



New Records of Ground Beetles Genera (Coleoptera: Carabidae: Scaritinae: Clivinini) from Brazilian Caves

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Abstract. Taxonomic knowledge of Clivinini Rafinesque, 1815 in subterranean environments is limited. New genera records of this tribe in Brazilian caves are presented as well as a map with their geographical distribution. In total, nine genera were recorded in six Brazilian states, Piauí (*Aspidoglossa* Putzeys, 1846), Bahia (*Aspidoglossa*, *Whiteheadiana* Perrault, 1994, *Oxydrepanus* Putzeys, 1866, *Schizogenius* Putzeys, 1846), Goiás (*Aspidoglossa*, *Paraclivina* Kult, 1947, *Semiclivina* Kult, 1947 and *Stratiotes* Putzeys, 1846), Minas Gerais (*Pyramoides* Bousquet, 2002, *Semiardistomis* Kult, 1950, *Semiclivina*, *Oxydrepanus*), São Paulo (*Semiardistomis*) and Pará (*Paraclivina*, *Oxydrepanus*). This work is the first contribution to the understanding of the Clivinini taxa in Brazilian caves.

Keywords: Ardistomina; Clivinina; Cave-dwelling species; Forcipatorina; Reicheiina.

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Insects represent the richest and most diversified group of animals around the world, with more than one million known species and many still to be discovered (GRIMALDI & ENGEL 2005; MAYHEW 2007; ZHANG 2013; BEUTEL *et al.* 2014). Among the insect lineage, the most notable are beetles (Order Coleoptera), having the highest richness of known fauna species on Earth, with over 380,000 species and many more to be described (GROVE & STORK 2000; SLIPINSKI *et al.* 2011; ZHANG *et al.* 2018). The exceptional species richness and diversity of forms, colors, and behaviors have attracted attention, as have the different environments where they can be found, such as the subterranean environment (CROWSON 1981).

Caves are an endangered subterranean environment worldwide. They are spaces of varying dimensions that can provide refuge or habitat for a high diversity of beetle species, including troglobites (restricted to the cave environment), which have been recorded and described over the decades (BARR 1964; TRAJANO *et al.* 2016; PELLEGRINI & FERREIRA 2017; BALKENOHL *et al.* 2018; GALLÃO & BICHUETTE 2018). In Brazil, Carabidae is one of the richest beetle families recorded in caves (TRAJANO & BICHUETTE 2010; TRAJANO *et al.* 2016; PELLEGRINI *et al.* 2021, 2022a, 2022b; ZAMPAULO *et al.* 2021). However, knowledge about this group in the subterranean environments of Brazil is still scarce and in the early stages, especially within the Clivinini tribe (Scaritinae) (WHITEHEAD 1972; BALKENOHL *et al.* 2018).

To date, only two species have been described in Brazilian caves: *Ardistomis ferrera* Balkenohl, Pellegrini & Zampaulo, 2018 (Clivinini Rafinesque, 1815, Ardistomina Putzeys, 1867), from the Carajás mineral province, and *Schizogenius ocellatus* Whitehead, 1972 (Clivinini, Schizogeniina Dostal, 2017), from the Alto Ribeira karst area (BALKENOHL *et al.* 2018); both are considered troglobites. Despite intense research and surveys over the last two decades, little knowledge is available about the Clivinini recorded in caves in Brazil. However, the number of described Zuphiini species (Dryptinae) from the genus *Coarazuphium* Gnaspini, Vanin & Godoy, 1998 (Zuphiini, Zuphiina) has greatly increased in recent years (ASENJO *et al.* 2022; PELLEGRINI *et al.* 2022a, 2022b).

Studies on Clivinini are urgent and necessary. Clivinini is the most diversified tribe of Scaritinae Bonelli, 1810, with 1,271 species described worldwide (ANICHTCHENKO 2014). Despite this, the Brazilian Clivinini fauna are poorly understood, especially the subterranean fauna, with few works published on their taxonomy or systematics (WHITEHEAD 1972; REICHARDT 1977; BALKENOHL *et al.* 2018). Biodiversity documentation is the ground for planning and monitoring Brazilian cave species conservation. It is essential to first know and document the occurrence of these taxa and, afterward, to recognize and describe new species that may be found in caves. This work provides new distribution records of the Clivinini genera occurring in Brazilian caves.

MATERIAL AND METHODS

The studied materials were collected by the Laboratório de Estudos Subterrâneos team during several expeditions from 2006 to 2018. Specimens were preserved in 70% ethanol. The geographical coordinates and information about the caves where the specimens were collected were taken on location and are presented in degrees/minutes/seconds,

Datum WGS 84. A map of the distribution of Clivinini genera occurring in caves in Brazil was produced using QGIS version 2.18 (QGIS 2017). Photographs of the caves where the Clivinini were collected are shown in Figures 14 and 15.

The beetles were recorded in a mosaic of areas located in distinct geomorphological units (Figure 13). They occur in caves in semiarid regions, such as those in the states of Piauí and Bahia; Toca do Moquém and Toca do Gonçalves are relatively small caves formed by sandstone and limestone, respectively. Both caves are located in the "Caatinga" domain, composed of mesophytic and xeromorphic forests (AB'SABER 1977), with annual temperatures ranging from 25 °C to 31 °C and approximately 689 mm of average annual precipitation, which is concentrated in the summer, from November to March (NIMER 1989). Toca do Moquém cave has relatively low air humidity (approximately 50%) and high temperatures (30 °C on average), while Toca do Gonçalves cave has higher air humidity (reaching 70-80% in the deepest zones) and lower temperatures compared to the surface (approximately 25-27 °C), representing a possible refuge for ground beetles.

The caves of the São Desidério (Gruta da Sucupira) and Coribe (Gruta do Enfurnado) regions are large and are located in the Bambuí geomorphological group (RUBBIOLI et al. 2019). The climate is characterized by dry winters, and the annual precipitation is approximately 640 mm, concentrated from November to March (NIMER 1989). The dominant vegetation is the "Caatinga" interspersed with "Cerrado" (savannah-like vegetation) (AB'SABER 1977). Both caves surpassed 3 km of extension, with mild temperatures (27-28 °C) and high humidity (70-80%); therefore, they are possible climatic refuges for subterranean fauna.

Caves in the state of Goiás (Gruta Pasto de Vacas I, Lapa Terra Ronca II, and Lapa do Angélica) are also located within the Bambuí geomorphological group (RUBBIOLI et al. 2019); all are formed by carbonates (limestone caves) surrounded by the "Cerrado" domain (AB'SABER 1977). These caves have large extensions (from 5 to 13 km) and drainages crossing them; therefore, they show high air humidity (reaching 80-90%), even in the dry season (winter), and mild temperatures (reaching 24-25 °C on average), following the annual averages.

Caves from the Januária/Itacarambi and Cordisburgo regions in the state of Minas Gerais are included in the Bambuí geomorphological group (KARMANN & SÁNCHEZ 1979). Itacarambi and Januária municipalities are located in the transition zone between the "Cerrado" and "Caatinga" morphoclimatic domains (AB'SABER 1977). The climate is tropical, with dry winters between March and October (PEEL et al. 2007). Gruta do Janelão and Lapa da Onça are limestone caves and have approximately 5 km and 1.7 km of extension, respectively, with mild temperatures (approximately 24-26 °C) and high humidity (70-80%). The Cordisburgo area is located within the "Cerrado" Domain (AB'SABER 1977), and the climate is tropical sub-warm and semi-humid (NIMER 1989), with a dry period from May to September. Gruta Morena, a limestone cave, has more than 5 km of extension, with mild temperatures and high humidity.

The Alto Ribeira karst area, state of São Paulo, where the Gruta do Termimina II cave is located, is one of the largest fragments of the Brazilian Atlantic Rainforest. The region has the Atlantic Rainforest as the main vegetation domain (AB'SABER 1977) and a subtropical humid climate without a dry season. All caves in this region are highly humid (80-90% of air humidity) and show temperatures ranging from 19-21 °C throughout the year. Gruta do Termimina II is within the Parque Estadual Turístico do Alto Ribeira (PETAR) boundaries. This limestone cave is located in the Açungui geomorphological group (KARMANN & SÁNCHEZ 1979).

The caves from the Chapada Diamantina region, state of Bahia (Lapa Doce and Gruta Rio dos Pombos), are located in the Caatinga domain (Lapa Doce), with a remnant of Rainforest and "Campos Rupestres" at higher altitudes (Gruta Rio dos Pombos) (AB'SABER 1977). The dry months are between April and November. Both caves have high air humidity (70-80%) and mild temperatures (22-23 °C). Geologically, Lapa Doce is formed by carbonate rocks from the Una Group, and Gruta Rio dos Pombos is formed by sandstones of Serra do Espinhaço (KARMANN & SÁNCHEZ 1979).

In the speleological province of Altamira-Itaituba, state of Pará, where the Abrigo do Abutre and Abrigo Cama de Vara caves are located, the caves developed over sandstone outcrops (VASQUEZ et al. 2008). The region is located in the Amazon Rainforest (AB'SABER 1977) with a hot and humid tropical monsoon climate (ALVARES et al. 2014). These caves are relatively small, receive abundant and continuous food input from the rainforest in the surrounding area and have high temperatures and air humidity (FERNANDES et al. 2019).

The Presidente Olegário karst area is in the northeastern portion of the state of Minas Gerais. This is also a limestone area of the Bambuí geomorphologic unit (RUBBIOLI et al. 2019). The region experiences dry winters and warm summers. The landscape is originally covered by the Cerrado domain (AB'SABER 1977), with transition areas of seasonal semideciduous forest (Atlantic rainforest) near the limestone outcrops where caves are located. Lapa Vereda da Palha is a relatively large cave (approximately 2 km of extension), crossed by a small drainage area, with high humidity and mild temperatures.

Morphological study and visualization of the specimens were carried out with ZEISS Stemi 508 and Stemi 305 stereoscopic microscopes. The images of the examined taxa were obtained with a Leica M25 digital camera attached to a Leica DFC 295 stereoscopic microscope located at Centro de Coleções Entomológicas da UFPA (CEUFLA).

Identification followed the descriptions and keys available for Clivinini genera (PUTZEYS 1846, 1866; KULT 1947, 1950; PERRAULT 1994; REICHARDT 1977; VALDÉS 2012; DOSTAL & VIEIRA 2018).

RESULTS AND DISCUSSION

Ground beetles (Carabidae) are known for their predatory behavior and success in both soil and subterranean environments (REICHARDT 1977; LÖVEI & SUNDERLAND 1996). Several species have been recorded and described in caves worldwide (e.g., BARR 1964; GIUSEFFI et al. 1978; REDDELL & COKENDOLPHER 2004; TIAN 2014; TIAN & HE 2020; MALEK-HOSSEINI et al. 2021). Although ground beetles are widely found in caves in Brazil (BALKENOHL et al. 2018), the status of these caves is scarce and lacks information, and little is known about these beetles, with the exceptions of the following publications, which recently reported species of the genera *Coarazuphium*, *Perigona* Laporte, 1835, *Ardistomis* Putzeys, 1846, and *Schizogenius* Putzeys, 1846 (ÁLVARES & FERREIRA 2002; TRAJANO & BICHUETTE 2010; PELLEGRINI & FERREIRA 2011, 2014; TRAJANO et al. 2016; PELLEGRINI & FERREIRA 2017; BALKENOHL et al. 2018; GALLÃO & BICHUETTE 2018; PELLEGRINI et al. 2020, 2022a, 2022b).

A total of 40 specimens belonging to the Clivinini tribe (Carabidae: Scaritinae) were identified to the genus level (Table 1). The lack of taxonomical studies and the difficulty in accessing the type material did not allow us to identify the specimens to the species level. All Neotropical subtribes of Clivinini (*Ardistomina*, *Clivinina* Rafinesque, 1815, *Forcipatorina* Bänninger, 1938, *Reicheiina* Jeannel, 1957 and *Schizogeniina*) (REICHARDT 1977) were identified in the material analyzed from 16 caves of six Brazilian states (Table 1).

Considering all these subtribes, we recorded nine genera of Clivinini, of which eight were recorded in caves of Brazil for the first time in this study.

All three Ardistomina genera are distributed in the Neotropical region and have been recorded in Brazilian caves. Among them, *Aspidoglossa* Putzeys, 1846 (Figures 1, 2) and *Semiardistomis* Kult, 1950 (Figures 3, 4) were recorded in Brazilian caves for the first time in this study. In contrast, the genus *Ardistomis*, which was not found in the available material, was recently reported by BALKENOHL *et al.* (2018), who described a new species for this genus associated with iron ore caves of the state of Pará. Here, four genera of Clivinina were also recorded for the first time in Brazilian caves:

Paraclivina Kult, 1947 (Figure 5), *Pyramoides* Bousquet, 2002 (Figure 6), *Semiclivina* Kult, 1947 (Figure 7), and *Whiteheadiana* Perrault, 1994 (Figure 8), which represent approximately 45% of the Neotropical Clivinina genera.

Regarding the subtribe Forcipatorina, the genus *Stratiotes* Putzeys, 1846 was recorded for the first time in Brazilian caves (Figure 9), representing approximately 14% of the Neotropical genera of this subtribe. The monobasic subtribe Reicheiina was represented only by *Oxydrepanus* Putzeys, 1866 (Figures 10, 11), also recorded for the first time in Brazilian caves. Finally, the subtribe Schizogeniina has four genera with Neotropical occurrence (REICHARDT 1977), but only the genus *Schizogenius* (Figure 12) has been recorded in

Table 1. Subtribes of Clivinini (Coleoptera, Carabidae, Scaritinae) that occur in caves in Brazil. In *the taxa reported for Brazilian caves for the first time. The column Protection corresponds if the cave is included in a protection area (Conservation Unit).

	Genera	Morphotypes	State	Municipality	Cave/locality	Protection
Ardistomina Putzeys, 1867	* <i>Aspidoglossa</i> Putzeys, 1846	<i>Aspidoglossa</i> sp. 1	Piauí	Caracol	Toca do Moquém	No
	* <i>Aspidoglossa</i>	<i>Aspidoglossa</i> sp. 2	Bahia	São Desidério	Gruta da Sucupira	No
	* <i>Aspidoglossa</i>	<i>Aspidoglossa</i> sp.3	Bahia	Umburanas	Toca do Gonçalves	No
	* <i>Aspidoglossa</i>	<i>Aspidoglossa</i> sp.4	Goiás	Mambaí	Gruta Pasto de Vacas I	Environmental Protection Area (APA)
	* <i>Semiardistomis</i> Kult, 1950	<i>Semiardistomis</i> sp.1	Minas Gerais	Januária/ Itacarambi	Gruta do Janelão	National Park
	* <i>Semiardistomis</i>	<i>Semiardistomis</i> sp.2	São Paulo	Iporanga	Gruta do Termimina II	State Park
Clivinina Rafinesque, 1815	* <i>Paraclivina</i> Kult, 1947	<i>Paraclivina</i> sp.1	Goiás	Mambaí	Gruta Pasto de Vacas I	Environmental Protection Area (APA)
	* <i>Paraclivina</i>	<i>Paraclivina</i> sp.2	Pará	Altamira	Abrigo Cama de Vara	No
	* <i>Pyramoides</i> Bousquet, 2002	<i>Pyramoides</i> sp.	Minas Gerais	Januária/ Itacarambi	Lapa da Onça	National Park
	* <i>Semiclivina</i> Kult, 1947	<i>Semiclivina</i> sp.1	Goiás	Mambaí	Gruta Pasto de Vacas I	Environmental Protection Area (APA)
	* <i>Semiclivina</i>	<i>Semiclivina</i> sp.2	Goiás	São Domingos	Lapa Terra Ronca II	State Park
	* <i>Semiclivina</i>	<i>Semiclivina</i> sp.3	Minas Gerais	Cordisburgo	Gruta Morena	No
	* <i>Whiteheadiana</i> Perrault, 1994	<i>Whiteheadiana</i> sp.	Bahia	Iraquara	Lapa Doce	No
Forcipatorina Bänninger, 1938	* <i>Stratiotes</i> Putzeys, 1846	<i>Stratiotes</i> sp.	Goiás	Mambaí	Gruta Pasto de Vacas I	Environmental Protection Area (APA)
Reicheiina Jeannel, 1957	* <i>Oxydrepanus</i> Putzeys, 1866	<i>Oxydrepanus</i> sp.1	Bahia	Coribe	Gruna do Enfurnado	No
	* <i>Oxydrepanus</i>	<i>Oxydrepanus</i> sp.2	Bahia	Andaraí, Povoado de Igatu	Gruna Rio dos Pombos	National Park
	* <i>Oxydrepanus</i>	<i>Oxydrepanus</i> sp.3	Pará	Altamira	Abrigo do Abutre	No
	* <i>Oxydrepanus</i>	<i>Oxydrepanus</i> sp.4	Goiás	São Domingos	Lapa do Angélica	State Park
	* <i>Oxydrepanus</i>	<i>Oxydrepanus</i> sp.5	Minas Gerais	Presidente Olegário	Lapa Vereda da Palha	No
Schizogeniina Dostal, 2017	<i>Schizogenius</i> Putzeys, 1846	<i>Schizogenius</i> sp.	Bahia	Coribe	Gruna do Enfurnado	No

caves, representing 25% of the genera for this tribe in Brazil.

Last, among the Neotropical Carabidae Clivinini genera, approximately 46% occur in Brazilian caves. Therefore, currently, ten genera have been reported in Brazilian caves, of which two of them, *Ardistomis* and *Schizogenius*, were previously recorded. This study increases the knowledge of these taxa by 80% with eight new records as well as

their subterranean habitat distributions, which have been unknown until now.

Of the 16 Brazilian caves in this study, *Aspidoglossa* (subtribe *Ardistomina*) was found in four of them: Toca do Moquém, Gruta do Sucupira, Toca do Gonçalo, and Gruta Pasto de Vacas I, while *Semiardistomis* (*Ardistomina*) was found in two of them: Janelão Cave and Gruta do Termimina II (Table 1). The



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Figures 1-4. Genera of the Subtribes of Clivinini (Coleoptera, Carabidae, Scaritinae) occurring in caves of Brazil. Figures 1-4: *Ardistomina* Putzeys, 1867, Figures 1-2: Morphospecies **Aspidoglossa* Putzeys, 1846; Figures 3-4: Morphospecies **Semiardistomis* Kult, 1950. ***Taxa reported for Brazilian caves for the first time.** Scale bars= 1mm

subtribe Clivinina was reported in six caves: *Paraclivina* in the Gruta Pasto de Vacas I and Abrigo Cama de Vara; *Pyramoides* in the Lapa da Onça; *Semiclivina* in the Gruta Pasto de Vacas I, Lapa Terra Ronca II, and Gruta Morena; and *Whiteheadiana* in the Lapa Doce. *Stratiotes* (subtribe Forcipatorina) were found only in one cave, Gruta Pasto de Vacas I, while *Oxydrepanus* (subtribe Reicheiina) was found in five caves, Gruta do Enfurnado, Gruta Rio dos Pombos, Abrigo do Abutre, Lapa do

Angélica, and Lapa Vereda da Palha. The genus *Schizogenius* (subtribe Schizogeniina) was recorded only in the Gruta do Enfurnado cave (Figure 13).

Clivinini ground beetles were found in microhabitats with high humidity, close to sources of organic matter, such as leaf litter accumulation in river sediment banks, and in different zones (entrance, twilight, and aphotic). More



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Figures 5-8. Genera of the Subtribes of Clivinini (Coleoptera, Carabidae, Scaritinae) occurring in caves of Brazil. Figures 5-8: *Clivinina* Rafinesque, 1815. Figure 5: **Paraclivina* Kult, 1947; Figure 6: **Pyramoides* Bousquet, 2002; Figure 7: **Semiclivina* Kult, 1947; Figure 8: *Whiteheadiana* Perrault, 1994. ***Taxa reported for Brazilian caves for the first time.** Scale bars= Figures 5, 7, 8: 1mm; Fig. 6: 500 μ .

specifically, *Aspidoglossa* (Ardistomina) was found in humid unconsolidated substrates and in substrates composed of clay and accumulated leaf litter. The genera *Semiardistomis* (Ardistomina) and *Schizogenius* (Schizogeniina) were found in river sediment banks. *Stratiotes* (Forcipatorina) and specimens of the subtribe Clivinina were mainly found in humid unconsolidated substrates, and the genus *Paraclivina*

(Clivinina) was also found in bat guano accumulations (frugivorous and insectivorous combined guano). The genus *Oxydrepanus* (Reicheiina) was found in river sediment banks as well as substrates composed of humid clay and sand and vegetal organic matter.



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Figures 9-12. Genera of the Subtribes of Clivinini (Coleoptera, Carabidae, Scaritinae) occurring in caves of Brazil. Figure 9: Subtribe Forcipatorina Bänninger, 1938; Figure 9: * *Stratiotes* Putzeys, 1846. Figures 10-11: Reicheiina Jeannel, 1957. Figures 10-11: Morphospecies **Oxydrepanus* Putzeys, 1866. Figure 12: *Schizogeniina* Dostal, 2017. Figure 12: *Schizogenius* Putzeys, 1846. *Taxa reported for Brazilian caves for the first time. Scale bars = Figures 9, 12: 1mm; Figs. 10-11: 500 μ .

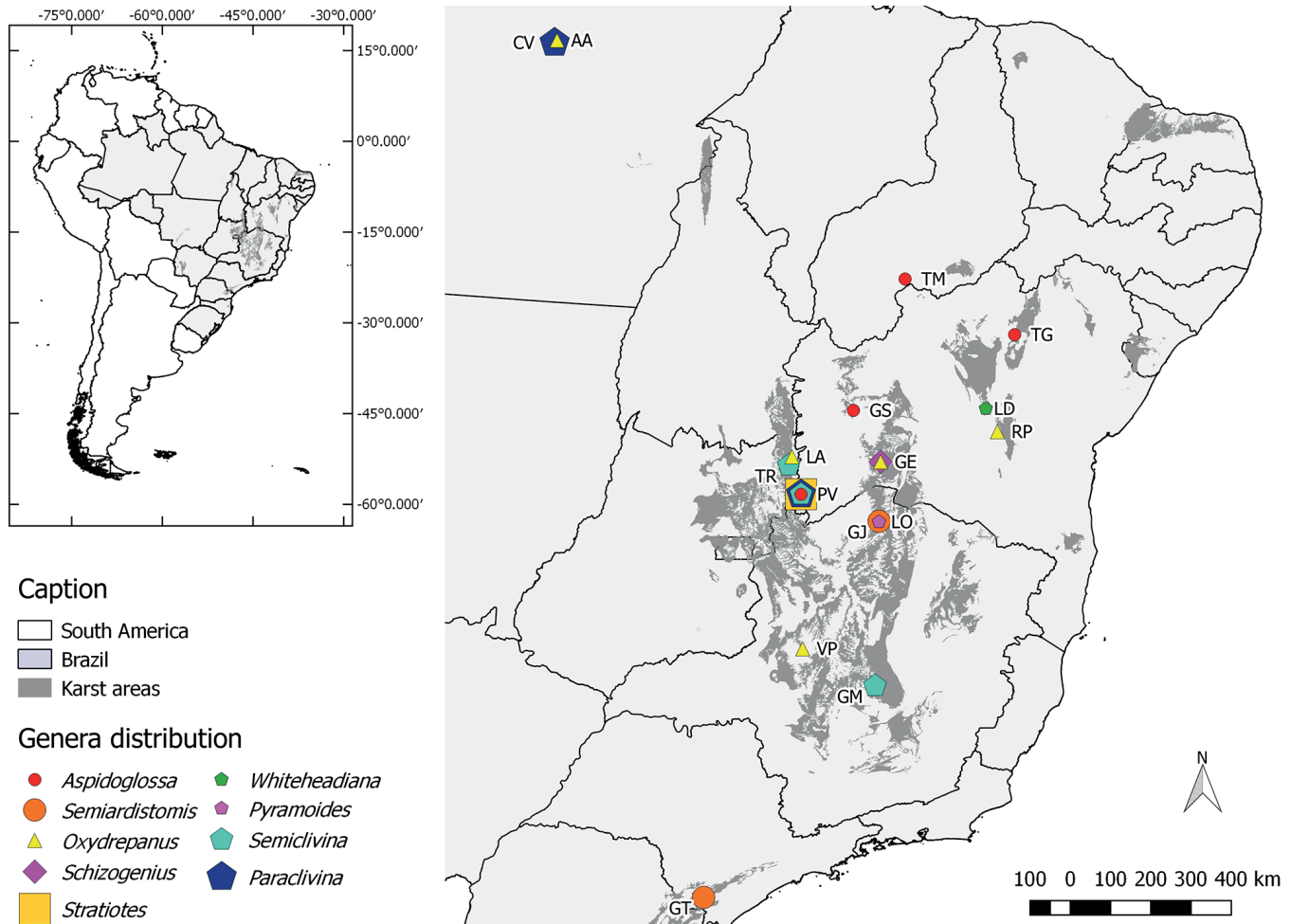


Figure 13. Map of the distribution of Clivinini genera (Coleoptera, Carabidae, Scaritinae) occurring in caves of Brazil. Cave abbreviations: TM = Toca do Moquéim (state of Piauí); GS = Gruta da Sucupira, TC = Toca do Gonçalves, LD = Lapa Doce, GE = Gruna do Enfurnado, RP = Gruna Rio dos Pombos (state of Bahia), PV = Gruta Pasto de Vacas I, TR = Lapa Terra Ronca II, LA = Lapa do Angélica (state of Goiás), GJ = Gruta do Janelão, LO = Lapa da Onça, GM = Gruta Morena, VP = Lapa Vereda da Palha (state of Minas Gerais), GT = Gruta do Temimina II (state of São Paulo), AA = Abrigo do Abutre, CV = Abrigo Cama de Vara (state of Pará).

The recorded morphospecies are likely troglophiles, i.e., they have established populations in both subterranean and epigeal environments (sensu BARR & HOLSINGER 1985). Clivinini has some morphological adaptations to living and establishing populations in environments similar to caves. For example, the fossorial protibia, which is small in size compared to that of other Scaritinae, and an elongated body that allows Clivinini to dig between narrow spaces between rocks (BRANDMAYR 2021). Troglóbites usually have morphological specializations, such as reduced exoskeleton pigmentation and reduced compound eyes, among other specializations related to life in the subterranean environment (BARR 1964; CROWSON 1981); these morphological features were not observed in any of the analyzed specimens. Clearly, the specimens reported here are different from *Schizogenius ocellatus* and *Ardistomis ferrerae* (BALKENOHL *et al.* 2018), the two troglóbitic Clivinini species known from Brazil to date.

Furthermore, Brazilian subterranean communities are composed mainly of troglóphilic species, which play an essential ecological role in this environment (TRAJANO & BICHUETTE 2010). This paper may support environmental studies that evaluate the conservation status of caves and their protection. Some regions where Clivinini were recorded present a high diversity of troglóbitic species and several threats to these fauna and caves (GALLÃO & BICHUETTE 2018). Some of the main threats and impacts are deforestation for pastures, agriculture, and/or charcoal production (Altamira, Coribe, São Domingos, Mambá, Presidente Olegário, Januária/Itacarambi, and Cordisburgo regions); hydroelectric (Presidente Olegário and Altamira) and mining projects (Coribe); road construction (São Desidério); pollution of subterranean drainage (São Desidério

and Alto Ribeira); lowering of the water table (Itaquara); uncontrolled tourism (Itaquara, Andaraí, and São Domingos); and illegal mining (São Domingos and Andaraí) (for more details, see GALLÃO & BICHUETTE 2018). Therefore, studies that expand the knowledge about subterranean fauna, regardless of their ecological-evolutionary classification, are essential for developing conservation strategies (TRAJANO & BICHUETTE 2010; GALLÃO & BICHUETTE 2015, 2018; ASENJO *et al.* 2022).

Occurrences of the genera *Aspidoglossa*, *Paraclivina*, *Oxydrepanus*, *Pyramoides*, *Semiardistomis*, *Semiclivina*, *Stratiotes*, and *Whiteheadiana* were recorded for the first time in Brazilian caves. With this knowledge of the ground beetle fauna associated with Brazilian caves, it is now possible to advance taxonomic and systematics studies to provide more informative checklists and conservation plans. Despite recent advances in the knowledge of ground beetle fauna that occur in caves in Brazil, these advances are still slow because of taxonomic impediments (TRAJANO *et al.* 2016). This scenario is caused by several reasons; for example, information about collections has been accumulated in scientific collections in recent years without a formal description, which is a consequence of the lack of resources and incentives to stimulate the qualification of taxonomists, resulting in a gap in the knowledge of these groups. It is hoped that this scenario will change, knowledge about the taxonomic diversity of carabids, as well as other insect lineages, will be broadened, and future research will be conducted.

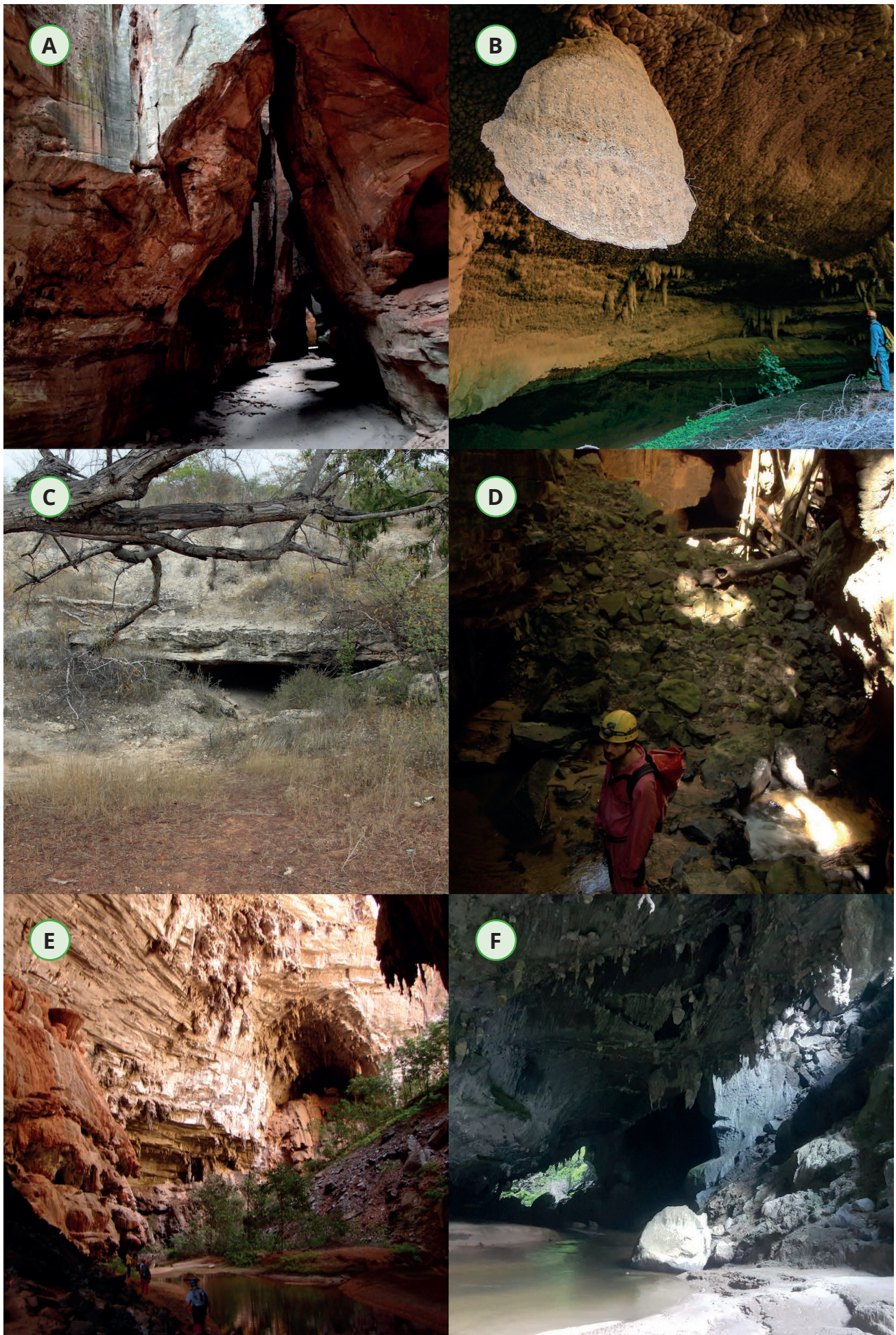


Figure 14. Brazilian caves with occurrence of Clivinini species. A = Toca do Moquém, cave gallery (Photo: D. F. Torres), B = Gruta da Sucupira, cave entrance with river gallery (Photo: A. O. Lobo), C = Toca do Gonçalves, cave entrance in the Caatinga domain (Photo: M. E. Bichuette), D = Gruta Pasto de Vacas I, cave entrance, a typical sinkhole (Photo: P. P. Rizzato), E = Gruta do Janelão, cave gallery with river bank sediments (Photo: P. P. Rizzato), F = Gruta Termimina II, cave entrance with river bank sediments (Photo: J. S. Gallo).

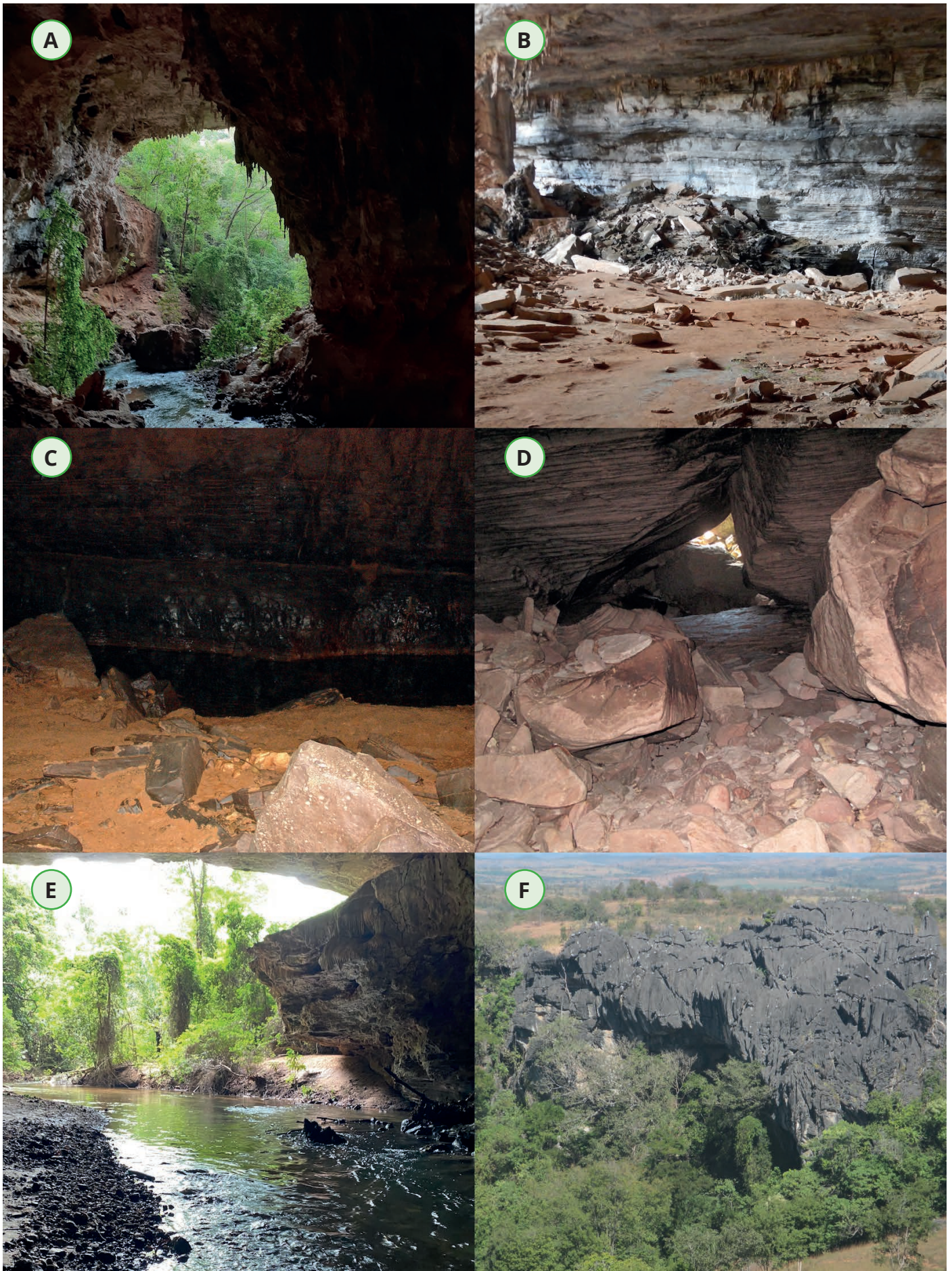


Figure 15. Brazilian caves with occurrence of Clivinini species. A = Lapa Terra Ronca II, cave river gallery with blocks and bank sediments (Photo: D. F. Torres), B = Lapa Doce, cave gallery in the entrance zone (Photo: M. E. Bichuette), C = Gruna do Enfurnado, river gallery, humid sediment with organic matter in the river margin (Photo: M. E. Bichuette), D = Gruna Rio dos Pombos, a sandstone cave, main gallery (Photo: M. E. Bichuette), E = Lapa do Angélica, river gallery with bank sediments (Photo: M. E. Bichuette), F = Lapa Vereda da Palha, cave entrance (Photo: M. E. Bichuette).

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