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Chiroderma doriae (Chiroptera: Phyllostomidae)

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Abstract: *Chiroderma doriae* O. Thomas, 1891 is a phyllostomid commonly called the Brazilian big-eyed bat. A brown bat with striking facial and dorsal stripes, it is the 2nd largest of the 5 species in the genus *Chiroderma*. It is endemic to southeastern Brazil with a single record from bordering Paraguay. *C. doriae* occurs in Atlantic Rain Forest, as well as in a variety of primary and secondary forests and even occasionally in urban parklands. It apparently specializes on wild figs. *C. doriae* is classified as vulnerable. DOI: 10.1644/816.1.

Key words: Brazil, Brazilian big-eyed bat, phyllostomid, rain forest, South America, vulnerable species

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Chiroderma doriae O. Thomas, 1891
Brazilian Big-eyed Bat

[*Phyllostoma*] *dorsale* Lund, 1842a:134. Nomen nudum.
[*Phyllostoma*] *dorsale* Lund, 1842b:200. Nomen nudum.
Chiroderma villosum: Dobson, 1878:534. Not *Chiroderma villosum* W. Peters, 1860.
Ch[*iroderma*]. *doriae* O. Thomas, 1891:881. Type locality "Minas Geraes," Brazil.

CONTEXT AND CONTENT. Order Chiroptera, suborder Microchiroptera, family Phyllostomidae, subfamily Stenodermatinae, tribe Stenodermatini (Baker et al. 1989), genus *Chiroderma*. The genus *Chiroderma* contains 5 species, and *C. doriae* is monotypic (Gardner 2007; Simmons 2005).

DIAGNOSIS

Nasal bones in the genus *Chiroderma* are always reduced, leaving a cleft that can extend to the orbits (Peracchi et al. 2006). Some authors associated this emargination with the absence of nasal bones (e.g., Eisenberg and Redford 1999; Nowak 1994; Taddei 1973), but fetal analysis revealed that nasal bones are present while the fetus is developing (Straney 1984). Developing bones are displaced laterally, never meeting in the midline, and subsequently become fused with frontals and maxillae, leaving the opening seen in adult skulls.

Chiroderma doriae (Fig. 1) is similar to *C. improvisum* in some measurements and is the 2nd largest species in the genus (Jones and Baker 1980). It can be distinguished from *C. salvini*, *C. trinitatum*, and *C. villosum* by its larger size

Fig. 1.—Adult female *Chiroderma doriae* from Brazil. Photograph used with permission from Marco Aurélio R. de Mello.

(length of the body: 69–78 mm; length of forearm: 49–56 mm; and condylobasal length: 25–27 mm—Koopman 1994; Taddei 1979). *C. doriae* can be distinguished from *C. villosum* by its conspicuous middorsal stripe and its anterior lower premolar with its distinctive anterior cusp (Taddei 1979; Thomas 1891).

GENERAL CHARACTERS

The rostrum of *Chiroderma doriae* is shorter than that of bats in the genus *Artibeus*. The yellow-rimmed ears are shorter than the head, longer than wide and with rounded extremities; internal margin convex and external margin with strong concavity medially; tragus and nose leaf as in *A. jamaicensis*, but shorter and with round bases. The interfemoral membrane is densely covered with thick, light brown fur with grayish tips. Dorsally, the fur color is medium brown with a middorsal white stripe, and the venter is dark brown. There are 2 white stripes above the eyes, ranging from the posterior bases of the ears to the base of the nose leaf. Wing membrane is attached to the metatarsus. Parts of the forearm, legs, interfemoral membrane, and feet are covered by fur (Koopman 1994; Vieira 1942).

Taddei (1979) provided the 1st detailed description of *C. doriae* from 39 specimens (males and females) in diverse stages of development and reproduction from São Paulo, Brazil. Young male individuals ($n = 2$) had grayish brown fur dorsally, grayish fur ventrally, and forearm lengths of 52.0 and 53.0 mm; 1 individual weighed 26.79 g. Adult males were darker than young, with dorsal fur varying from grayish brown to reddish brown, sometimes with yellowish fur above the plagiopatagium and posterior regions. The ventral area was grayish, like that of the young, sometimes with yellowish parts. Mass (in g) averaged 30.18 ($n = 13$, range = 27.13–33.02). One young female had fur similar to that of the young males, length of forearm of 51.5 mm, and mass of 23.7 g. Adult females had fur similar to that of adult males.

Means and ranges (in mm) of measurements of external characters for 15 males and 21 females (in parentheses) from São Paulo, Brazil, are: total length, 74.80, 69.0–78.5 (75.45, 70.0–80.0); length of ear, 20.17, 19.0–21.5 (20.36, 19.0–21.5); length of tragus, 7.27, 7.0–7.5 (7.33, 7.0–7.5); length of forearm, 52.03, 49.5–53.5 (53.02, 51.0–55.5); length of thumb, 7.93, 7.5–8.5 (8.05, 7.5–8.5); length of 3rd metacarpal, 49.13, 47.0–50.5 (50.38, 48.0–52.5); length of 1st phalanx III, 20.45, 19.5–21.5 (20.53, 19.0–21.5); length of 2nd phalanx III, 28.57, 26.5–29.5 (28.9, 27.0–31.0); length of 3rd phalanx III, 15.20, 14.0–16.5 (15.67, 14.5–17.0); length of 4th metacarpal, 48.33, 45.5–50.0 (49.69, 47.0–52.0); length of 1st phalanx IV, 16.77, 16.0–17.5 (16.90, 16.0–18.0); length of 2nd phalanx IV, 16.43, 15.0–18.0 (16.95, 16.0–18.5); length of 5th metacarpal, 49.8, 47.0–51.5 (50.78, 48.5–53.5); length of 1st phalanx V, 12.97, 12.0–14.0 (13.00, 12.0–13.5); length of 2nd phalanx V, 13.57, 13.0–14.0 (13.88, 13.0–15.0); length of tibia, 19.30, 18.5–20.5 (19.50, 18.0–21.5); length of hind foot, 10.77, 10.0–11.5 (10.98, 10.0–12.0); length of calcar, 6.90, 6.0–7.5 (7.17, 6.0–8.0).

Means and ranges for cranial and dental measurements (in mm) for 15 males and 15 females (in parentheses) above are: length of skull, 27.96, 27.3–28.7 (28.15, 27.5–28.7); condylobasal length, 26.12, 25.5–26.8 (26.29, 25.6–26.7); condylocanine length, 25.25, 24.6–25.8 (25.41, 24.9–26.1); basal length, 22.90, 22.3–23.6 (23.10, 22.7–23.8); length of palate, 14.99, 14.3–15.8 (15.12, 14.6–15.5); length of maxillary toothrow, 10.15, 9.9–10.4 (10.25, 10.1–10.5); length of mandibular toothrow, 11.24, 10.9–11.5 (11.36, 11.0–11.6); length of mandible, 19.75, 19.3–20.2 (19.80, 19.4–20.3); width across canines, 6.41, 6.2–6.6 (6.47, 6.1–6.8); width across molars, 12.99, 12.5–13.2 (13.01, 12.2–13.6); interorbital width, 7.17, 6.5–7.8 (7.23, 7.0–7.5); postorbital width, 6.30, 5.9–6.7 (6.30, 6.1–6.6); zygomatic width, 17.64, 17.2–18.5 (17.81, 16.9–18.4); width of braincase, 11.95, 11.6–12.3 (12.12, 11.5–12.6); mastoid width, 13.83, 13.6–14.3 (13.95, 13.6–14.3); width of palate, 7.39, 7.1–7.9 (7.49, 6.9–8.1); height of braincase, 10.30, 9.9–10.5 (10.33, 10.0–10.7); occipital height, 7.29, 6.9–7.6 (7.38, 7.0–7.7—Taddei 1979). Similar values from 4 specimens (2 males and 2 females) from Brazil were provided by Swanepoel and Genoways (1979) and from 5 specimens (2 males and 3 females) from Brazil by Dias et al. (2002).

A phenetic analysis of the Stenodermatinae showed little coherence for the genus *Chiroderma* (Owen 1988). Despite the reduced nasal bones and spikelike upper incisors of *Chiroderma* (Fig. 2) that easily distinguish it from all other genera, the 5 species were phenetically less homogeneous than any other genus except *Vampyressa* (Owen 1988). The 5 species of *Chiroderma* were divergent, and the species relationships were inconsistent. *C. doriae* was allied with bats of the genus *Vampyressa* in the majority of the analysis, more than with its congeners (Owen 1988).

DISTRIBUTION

Chiroderma doriae was thought to be endemic to southeastern Brazil (Marinho-Filho 1996). According to Simmons (2005), it occurs in the states of São Paulo and Minas Gerais in Brazil and in Paraguay (Fig. 3). *C. doriae* also is reported from the states of Paraná and Santa Catarina in southern Brazil (Taddei 1979); Minas Gerais, Rio de Janeiro, and São Paulo in southeastern Brazil (Aguiar and Pedro 1998; Taddei 1973); Pernambuco and Sergipe in northeastern Brazil (Mikalauskas et al. 2006; Peracchi et al. 2006; Souza et al. 2004); and Goiás, Mato Grosso do Sul, and Distrito Federal in midwestern Brazil (Coimbra et al. 1982; Gregorin 1998). There is a single record from Paraguay (López-González et al. 1998).

Fig. 2.—Dorsal, ventral, and lateral views of cranium and lateral view of mandible of an adult male *Chiroderma doriae* (United States National Museum 542616) from São Paulo, Brazil.

FOSSIL RECORD

A Quaternary fossil from Minas Gerais, Brazil, was reported by Lund in 1840 (Czaplewski and Cartelle 1998).

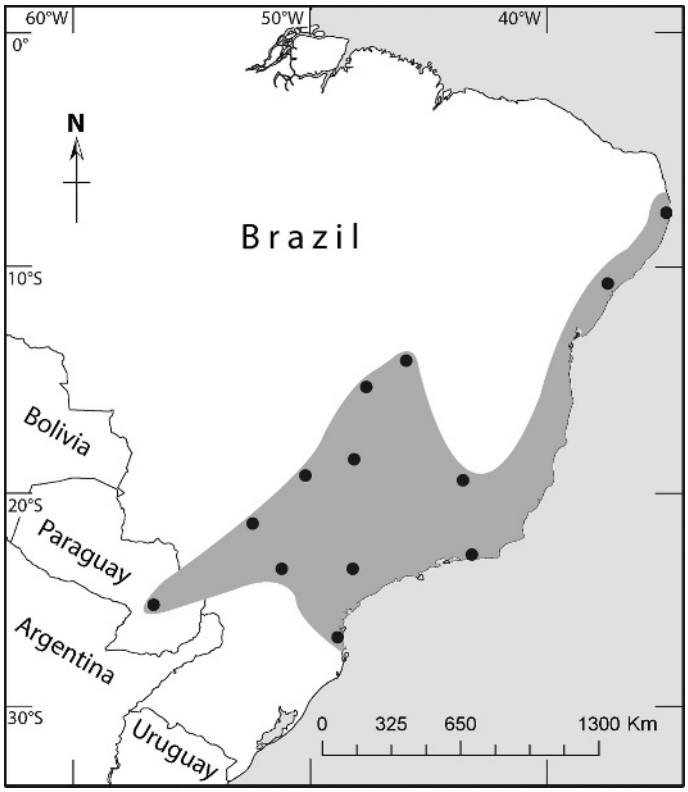

Fig. 3.—Geographic distribution of *Chiroderma doriae* based on information from A. L. Gardner (United States Geological Survey, Patuxent Wildlife Research Center).

Later, this specimen was sent to the Zoological Museum of the University of Copenhagen in Denmark, where Winge (1893) confirmed it to be *Chiroderma doriae* (Czaplewski and Cartelle 1998).

FORM AND FUNCTION

Bats in the genus *Chiroderma* have a robust anterior zygomatic arch and a well-developed 2nd lower molar (Fig. 2). These features were thought to be adaptations for feeding on fig seeds (Nogueira et al. 2005). The hypothesis that *C. doriae* is adapted for seed eating led Nogueira et al. (2005) to examine a suite of morphological characters that could logically be expected to distinguish between granivory and frugivory. Their results suggested that the enlarged angular process is part of a masticatory apparatus that has evolved to grind small seeds, such as those found in the figs these bats are known to favor. The enlarged zygomatic arch should allow for attachment of a large masseter muscle, another potential adaption for dealing with hard food sources such as seeds. Finally, *C. doriae* has fewer, but larger molars than most other stenodermatines. The enlarged 2nd upper molar has a modified accessory cusp that might help

to form a seed trap that could aid in the crushing of small fig seeds (Nogueira et al. 2005).

The dental formula is i 2/2, c 1/1, p 2/2, m 2/2, total 28 (Koopman 1994). The basal metabolic rate for 2 specimens of *C. doriae* (body mass = 19.9 g) was 31.1 ml O_2/h (Cruz-Neto et al. 2001).

ONTOGENY AND REPRODUCTION

Examination of some data suggests that pregnancy and lactation of *Chiroderma doriae* are seasonal events (Peracchi et al. 2006). Nevertheless, Taddei (1973) captured pregnant females in January, February, June, July, August, September, and November. One lactating female from the state of São Paulo in November also was in the early stages of pregnancy; lactating females were captured in May and November; and 1 female captured in January gave birth to a female that was nursing 1 h after capture (Taddei 1973). The neonate had the following features: pointed and curved teeth; dorsal region densely covered by grayish brown fur, with conspicuous dorsal white stripe formed by fur with white tips, from the shoulders to the uropatagium; white facial stripes conspicuous in the adults nonexistent in the neonate; dorsal fur short and extended laterally, covering about two-thirds of the forearm to the propatagium and plagiopatagium, bordering the body on the plagiopatagium, above the thigh and leg and all of the uropatagium, including feet; propatagium, plagiopatagium, and uropatagium with short and rarefied hair growing laterally to the body.

Means and ranges (in mm) of measurements of external characters for that neonate and the proportion to its mother's measurements (in parentheses) are: total length, 48.0 (64%); length of ear, 14.0 (65%); length of tragus, 4.5 (60%); length of forearm, 25.0 (46.2%); thumb, 7.0 (87.5%); length of 3rd metacarpal, 20.0 (39.2%); length of 1st phalanx III, 8.0 (39%); length of 2nd phalanx III, 10.0 (35%); length of 3rd phalanx III, 5.0 (31.2%); length of 4th metacarpal, 20.0 (39.6%); length of 1st phalanx IV, 7.0 (41%); length of 2nd phalanx IV, 7.0 (43.7%); length of 5th metacarpal 21.0 (41.1%); length of 1st phalanx V, 6.0 (48%); length of 2nd phalanx V, 5.5 (39.2%); length of tibia, 10.5 (55.2%); length of hind foot, 10.0 (91.6%); weight (in g), 8.13 (25.2%—Taddei 1973).

Taddei (1973) recorded embryos of 7–48 mm in length with forearms of 9–25 mm from females collected in January–February and August–September. Reproductive males were captured in March, April, May, June, August, and November; testis means and ranges (in mm) from 14 individuals were: testis width, 5.46, 4.5–6.4, and length of testis, 7.24, 6.5–8.0 (Taddei 1973). Nonpregnant females were captured only in May and August (Taddei 1973). Esbérard et al. (1996) found pregnant females between August and October and lactating ones in January in Rio de Janeiro State.

ECOLOGY

The natural history of the genus *Chiroderma* is poorly known (Peracchi et al. 2006). *C. doriae* was thought to be found only in rain-forest habitats (Bordignon 2005), but it occurs in a variety of habitats such as primary and secondary forests, small forested fragments, cultivated areas (Faria 1995), and even urban parks (Esbérard et al. 1996). Use of human-dominated areas indicates some flexibility of *C. doriae* to colonize or at least forage in urban areas if its food resource is available (Nogueira and Peracchi 2002). These records of *C. doriae* in disturbed areas are only from Rio de Janeiro (Esbérard 2003). Information about roosts is scarce (Peracchi et al. 2006).

Species of *Chiroderma* are considered predominantly frugivorous and have been grouped with sympatric forms (e.g., *Artibeus*, *Plathyrrhinus*, and *Vampyressa*) in the canopy or fig-eating guild (Giannini and Kalko 2004; Kalko and Handley 2001). *C. doriae* apparently specializes on wild figs (Esbérard et al. 1996; Faria 1996; Nogueira and Peracchi 2002; Pedro and Taddei 1997; Sipinski and Reis 1995; Tavares 1999). In a study in the state of São Paulo, Brazil, almost all specimens of *C. doriae* were captured close to fig trees (Taddei 1973).

Chiroderma doriae and its congener *C. villosum* are more specialized in their use of figs than any other frugivorous bat; both species can act as predispersal predators of small seeds of *Ficus* (Nogueira and Peracchi 2003). Unlike other fig-eating bats, both species chew the seeds, making it possible for them to optimize nutrient intake (Nogueira and Peracchi 2002). Although many bats seem to obtain a nutritious diet from fruit alone (Wendeln et al. 2000), it seems clear that adding seeds into the diet should result in a significant increase in protein and energy (Morrison 1980). Nogueira and Peracchi (2003) assumed that a strict fig diet is possible for *C. doriae*, because they showed convincingly that this species eats the seeds as well as the pulp of fig fruits.

That *C. doriae* is a true seed predator was established by Nogueira and Peracchi (2003). They also showed that *C. doriae* takes much longer to ingest figs than do fig-eating bats in other genera. On average, both male and female *C. doriae* spend about 3 times as long per fig than does *Artibeus jamaicensis* (ca. 30 min versus 10 min). Furthermore, individuals of *C. doriae* spent twice as long masticating seeds than they did chewing pulp of the figs (74 min on seeds versus 31 min on pulp). Passage time through the gut averaged about 14 min for *C. doriae* (Nogueira and Peracchi 2003).

Chiroderma doriae is frequently captured flying near fruiting trees with species such as *Artibeus planirostris*, *A. lituratus*, *Chiroderma villosum*, *Sturnira lilium,* and *Platyrrhinus lineatus*. All captures of *C. doriae* were made using mist nets (Aguiar and Pedro 1998; Bordignon 2005;

Coimbra et al. 1982; Dias et al. 2002; Esbérard et al. 1996; Faria 1996; Gregorin 1998; López-González et al. 1998; Mikalauskas et al. 2006; Nogueira and Peracchi 2002; Pedro and Taddei 1997; Peracchi et al. 2006; Sipinski and Reis 1995; Souza et al. 2004; Taddei 1973; Tavares 1999).

Several attempts to keep *C. doriae* in captivity by providing fruits usually consumed by other bats were unsuccessful (Taddei 1973, 1980). Positive results over a 30-day period were obtained only when native figs were offered as food (Nogueira and Peracchi 2003; Taddei 1973). To confirm the predation of *Ficus* seeds, 6 individuals of *C. doriae* were captured to conduct a field experiment. The bats were maintained inside bags, a ripe fig from *F. cyclophylla* was offered to each bat, and pellets composed of seed-coat fragments were collected (Nogueira and Peracchi 2003).

In addition to their known preference for figs, there are at least 2 records suggesting that *C. doriae* may visit flowers. Esbérard et al. (1996) caught a single individual with pollen on its head, which suggested it had visited flowers. Similarly, while specifically netting bats visiting *Mabea fistulifera* (Euphorbiaceae), Olmos and Boulhosa (2000) caught a single *C. doriae* with a small amount of pollen on it.

Chiroderma doriae is active all night long, but it is mostly captured after midnight (66% of the captures in the study—Esbérard and Bergallo 2005). The majority of the records of *C. doriae* in the literature are of 1–5 individuals. The few specimens in museum collections and small number of captures in fieldwork are indirect evidence of rarity (Gregorin 1998).

GENETICS

Like all *Chiroderma*, *C. doriae* has a diploid number of 26 and a fundamental number of 48 (Eisenberg and Redford 1999). Although chromosomal data from the 5 species of *Chiroderma* (Baker 1973, 1979; Baker and Genoways 1976; Baker and Hsu 1970; Varella-Garcia et al. 1989; Varella-Garcia and Taddei 1989) indicate the close phylogenetic relationship of these taxa, karyotypes are less useful in resolving interspecific relationships (Baker et al. 1994).

Examination of data from the cytochrome-*b* gene indicates that the ancestors of *Uroderma* and *Chiroderma* diverged from each other 7.2 million years ago and that *C. salvini* diverged from the remainder of the genus 4.6 million years ago. The *doriae–trinitatum* clade was estimated to have diverged from the *villosum–improvisum* clade 2.6 million years ago. The same study estimated that *C. villosum* diverged from *C. improvisum* 2.1 million years ago, and *C. trinitatum* and *C. doriae* diverged from each other 1.6 million years ago (Baker et al. 1994). Perhaps most interesting of these estimates of time of divergence is the *trinitatum–doriae* date, given the difference in their respective body sizes (Baker et al. 1994).

CONSERVATION

Chiroderma doriae is recognized as a threatened species in Brazilian regional lists because of its restricted geographic range and occurrence in habitats under severe anthropogenic pressure such as the Atlantic Rain Forest (Aguiar and Pedro 1998; Aguiar and Taddei 1995; Bergallo et al. 2000; Nogueira and Peracchi 2002). *C. doriae* is classified as vulnerable on the Red List of Threatened Species (Chiroptera Specialist Group 1996). On the most recent list of the Brazilian Threatened Fauna, *C. doriae* was moved from ''threatened'' to ''data deficient'' status (Machado et al. 2005). New geographic distribution records may have contributed to this change in conservation status (Peracchi et al. 2006).

REMARKS

Chiroderma is from the Greek words for hand and skin. The specific epithet *doriae* was chosen by Oldfield Thomas (1891:881) because: ''I propose to name it *Ch. doriae* in honour of the Marquis G. Doria, my colleague in the first examination of the question in Genoa, and a naturalist whose intimate knowledge and magnificent collection of Chiroptera are always at the service of other workers in the same field.''

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