 2022) or imprecisely documented [as in Silva et al., 2021, which mentioned the use of "caves" by Paleosuchus palpebrosus (Cuvier 1807) without citing the original source]. Besides, there are some Quaternary fossil records (Castro et al., 2014).

Although some individuals can explore or permanently use the aphotic zones of the cave ecosystems they inhabit (e.g., Wilson, 1987), crocodilians do not show any of the morphological troglomorphic traits usually observed in cave-obligate tetrapods. These traits include reduced eyes and/or limbs and reduced pigmentation, as observed in salamanders of the Plethodontidae and Proteidae families (Recknagel & Trontelj, 2021). However, a slightly reduced body condition and a distinct diet (based mostly on cavernicolous animals, including crickets and bats) have been recorded among cave-dwelling crocodilians, in comparison to their surface-dwelling conspecifics (Handwerk, 2003; Shirley et al., 2017; IRD, 2022).

We here provide detailed information on the presence of individuals of the Spectacled Caiman, *Caiman crocodilus* (Linnaeus, 1758) (Alligatoridae), in a karstic cave, in the western portion of the Brazilian Cerrado savanna, at the southernmost limit of the species' range. The study site is located within the limits of a private property named Parque SESC Serra Azul (PSSA), in the municipality of Rosário Oeste, state of Mato Grosso, midwestern Brazil. The local drainages are part of the Cuiabazinho river subbasin, part of the Upper Paraguay river basin. The region is characterised by a sub-humid tropical climate — Aw (tropical with dry winter, or Savanna climate), according to the Köppen's climatic classification system — with the dry season occurring between May and October and the rainy season between November and April (Alvares et al., 2013).

There are many limestone caves within the limits of the PSSA, the largest of which is "Labirinto do Jacaré" (meaning caiman's labyrinth; 14°31′28.52″ S, 55°48′01.79″ W; Fig. 1). The cave has approximately 700 m of horizontal development and 15 m of unevenness, with many sections not yet mapped. Its speleogenesis is linked to the dissolution of carbonate rocks of the Cambrian Araras formation (Figueiredo et al., 1974), in the Upper Paraguay karst area. The cave presents an orthogonal rectilinear structuring pattern, with some horizontal labyrinthic passageways and small conduits and crevices that lead to skylights and secondary

entrances. From the large and gloomy first hall, the cave develops into aphotic rectilinear galleries that lead to other halls and secondary entrances. During the dry season, there are several internal lakes and sandy banks in the cave. After the onset of the annual rains, however, the cave becomes flooded, and its galleries are filled both by internal and external sources of water, when the Cuiabazinho river and its interconnected streams and channels overflow. One of the entrances of the cave is contiguous to an external lentic and flooded area, seasonally connected with the Cuiabazinho river system.

We searched the Labirinto do Jacaré cave twice for cave-dwelling reptiles: at the end of the 2021 dry season (October 3–9) and at the end of the 2022 rainy season (March 22–27). On each occasion, active, time-limited visual searches were carried out by two observers, slowly walking during the morning, evening, and night, totalling 12 observer-hours in each season. However, due to the complete submersion of entrances and internal passageways of the cave, observations deep inside the cave were not possible during the rainy season, and thus were limited to the vicinity of the entrance.

We recorded seven adult *Caiman crocodilus* inside the Labirinto do Jacaré cave only during the dry season. The individuals were recorded during the day and night, floating at apparent rest (partially submerged, with only their nostrils above water) at the centre or at the margins of internal lakes located under skylights, between 10 and 100 m of the main cave entrance (Fig. 2). We also observed caiman tracks on sandy banks in the main halls and conduits, indicating that caimans also travel using the terrestrial substrate. Neither nest-building materials nor hatchlings of *C. crocodilus* were recorded inside the cave. Females of this species build one nest per year during the rainy season, in areas away from the shoreline; they show parental care and spend most of their time in the vicinity of the nesting site (Villamarín et al., 2011). As Labirinto do Jacaré is subject to seasonal flooding and becomes entirely water-filled during the rainy season, it is unlikely that it will be used for reproduction and nesting.

One of the adults of *C. crocodilus* was feeding on an owl (Strigiformes), at 10 a.m. (Fig. 3), on a sandy bank 50 m from the cave entrance. Owl wings were also found at the entrance to the cave. A few published records mention domestic (*Gallus gallus domesticus*) or native birds (*Porphyrio martinica*) as prey for this crocodilian species (Thorbjarnarson, 1993; Laverty & Dobson 2013; Bontemps et al., 2016). *Porphyrio martinica* prefers semi-aquatic habits, different from owls, that are nocturnal and roost in the understory

(Wikiaves, 2023). *Caiman crocodilus* is a generalist, opportunistic predator, and consumes a variety of both aquatic and terrestrial prey items (Thorbjarnarson, 1993; Da Silveira et al., 1997; Krysko et al., 2010; Laverty & Dobson 2013; Figueiredo et al., 2021), depending on their occurrence and abundance (Silva et al., 2021). Thus, it is possible that feeding on owls is an occasional event due to availability.

Caiman crocodilus is widely distributed in South America. In Brazil, the species occurs mostly along the Amazon basin (Silva et al., 2021), but also in drainages within the limits of the Cerrado biome and has been previously recorded in areas of the Upper Paraguay river basin (Strüssmann, 2000, 2003; Mudrek et al., 2021). Individuals of the species can thrive in a range of habitats including marshes, large rivers, small streams and channels, lakes, mangroves, and sandbanks, besides dams and estuarine environments (see Silva et al., 2021 and references therein). At PSSA, besides the records within the cave, individuals of the species can be found along the main channel and tributaries of the Cuiabazinho river, in riverine floodplains, and in a dammed stream. *Caiman crocodilus* occurs in sympatry with *Paleosuchus palpebrosus* in the adjacent lentic habitat reported herein. However, individuals of *P. palpebrosus* mainly occupy oligotrophic streams and palm swamps dominated by *Mauritia flexuosa* L.f. (authors' unpublished data) and were not yet recorded inside any of the caves existing in the PSSA.

Overall, our observations suggest that some individuals of *C. crocodilus* come from temporary water bodies in the neighbourhood of the cave (when they are drying out), and stay inside the cave, at least during the dry season. The large dimensions of Labirinto do Jacaré, the connectivity between internal lakes and external waterbodies, and the availability of resources (seasonal shelters, food, and water) are factors that may provide good conditions for the survival of crocodilians. Furthermore, the location within a private area with limited access by the public can minimize disturbance towards individuals. Thus, the Labirinto do Jacaré cave may play an important role in the conservation of the species in the region, providing beneficial conditions to persistence and maintenance of populations, especially in the dry season. We recommend carrying out additional research to assess the role of Labirinto do Jacaré cave in the conservation of local populations of *Caiman crocodilus*.

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Table 1. Cave-dwelling crocodilians reported in different parts of the world.

Species	Locality	References
Alligator sinensis Fauvel 1879	China	Chenyuan et al., 1996
Crocodylus johnstoni Krefft 1873	Australia	Somaweera, Woods & Sonneman, 2014
Crocodylus niloticus Laurenti 1768	Madagascar, Australia and Mauritania	Wilson, 1987; Shine et al., 2001; Brito et al., 2011
Osteolaemus tetraspis Cope 1861 *Osteolaemus* sp.	Gabon	Shirley et al., 2017, IRD, 2022
Paleosuchus trigonatus (Schneider 1801)	French Guiana	Lemaire et al., 2018
Tomistoma schlegelii (Müller 1838)	Malaysia	Steubing et al., 2004

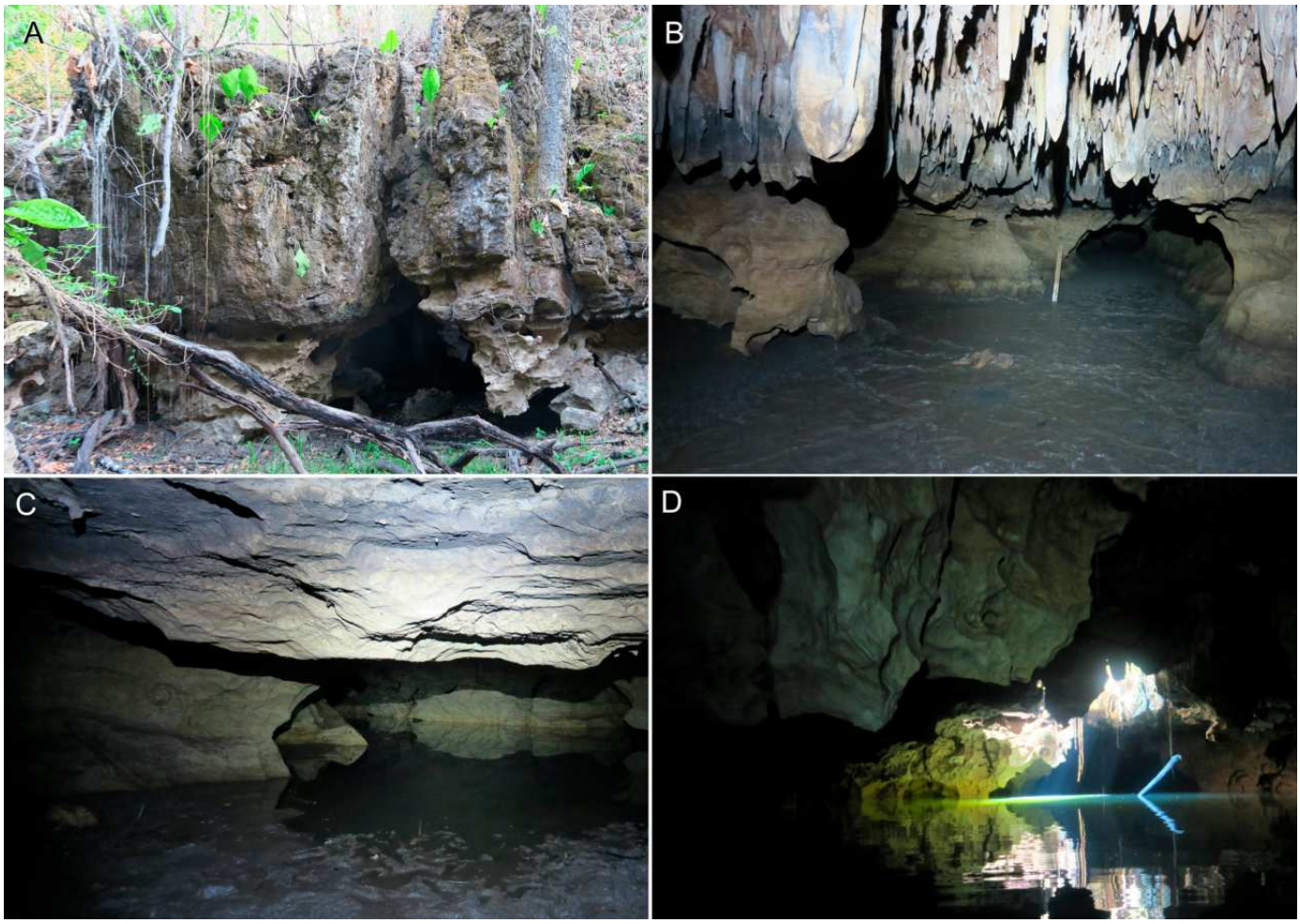

Figure 1. Labirinto do Jacaré cave in Parque SESC Serra Azul, Rosário Oeste, state of Mato Grosso, Brazil. (A) View from one of the cave entrances; (B) area inside the cave, with a ceiling decorated with stalactites and a floor covered with post-flood mud; (C) site inside the cave with water and mud; (D) skylight over lake inside the cave.

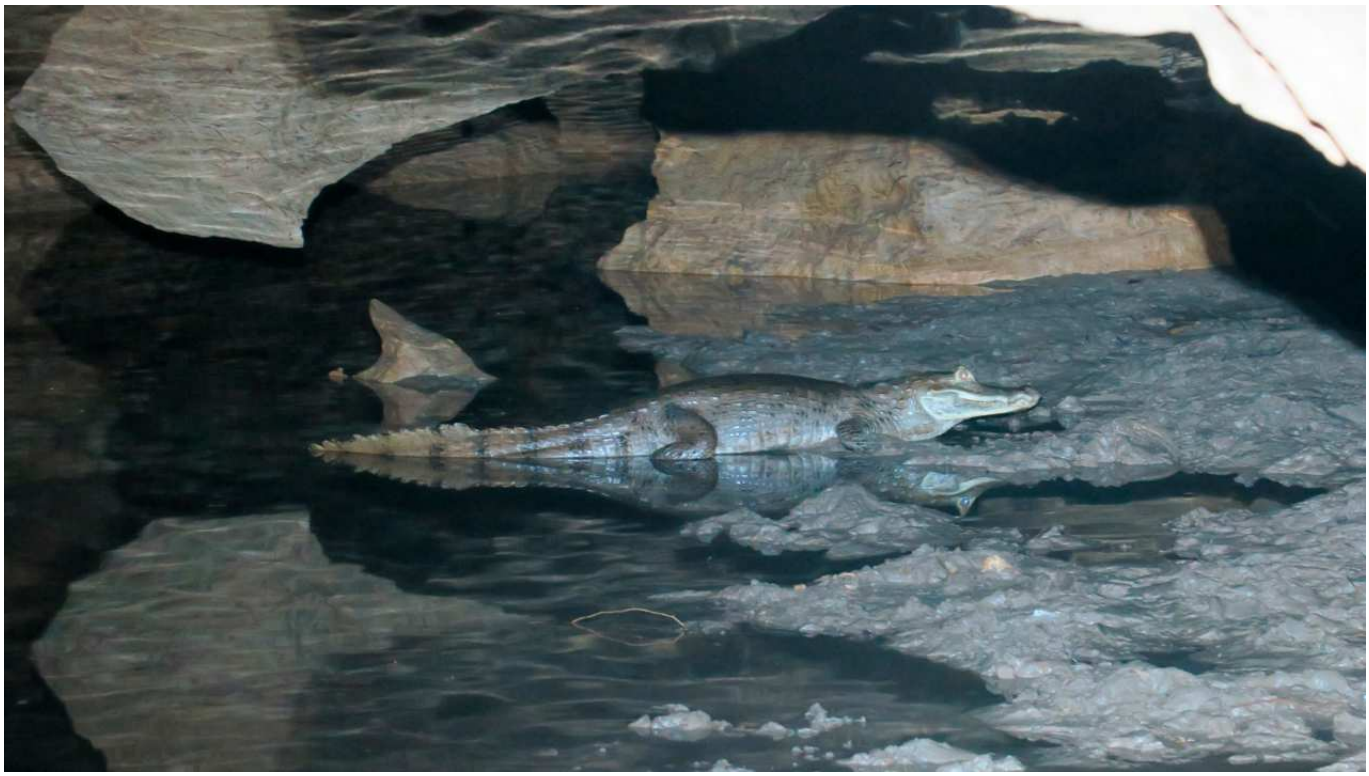

Figure 2. An adult Caiman crocodilus recorded inside the Labirinto do Jacaré cave (Parque SESC Serra Azul, Rosário Oeste, state of Mato Grosso, Brazil).



Figure 3. An adult Caiman crocodilus feeding on an owl (Aves, Strigiformes) inside the Labirinto do Jacaré cave (Parque SESC Serra Azul, Rosário Oeste, state of Mato Grosso, Brazil)