Nota

Cuad. herpetol. 40 (2): 165-172 (*2026*)

New records of *Lachesis rhombeata* and *Bothrops bilineatus* (Squamata, Viperidae) in the Atlantic Forest of Minas Gerais state, Southeast Brazil

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Recibida: 28 Enero 2026
Revisada: 02 Febrero 2026
Aceptada: 07 Septiembre 2026
Editor Asociado: P. Carrasco

doi: 10.31017/CdH.2026.(2026-01)

ABSTRACT
Several snake species with broad geographic distributions tend to exhibit less concerning conservation statuses when assessed at large spatial scales. However, when evaluated at a regional scale, a markedly more concerning scenario may emerge. In this context, we updated the regional distribution map of *Lachesis rhombeata* and *Bothrops bilineatus*, encompassing the state of Minas Gerais in southeastern Brazil. Although new areas of occurrence were identified for both species, available records remain scarce, indicating that they are rare within the state. Moreover, a substantial proportion of the records is historical, and many of the localities where these records were obtained no longer provide suitable ecological conditions for the persistence of these species. Considering this evidence, we suggest that both species face a critical conservation scenario at the state level.

Key Words: Wallacean Shortfall; Snakes; Atlantic Forest Bushmaster; Green Jararaca; Conservation.

Updating species occurrence data is essential for addressing knowledge gaps in biodiversity and reducing the Wallacean shortfall, that is the lack of information about geographic distribution of species (Hortal *et al*., 2015). In this context, new records provide valuable insights for identifying priority areas for conservation (Smith *et al*., 2014; Assis *et al*., 2024) and for protecting specific taxonomic groups (e.g., Roberto and Loebmann, 2016). For snakes, such data have already contributed to the development of more comprehensive and accurate distribution maps, serving as a crucial tool for understanding patterns and informing conservation strategies (Guedes *et al*., 2014; Moura *et al*., 2017; Nogueira *et al*., 2019).

Several species of South American snakes exhibit a broad geographic distribution, spanning extensive areas within a single biome and, in some cases, extending across multiple biomes (Nogueira *et al*., 2019). For many of these species, comprehensive assessment suggests a conservation status of least concern (Gutiérrez-Cárdenas *et al*., 2021; Silveira *et al*., 2021; Catenazzi *et al*., 2021). However, when

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evaluated at a regional scale, a more concerning scenario emerges. This is the case for the Atlantic Bushmaster *Lachesis rhombeata* (Wied, 1824) and Green Jararaca *Bothrops bilineatus* (Wied-Neuwied, 1821) (Squamata, Viperidae). While both species occur in the Atlantic Forest of southeastern and northeastern Brazil, only *B. bilineatus* currently presents a broader distribution that also includes the Amazon rainforest (Nogueira *et al.*, 2019).

The snake *B. bilineatus* is predominantly arboreal, being found active on vegetation at night and resting on this substrate during the day (Turci *et al.*, 2009; Fonseca *et al.*, 2021). Its green coloration provides effective camouflage within the vegetation canopy (Argôlo, 2004; Campbell and Lamar, 2004). In the Atlantic Forest, the species attains a maximum total length of 90 centimeters (Argôlo, 2004), with females typically reaching larger body sizes than males (Campbell and Lamar, 2004). Its prey includes amphibians, reptiles, and mammals (Venegas *et al.*, 2019), and both adults and juveniles may employ caudal luring while hunting (Fonseca *et al.*, 2019).

Regarding the South American bushmaster, this taxon has historically been treated under a broader taxonomic concept. It was formerly regarded as a single, widely distributed species, *Lachesis muta*, occurring in both the Amazon and Atlantic Forest (Hoge, 1965; Fernandes *et al.*, 2004; Nogueira *et al.*, 2019). However, a recent taxonomic revision based on genomic, morphological, venomic, and ecological evidence recognized the Atlantic Forest population as a distinct species, *Lachesis rhombeata* (Hamdan *et al.*, 2024). This species is among the largest vipers in the world, exceeding 2 meters, and is characterized by a yellowish body marked with dark blotches, giving it a distinctive coloration (Liais, 1872; Campbell and Lamar, 2004; Padrón *et al.*, 2023). It is strongly associated with forested habitats, including both primary and secondary forests, and generally avoids extensively open areas (Padrón *et al.*, 2023). The species also occurs in cacao and rubber plantations, provided that these are contiguous with forested areas or retain a dense understory vegetation structure (Argôlo, 2004; Padrón *et al.*, 2023).

Despite their wide geographic ranges, neither species is included in the current Brazilian Red List (MMA, 2026). Of the two species, only *Lachesis rhombeata* has an assessment published on the IUCN Red List. However, this assessment was conducted more than 25 years ago, when the taxon was treated as the Atlantic Forest-endemic subspecies *Lachesis muta rhombeata* and classified as Vulnerable (VU) (Martins & Marques, 2000). Therefore, the assessment does not reflect the current recognition of *L. rhombeata* as a distinct species (Hamdan *et al.*, 2024). The recent taxonomic validation of these snake species therefore highlights its evolutionary and geographic distinctiveness and underscores the urgency of distributional studies such as the present one, which provide essential baseline data for future conservation assessments.

Within the Brazilian Atlantic Forest, however, both species are already included on state red lists, indicating population declines or possible local extinction, though *Lachesis rhombeata* is still listed under the name *L. muta* (Rocha *et al.*, 2000; Espírito Santo, 2022). The Atlantic Forest, a recognized biodiversity hotspot, has suffered continuous deforestation since colonial times and is now highly fragmented (Resende *et al.*, 2018), placing forest-dependent species at increased risk (Galetti *et al.*, 2021).

In this context, and from a regional perspective, the distribution of snakes such as *Bothrops bilineatus* and *Lachesis rhombeata* should be regularly updated. This effort is essential for future assessments of their conservation status and for identifying priority areas for their protection. Therefore, we report new and recent records and provide a geographic distribution map for both species within the Atlantic Forest of the Minas Gerais state, southeastern Brazil.

To develop the distribution map of these snake species, we consulted the evidence contained in the studies of Machado *et al.* (1998), Feio and Caramaschi (2002), Fernandes *et al.* (2004), Dias *et al.* (2008), Nogueira *et al.* (2019), Bernarde *et al.* (2021), Cavalcante *et al.* (2022), and Hamdan *et al.* (2024). We incorporated records obtained from rural residents or nature-appreciating observers (occasional records), provided they were accompanied by photographic evidence allowing for unequivocal species identification. We also included records obtained directly from researchers during fieldwork (license SISBIO 72874-1). Additionally, we examined the herpetological collection of the Museu de Zoologia João Moojen (MZUFV) at the Universidade Federal de Viçosa, located in the municipality of Viçosa, Minas Gerais.

We report eight records of *Bothrops bilineatus* from seven localities in the state of Minas Gerais, Brazil, at elevations ranging from 191 to 791 meters ($\bar{x}$ = 559 m), with most records obtained between 2000 and 2021 (Table 1). Of these, fieldwork yielded

Table 1. Details of records of *Bothrops bilineatus* and *Lachesis rhombeata* in the State of Minas Gerais, Southeast Brazil. Legend: (1) literature record, (2) occasional records, (3) fieldwork, (4) herpetological collection of the Museu de Zoologia João Moojen, (*) protected area, (IBSP) Instituto Butantan - São Paulo, (MZUFV) Museu de Zoologia João Moojen - Universidade Federal de Viçosa - Minas Gerais.

Municipality	Locality	Coordinates		Alt.	Record year or accession to the collection	Source	Evidence
Bothrops bilineatus							
Alto Jequitibá	Estação Presidente Soares	-20.425	-41.967	656	-	1	IBSP 629
Marliéria	* Parque Estadual do Rio Doce	-19.683	-42.513	282	2005	1	Photo
Periquito	Estação Pedra Corrida	-19.093	-42.156	191	-	1	IBSP 9571
Teófilo Otoni	-	-17.867	-41.51	407	-	1	IBSP920-1
Jordânia	* RPPN Mata do Passarinho	-15.783	-40.511	739	2016	3 (new record)	Photo
Jordânia	* RPPN Mata do Passarinho	-15.783	-40.508	731	2021	3 (new record)	Photo
Salto da Divisa	* Parque Estadual Alto do Cariri	-16.3	-39.983	679	2000	1, 4	MZUFV 1028
Santa Maria do Salto	* Parque Estadual Alto do Cariri	-16.411	-40.062	791	2004	1, 4	MZUFV 1133
Lachesis rhombeata							
Muriaé	Bom Jesus da Cachoeira	-21.26	-42.404	296	1980	1	MZUFV 1357
Carangola	-	-20.733	-42.029	421	1934	1	IBSP 8439, 8429
Lajinha	-	-20.151	-41.623	494	1968	1	IBSP 29283
?	Rio Doce	-20.244	-42.898	416	1949	4 (new record?)	MZUFV 329
Caratinga	* RPPN Miguel Feliciano Abdala	-19.733	-41.817	435	1985	1	IBSP 9
Marliéria	* Parque Estadual do Rio Doce	-19.763	-42.631	290	1949	1	?
Periquito	Estação Pedra Corrida	-19.1	-42.167	191	1936	1	IBSP 64668
Tumiritinga	Estação Cachoeirinha	-18.975	-41.642	136	1934-1935	1	IBSP 8650, 8683, 9308-10, 9320
Itueta	Cachoeirinha	-19.389	-41.25	197	-	1	?
Almenara	Fazenda São Miguel	-16.142	-40.985	860	2016	2 (new record)	Photo
Jordânia	* RPPN Mata do Passarinho	-15.778	-40.516	866	2009	3 (new record)	Photo
Bandeira	Fazenda Mombuca	-15.8	-40.533	602	2002	1	A skin was observed by the authors

two records from a previously undocumented locality for the species within the Reserva Particular do Patrimônio Natural Mata do Passarinho in the Vale do Jequitinhonha mesoregion, northeastern Minas Gerais (Fig. 1A and Fig. 2). This reserve preserves a well-structured fragment of Atlantic Forest, and both records were made within a stretch of well-preserved riparian forest. The first record, obtained in 2016, involved an individual observed approximately 1.5 meters above the ground, perched close to a stream. The second, recorded on January 18, 2021, also occurred along the riparian corridor, with the snake positioned at an estimated height of 3.7 meters above the ground.

In the case of *Lachesis rhombeata*, we recorded its presence in twelve distinct localities in the state of Minas Gerais, at elevations ranging from 136 to 860 meters (= 392 m), with the oldest record dating back to 1934 and the most recent from 2016 (Table 1). Of these records, two revealed new areas of occurrence for *L. rhombeata* in the state of Minas Gerais, within the Vale do Jequitinhonha mesoregion (Fig 1 B, C and Fig. 2). The first was obtained on February 22, 2009, when SD photographed an adult in the leaf litter inside a well-preserved forest within the protected area of the Reserva Particular do Patrimônio Natural Mata do Passarinho, in the municipality of Jordânia. The second record was

Figure 1. *Bothrops bilineatus* recorded in the Reserva Particular do Patrimônio Natural Mata do Passarinho, municipality of Jordânia (A); *Lachesis rhombeata* recorded in the municipalities of Almenara (B) and Jordânia (C); skin of *L. rhombeata* collected in 1949 at the "Rio Doce" locality (MZUFV 329).

obtained on October 22, 2016, when PMD, MBL, and OPR photographed an adult approximately 2 m in length in the municipality of Almenara. The snake was active during the morning and was moving through a forest fragment adjacent to the Reserva Biológica da Mata Escura, approximately 2 km from this protected area. In contrast, we consider three records to be dubious due to inconsistencies in the available data.

Here, we update the distribution map of *Bothrops bilineatus* and *Lachesis rhombeata* in the Brazilian state of Minas Gerais by providing new occurrence localities and highlighting the timing of the records for these snakes. In the case of *B. bilineatus*, our results indicate that its occurrences in Minas Gerais are scarce. However, we report new, recent, and recurrent records in the northeastern portion of the state, where significant remnants of Atlantic Forest still persist. This arboreal species, which has been reported as rare in snake assemblages, depends on well-preserved forests and is likely affected by deforestation in the biome (Argôlo, 2004; Bernarde *et al*. 2021). Considering the current status of the Atlantic Forest in Minas Gerais (Fundação SOS Mata Atlântica and INPE, 2025), the limited number of records, combined with the species' ecological traits, supports its inclusion in a state-level threat category. Although this recommendation had been previously proposed (Feio and Caramaschi, 2002), the species is not currently listed in the official state Red List (COPAM, 2010), in contrast to its conservation status in other parts of the Atlantic Forest. For example, in southeastern Brazil, *B. bilineatus* is considered likely extinct in the state of Rio de Janeiro and critically endangered in Espírito Santo (Rocha *et al*., 2000; Espírito Santo, 2022). A similar situation is observed in the Northeast Region, where the species is listed as vulnerable in the states of Bahia and Pernambuco (SEMA, 2017; SEMAS, 2017).

For *Lachesis rhombeata*, the context of its conservation status at the state level is unusual. The species was previously categorized as Critically Endangered in Minas Gerais (COPAM, 1995; Machado *et al*., 1998), yet, despite the absence of new confirmed records, it is currently omitted from the official state Red List (COPAM, 2010). Unsurprisingly, our results indicate that records of *L. rhombeata* in Minas Gerais are not only scarce but most of them date back to before 1985, suggesting a critical conservation scenario for this species in the region. This pattern aligns with its natural history. This forest-dwelling species has a home range of approximately 10 hectares (Padrón *et al*., 2023) and depends on well-preserved forest habitats, especially in lowland areas (Liais, 1872; Argôlo, 2004), environments that are currently rare in Minas Gerais (Fundação SOS Mata Atlântica and INPE, 2025). It is also noteworthy that there have been no recent reports of such a conspicuous snake, characterized by its large body size (exceeding 2 meters) and striking coloration (Hoge, 1965; Argôlo, 2004). These traits make *L. rhombeata* a highly noticeable species in forest environments, and its presence was already notable in the early 19th century. Historical accounts describe it as a highly feared species, often shot by hunters (Wied-Neuwied, 1824), and even regarded as the only snake in Brazil that actively attacks humans (Liais, 1872). In contrast, despite the widespread adoption of citizen science platforms and the increasing availability of photographic devices (Durso *et al*., 2021), we were able to document only two record of *L. rhombeata* in the state, which the last occurred nine years ago. Even in areas where it was historically reported, no recent observations exist, underscoring the current rarity of this species in Minas Gerais.

For the records of *Lachesis rhombeata* with uncertain occurrence, we considered either the absence of evidence or the inconsistency of the available evidence. For the municipality of Itueta, for example, the literature provides no evidence supporting the presence of this snake, despite this locality being included in recent reviews of the species' distribution (see Nogueira *et al*., 2019; Hamdan *et al*., 2024). A similar situation applies to the area currently protected by the Parque Estadual do Rio Doce, where since the 1990s the literature has indicated the presence of *L. rhombeata* (formerly *L. muta*) without support from observational, digital, or physical evidence (Machado *et al*., 1998; Nogueira *et al*., 2019; Hamdan *et al*. 2024; Signorelli *et al*. 2024). The origin of this record is likely associated with a skin deposited in the Museu de Zoologia João Moojen of the Universidade Federal de Viçosa (MZUFV 329). This skin corresponds to a specimen collected in 1949 at a locality referred to as "Rio Doce" by a hunter named Borges, a resident of the municipality of Viçosa (Fig. 1D). At that time, Rio Doce was a small district (currently a municipality) located approximately 50 km from Viçosa; conversely, the Parque Estadual do Rio Doce had only recently been established and was then known as the "Parque Florestal Estadual do Rio Doce." Borges hunted throughout the state

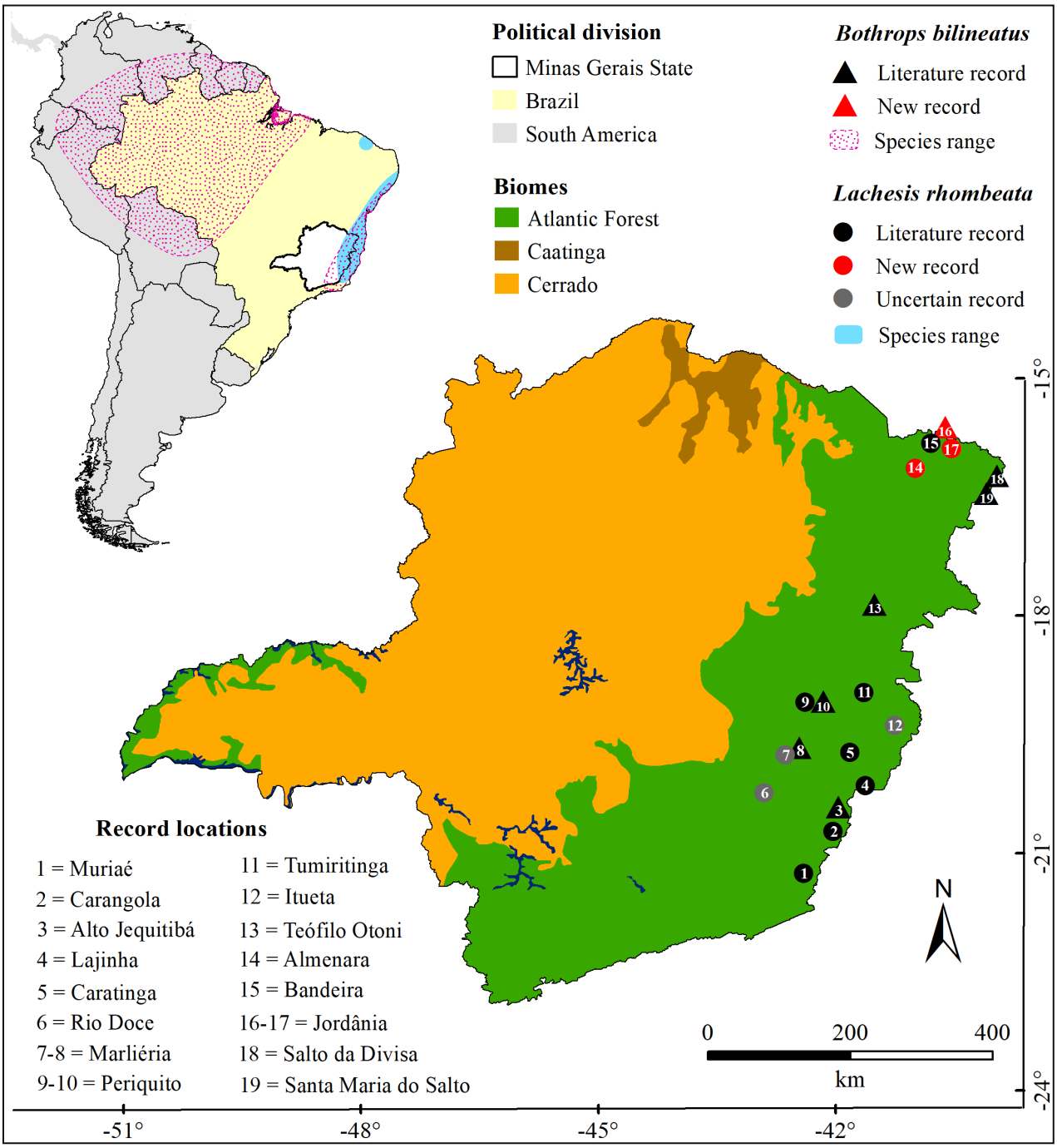

Figure 2. Distribution of *Lachesis rhombeata* and *Bothrops bilineatus* in State of Minas Gerais, Southeast Brazil.

of Minas Gerais, including the forests along the Rio Doce River basin, within which these localities are situated (J. L. Pontes, personal communication). In this context, it is not possible to determine the exact origin of this *L. rhombeata* skin, as both localities could have been designated as "Rio Doce."

In conclusion, our results indicate that records of these snakes in Minas Gerais are scarce and restricted to the southeastern, eastern, and northeastern portions of the state, primarily in low to mid elevation areas. However, their historical distribution does not appear to correspond to their current range. In the southeastern and eastern regions, particularly within the mesoregions of Zona da Mata and Vale do Rio Doce, many of the localities where historically recorded have undergone severe environmental degradation. Except for Parque Estadual do Rio Doce (a protected area where *Bothrops bilineatus* were documented) most of the remaining areas no longer sustain suitable habitats for these species.

Conversely, recent records of these snakes have been concentrated in the northeastern of the state. This region, known as the Vale do Jequitinhonha, harbors significant fragments of Atlantic Forest within protected areas such as the Reserva Particular do Patrimônio Natural Mata do Passarinho, Parque Estadual Alto do Cariri, and Reserva Biológica da Mata Escura. Currently, these sites represent the main strongholds for the persistence of these species in Minas Gerais state. Thus, the data indicate that both species face a critical conservation scenario at the state level, with greater severity for *Lachesis rhombeata*.

Acknowledgments

We are grateful to Sueli Damasceno (SD), Petrônio Mamed David (PMD), Moysés Bossi Lima (MBL), and Oswaldo Pereira Resende (OPR) for providing records and photos of *Lachesis rhombeata* from the Vale do Jequitinhonha. Henrique Caldeira Costa for his assistance with the dates of species records, and to José Lelis Pontes, Henrique Folly, and Rômulo Ribon for historical information on the snakes. We also thank Victor Almeida, Filipe Almeida, Pedro Prado, Luiz Carmo, and Miguel Relvas for their valuable assistance during fieldwork.

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