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The rise of actualistic taphonomy in South America

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THE RISE OF ACTUALISTIC TAPHONOMY IN SOUTH AMERICA

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Abstract. Over the past four decades, global actualistic taphonomy studies have grown significantly, driven by increased interest in present-day patterns and processes of fossilization. South America has mirrored this trend, though the exact growth level is unclear. This study compiles actualistic taphonomy research in South America based on internationally accessible journal articles and book chapters using databases such as Web of Science, ResearchGate, Google Scholar, and Academia. Results revealed a steady rise in studies from 1985, with Argentina leading, followed by Brazil, Uruguay, and a few other countries with lesser representation. Terrestrial environments have seen the most extensive research, largely due to archaeologists and vertebrate paleontologists, with marine environments (mainly mollusk-based studies) following. Freshwater actualistic taphonomy began in 2006 and was the next most commonly represented, while estuarine and lagoonal environments were the least studied. Most research has been naturalistic: examining taphonomic patterns, taphofacies, live-dead fidelity, and time-averaging. However, experimental studies increased markedly after 2009. Synthesis papers appeared from 2007, reflecting the growing body of literature. Archaeological studies have been the most prolific, with vertebrate studies dominating the region's actualistic taphonomy literature, followed by research on mollusks and lithics. Brachiopods, foraminifera, diatom, pollen, and phytoliths have developed less. Several groups, including plants, arthropods, worms, lichens, charcoal, pottery, rock art paintings, and sediments, remained poorly studied, highlighting the need for further research. This review underscores the significant progress made in South American actualistic taphonomy but also points to underrepresented environments and taxonomic groups that should be addressed in future studies.

Key words. Naturalistic studies. Experimental studies. Multidisciplinary. Environmental diversity. Geographical distribution.

Resumen. EL CRECIMIENTO DE LA TAFONOMÍA ACTUALISTA EN SUDAMÉRICA. En las últimas cuatro décadas, los estudios de tafonomía actualista a nivel mundial aumentaron significativamente, impulsados por el creciente interés en los patrones y procesos modernos de fosilización. Sudamérica ha seguido esta tendencia, aunque el nivel exacto de crecimiento no está claro. Este estudio compila investigaciones de tafonomía actualista en Sudamérica, basadas en artículos de revistas y capítulos de libros accesibles internacionalmente, utilizando bases de datos como *Web of Science*, *ResearchGate*, *Google Scholar* y *Academia*. Los resultados revelaron un aumento constante en los estudios desde 1985, con Argentina a la cabeza, seguida por Brasil, Uruguay y algunos otros países con menor representación. Los ambientes terrestres recibieron la mayor cantidad de investigaciones, principalmente debido a arqueólogos y paleontólogos de vertebrados, seguidos por los ambientes marinos (mayormente moluscos). Los ambientes dulceacuícolas, que comenzaron a investigarse en 2006, fueron los siguientes más representados, mientras que los estuáricos fueron los menos estudiados. La mayoría fueron investigaciones naturalistas: patrones tafonómicos, tafofacies, fidelidad vivo-muerto y promediación temporal. Los estudios experimentales aumentaron notablemente desde 2009. Los artículos de síntesis surgieron en 2007, reflejando el creciente cuerpo de literatura. Los estudios arqueológicos fueron los más prolíficos, con los vertebrados dominando la literatura, seguidos por moluscos y líticos. Braquiópodos, foraminíferos, diatomeas, polen y fitolitos tuvieron menor desarrollo, y varios grupos, como plantas, artrópodos, gusanos, líquenes, carbones, cerámicas, pinturas rupestres y sedimentos, permanecen poco estudiados. Esta revisión subraya el progreso de la tafonomía actualista en Sudamérica y señala los ambientes y grupos taxonómicos subrepresentados que deberían abordarse en futuros estudios.

Palabras clave. Estudios naturalistas. Estudios experimentales. Multidisciplinario. Diversidad ambiental. Distribución geográfica.

Actualistic Taphonomy is a multidisciplinary field that studies present-day patterns and processes of decay and burial of organic material (for example, bones, shells, or soft tissues) for understanding the principles governing the fossilization, as well as the preservation of lithic tools, pottery, and other archaeological materials (Behrensmeyer *et al.*, 2018, Behrensmeyer, 2021; Borrero, 2020; Domínguez-Rodrigo *et al.*, 2011). By studying modern processes, the discipline gathers insights into interpreting historical data within the fossil record, allowing for more accurate reconstructions of past ecological and environmental conditions (Kowalewski & LaBarbera, 2004). Although the systematic development of actualistic taphonomy in South America began in the late 20th century, earlier examples of taphonomic thinking can be traced back to the 19th and early 20th centuries. Notably, Florentino Ameghino and Charles Darwin made observational remarks on fossilization processes that, although not framed within a formal taphonomic approach, anticipated later concepts (Pomi & Tonni, 2008; Borrero, 2009; Nahuel-Ruiz *et al.*, 2024). Over the past four decades, the field of actualistic taphonomy has achieved global acceptance, as evidenced by the substantial increase in scientific publications across a wide range of disciplines, including paleontology, archaeology, and forensic sciences (Behrensmeyer, 2021).

The research themes encompassed a wide range of subjects, including biostratinomy, comparative taphonomy, taphofacies, live-dead fidelity, methodological biases, timeaveraging, and conservation paleobiology, among others (Kowalewski & LaBarbera, 2004; Assumpção & Ritter, 2025). The approaches employed can be categorized as naturalistic or experimental in origin, as defined by Marean (1995). In the former, researchers used observations from natural patterns to establish relations between taphonomic agents and their effects on the material (Alunni & Álvarez, 2017). The experimental approaches performed have been field-based, entailing the exposure of remains to a natural environment and the assessment of preservation modes, or laboratory-based, involving procedures conducted within a controlled laboratory setting (Parsons-Hubbard *et al.*, 2011).

The preponderance of actualistic taphonomy studies has been centered in the Northern Hemisphere, with a pronounced emphasis on mollusks and a predominant focus on marine and estuarine environments (*i.e.*, edited volumes by Kidwell & LaBarbera, 1993; Kowalewski & LaBarbera, 2004; Kowalewski & Rothfus, 2012). Conversely, South America is scarcely represented, despite its unparalleled environmental diversity and substantial paleontological and archaeological heritage (Ritter *et al.*, 2016). This discrepancy not only curtails our understanding of taphonomic processes in the Southern Hemisphere but also perpetuates a bias in formulating universal models, underscoring the pressing need to augment research endeavors in this region. Recent years have seen an uptick in actualistic taphonomy studies in South America, as evidenced by the publication of several synthesis works and thematic volumes (*e.g.*, Ritter *et al.*, 2016, 2023a; Alunni & Álvarez, 2017; Gutiérrez *et al.*, 2018; Mondini, 2018; Montalvo & Fernández, 2019; Martínez *et al.*, 2020). However, the question remains whether this signifies a transient phenomenon or a more extensive regional augmentation in research activity. To test this hypothesis, we reviewed actualistic taphonomy studies conducted in South America from their inception to the present.

MATERIALS AND METHODS

A comprehensive search of relevant international databases, including Web of Science, ResearchGate, Google Scholar, and Academia, was conducted to identify publications on actualistic taphonomy conducted in South America. These platforms were selected for their broad coverage of peer-reviewed articles, grey literature, and regionally relevant publications in paleontology, archaeology, and related disciplines. Although other databases contain valuable regional content, preliminary searches indicated that the most relevant studies indexed in these databases were also retrievable through our selected platforms. Nevertheless, we acknowledge that this selection may introduce a degree of publication bias. The compilation covered articles published in peer-reviewed scientific journals and book chapters with international reach. It is important to note that this study did not consider conference proceedings, abstracts, and theses.

The present study exclusively incorporates investigations that concentrate on actualistic taphonomy.

Taphonomic studies solely conducted on fossil (non-modern) successions were excluded, except when the study also included an actualistic sampling component. The main keywords used in the database searches contained 'taphonomy', 'actualism', 'taphonomic experiment', 'naturalistic', 'live-dead fidelity', 'time-averaging', 'taphofacies', and related terms in English, Spanish, and Portuguese. After retrieving the initial results, we thoroughly screened each article to confirm its relevance to original actualistic taphonomic research. We excluded studies that merely applied previously published actualistic data without contributing new observations, experiments, or syntheses, ensuring that our dataset reflected novel contributions to the field. However, this search strategy may limit the inclusion of studies that, although methodologically aligned with actualistic taphonomy, do not explicitly identify themselves using this terminology. As a result, certain areas—such as neoichnology or forensic sciences—may be underrepresented in our database despite addressing taphonomic processes through empirical and experimental approaches consistent with actualistic frameworks.

For each publication, the following data were collected: (a) publication year (up to 2023), (b) language (English, Spanish, or Portuguese), (c) journal (or publisher for books), (d) country of the study, (e) environment (marine, estuarine/lagoonal, freshwater, or terrestrial), (f) indicators analyzed (*e.g.*, mollusks, vertebrates, pollen, lithics), (g) study type (naturalistic, experimental, synthesis, theoretical, or methodological), (h) study focus (paleontological, archaeological, or forensic), and (i) geographic location of the sampled sites (only studies classified as naturalistic or field-based experimental were considered here). In the case of laboratory-based studies conducted within the study region, the coordinates of the city where the research was performed were also included.

RESULTS

A total of 310 articles were identified (see Suppl. Inf. 1). Of them, 234 (75.5%) came from Argentina, 56 (18.1%) from Brazil, 9 (2.9%) from Uruguay, and 7 (2.3%) from Chile. The remaining articles (1.3%) corresponded to French Guiana, Peru, Bolivia, and Colombia. The results revealed an increase in actualistic taphonomy studies in South America from 1985 (the earliest record in our database) to the present. Argentina led this trend, followed by Brazil (which started in 1995) and Uruguay (Fig. 1). The remaining countries only had sporadic records. Most studies were conducted in the Southern Cone, particularly in Argentina, with the majority focused within the province of Buenos Aires (Fig. 2).

Terrestrial environments have seen the most extensive research (70.8%), mainly due to contributions from archaeologists and vertebrate paleontologists, with marine environments following (16.2%). Freshwater actualistic taphonomy, which began in 2006, was the next most represented (8.4%), while estuarine and lagoonal environments were the least studied (Fig. 3). Studies on terrestrial environments were mostly situated in the Southern Cone, especially in Argentina (Fig. 4). Both marine and estuarine/lagoonal environments were mainly located on the Atlantic coast, while freshwater environments had disjunct distributions, with studies conducted in Brazil, Bolivia, and the Pampas of Argentina (Fig. 4).

Most research (68.4%) has been naturalistic, mainly focusing on taphonomic patterns observed in the field, taphofacies, live-dead fidelity, and time averaging. Experimental studies (24.4%) began in 1991 and significantly increased after 2009. By 2007, synthesis works (4.7%) started to emerge, likely driven by the substantial accumulation of data. More recently, since 2016, general theoretical (1.2%) and methodological studies (1.2%) have also been published (Fig. 5).

Among naturalistic studies, those with archaeological objectives were the most developed in South America, playing a pioneering role in the discipline. In contrast, studies with a paleontological focus have experienced rapid growth since 2015 (Fig. 6). Geographically, naturalistic studies with archaeological objectives have been more prevalent in continental regions of Argentina. In contrast, those with paleontological objectives have been more commonly conducted in coastal areas (Fig. 7).

Vertebrates dominated the literature (54.9%), with mollusks ranking second (16.9%). Lithics were the third most represented indicator (8.1%). Foraminifera, brachiopods, pollen, diatoms, and phytoliths collectively accounted for a smaller proportion (14.1%). Many indicators, including plants, arthropods, lichens, worms, sediments, echinoderms,

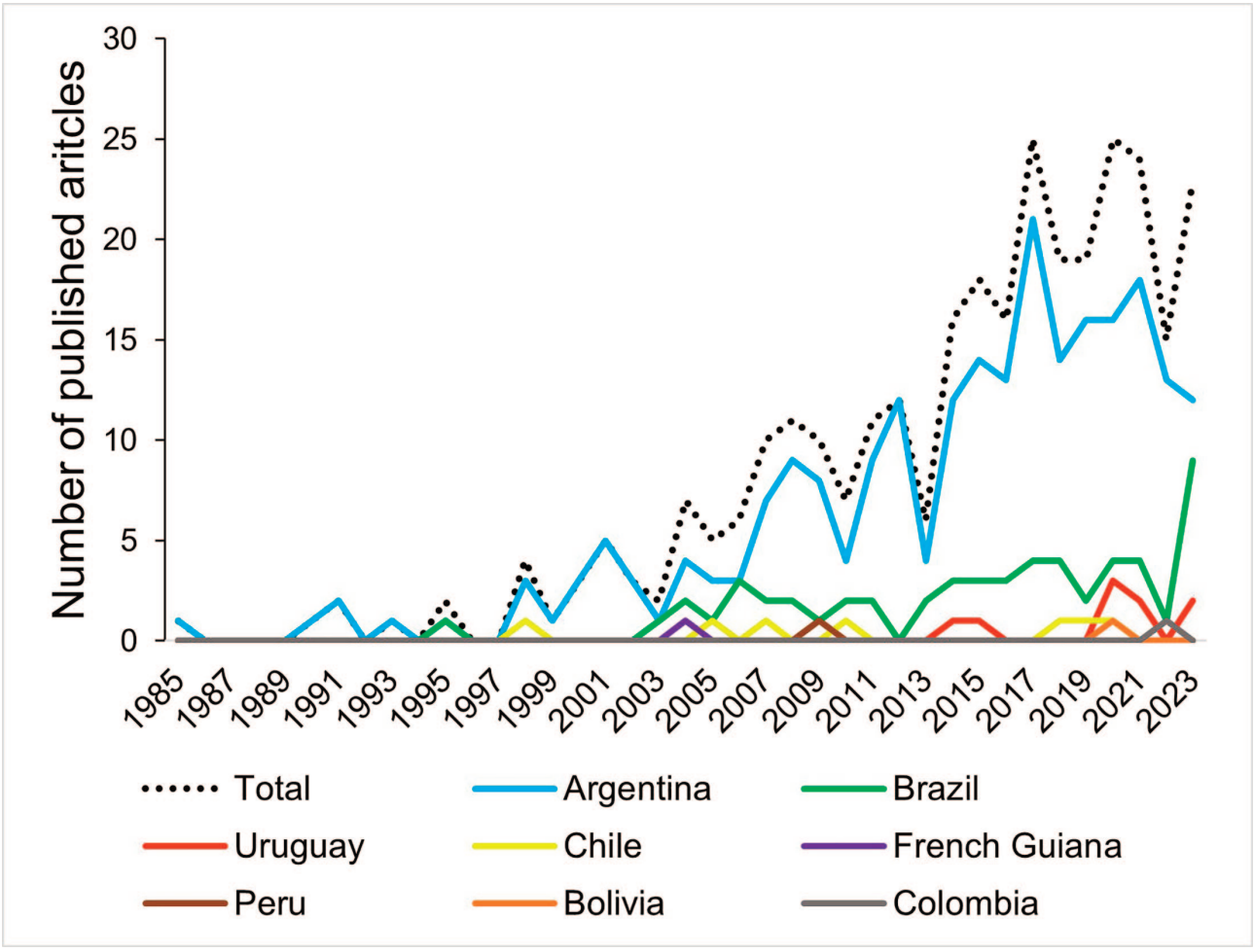

Figure 1. Number of actualistic taphonomy studies published per year from 1985 to 2023, shown by country.

charcoal, pottery, and rock art paintings, remained poorly studied (accounting for 5.9% when considered collectively) (Fig. 8). When examining the geographical distribution of the studies conducted (Fig. 9), it is noteworthy that most indicators have been predominantly studied in Argentina, generally with good regional coverage, except for the less-represented groups. The two dominant indicators (vertebrates and mollusks) showed a differential distribution pattern, with vertebrates mainly represented in terrestrial environments and mollusks in marine environments (Fig. 9). There were a few indicators that showed highly restricted localizations, such as diatoms in the Buenos Aires Province (Argentina) or brachiopods in Ubatuba Bay (Brazil). Others, such as pollen and phytoliths, showed disjunct distributions, with studies concentrated in some regions of Brazil and Argentina.

The dissemination of actualistic taphonomy research in South America has spanned 92 journals (Fig. 10) and 28 book chapters. Among them, *Palaios* stands out as the journal with the highest number of published studies (8.2%), followed by *Quaternary International* (6.4%) and the archaeological journal *Intersecciones en Antropología* (5.0%). Notably, 72.2% of South American actualistic taphonomy papers published in *Quaternary International* correspond to archaeological research (Suppl. Inf. 1). Indeed, a higher percentage (40.5%) of the total articles surveyed have been published in archaeological journals (*i.e.*, *Journal of Archaeological Science*, *Archaeofauna*, *Archaeological, and Anthropological Sciences*, among others). Regarding language, most publications (69.7%) were written in English, followed by 29.7% in Spanish, and only 0.6% in Portuguese (Suppl. Inf. 1).

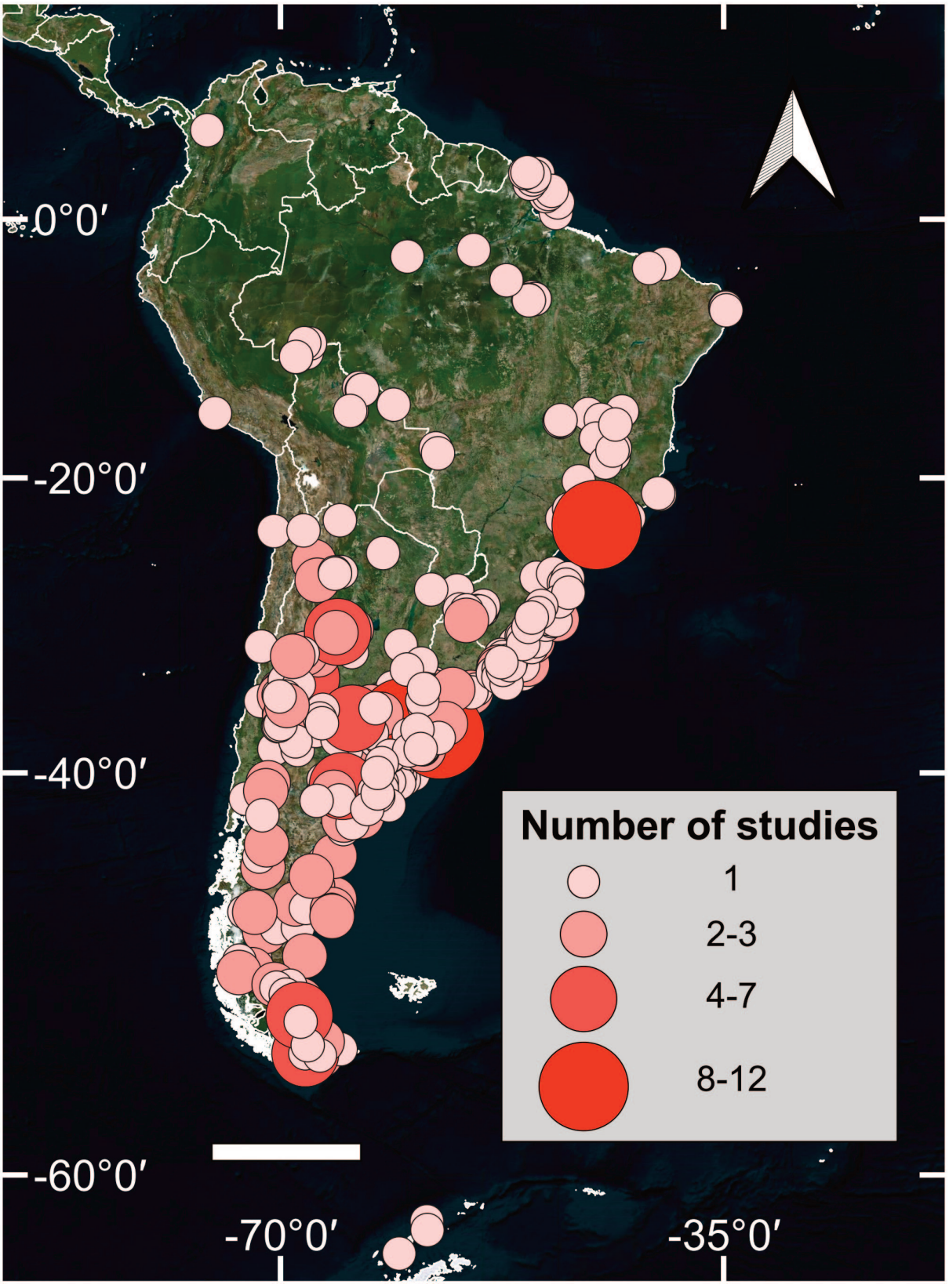

Figure 2. Map of South America showing the frequency of actualistic taphonomy studies conducted in different areas. Scale bar= 1000 km. (Satellite image Bing, QGIS, accessed July 2025).

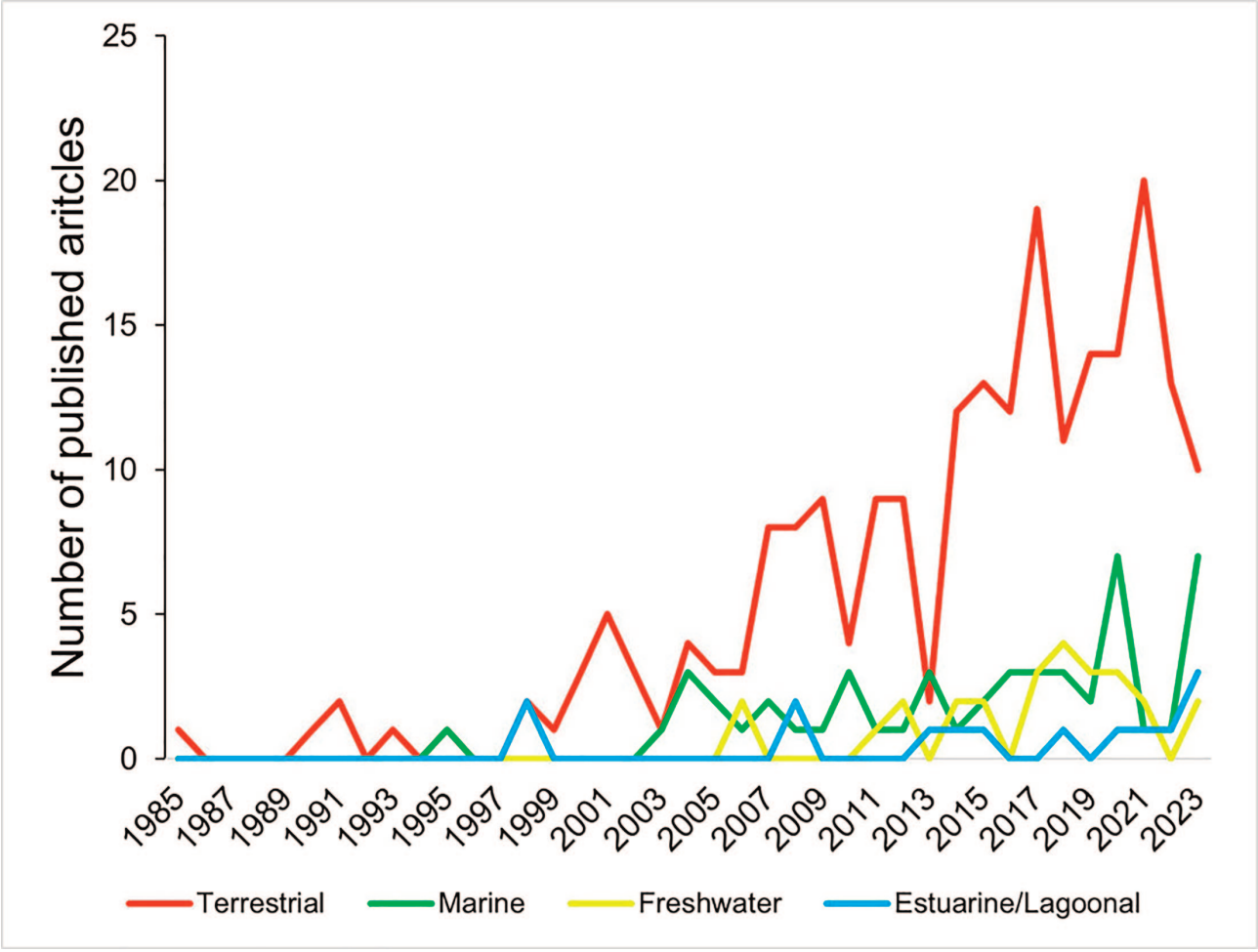

Figure 3. Number of actualistic taphonomy studies published per year from 1985 to 2023, categorized by environment type (marine, estuarine/lagoonal, freshwater, terrestrial).

DISCUSSION

Our results revealed a steady increase in actualistic taphonomy studies in South America from 1985, with Argentina leading this trend, followed by Brazil and Uruguay. However, this might be attributed to a stronger archaeological and paleontological tradition in these countries, although alternative explanations, such as more opportunities for funding availability or institutional support, cannot be ruled out. Argentina's prominence in these studies could be linked to several factors, such as the country's primary development of a strong academic archaeology, the theoretical influence of North American archaeology, abundant research in hunter-gatherer archaeology, and the early growth of zooarchaeology. In fact, the first actualistic taphonomy article in our database was a study aimed at addressing an archaeological question involving a two-year monitoring of guanaco skeletons in Tierra del Fuego, Patagonia, Argentina (Borrero, 1985). Since then, actualistic taphonomy studies rapidly expanded to mammalian carnivores, mostly in southwestern Patagonia and, to a lesser extent, southern Puna (Mondini & Muñoz, 2008). In the Pampas region, studies began later, towards the late 1990s and early 2000s (Gutiérrez *et al.*, 2018). In Brazil, unlike in Argentina, the rise of actualistic taphonomy began in 2003 with studies conducted in marginal marine environments, primarily focusing on subtidal accumulations of terebratulid brachiopods and, more recently, on mollusks. These studies played a key role in establishing the field and provided valuable insights into taphonomic processes in these settings (Simões *et al.*, 2009), especially concerning time-averaging estimates

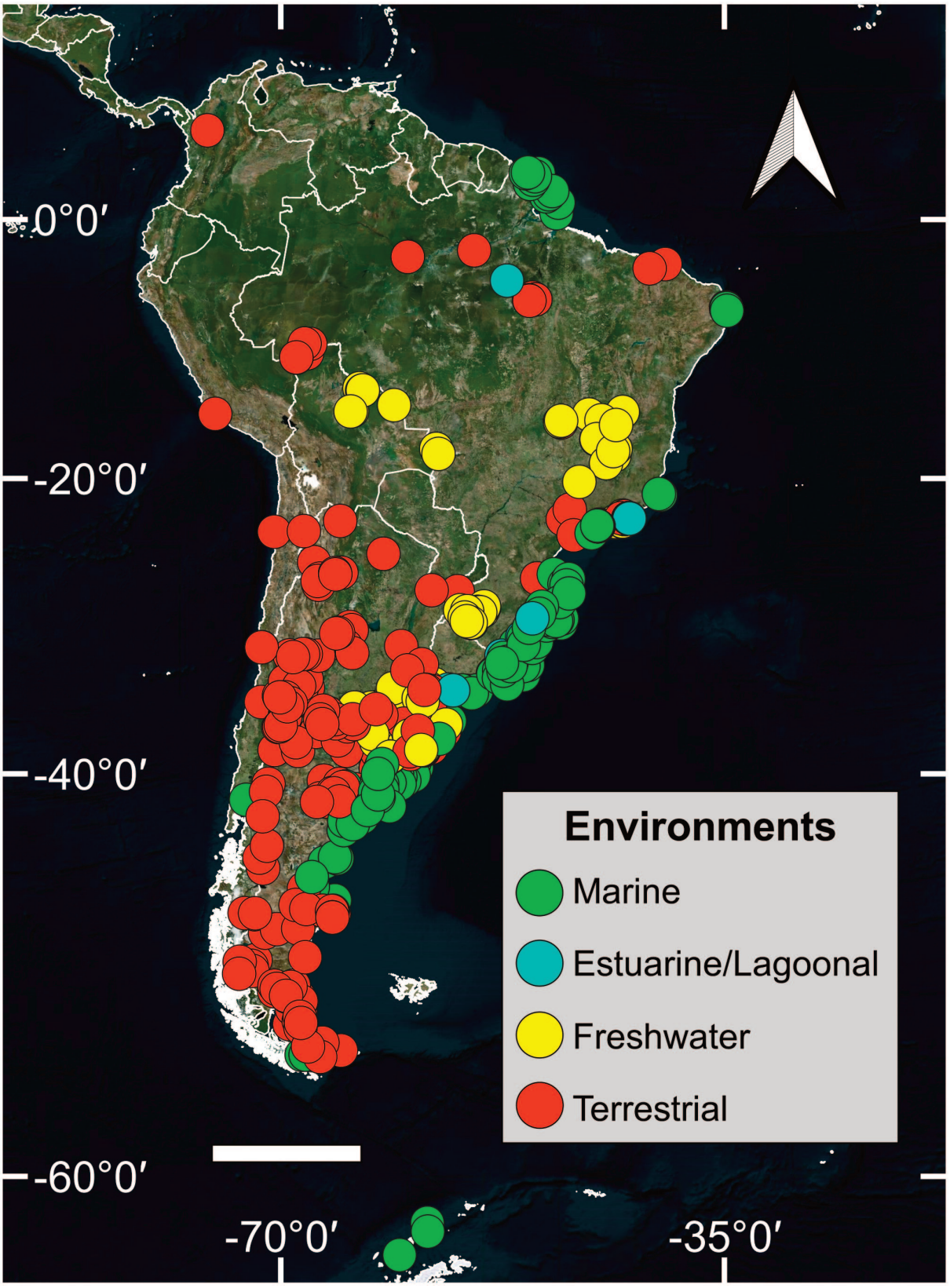

Figure 4. Map of South America showing the locations of all actualistic taphonomy study sites, differentiated by environment type (marine, estuarine/lagoonal, freshwater, terrestrial). Scale bar= 1000 km. (Satellite image Bing, QGIS, accessed July 2025).

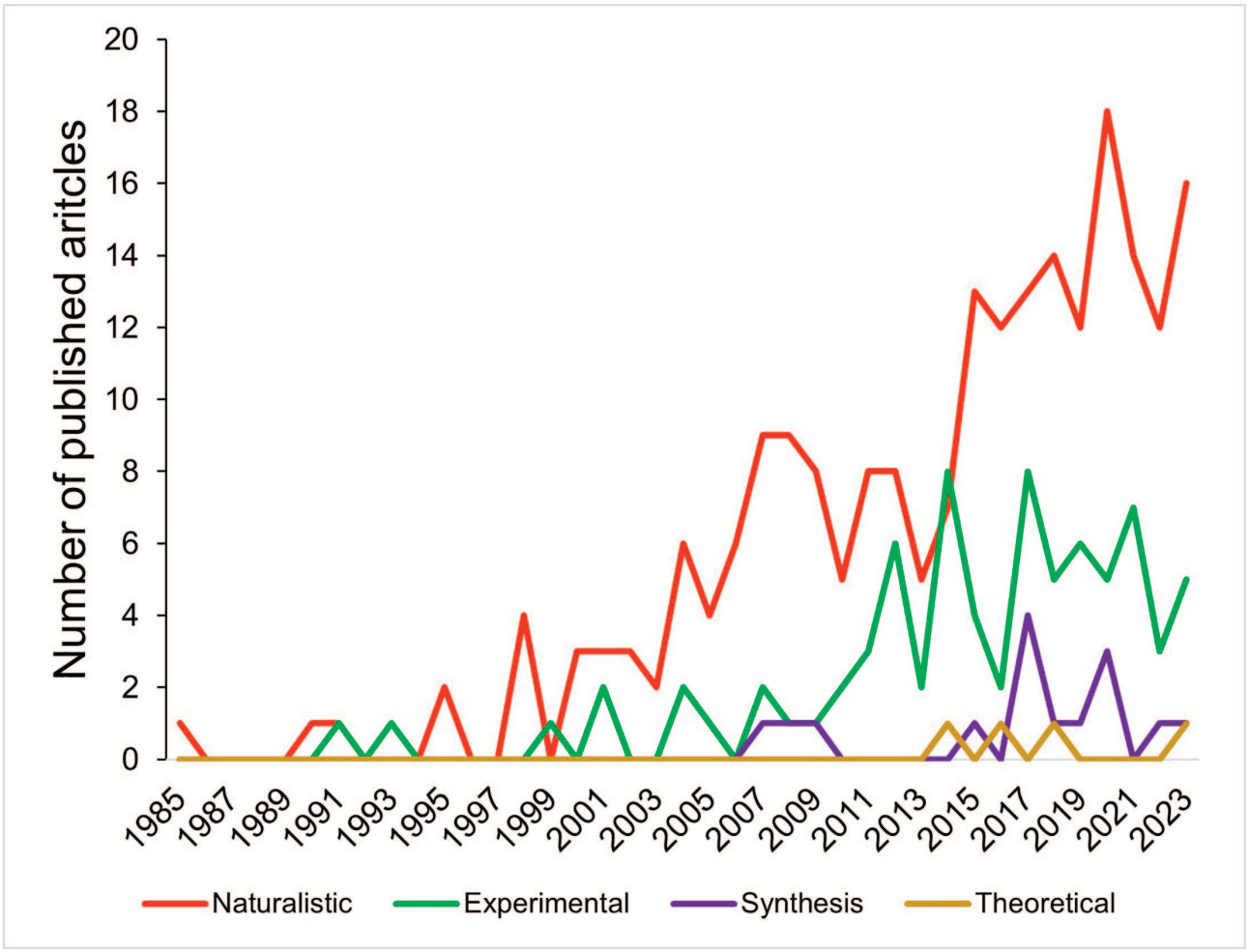

Figure 5. Number of actualistic taphonomy studies published per year from 1985 to 2023, categorized by study type (naturalistic, experimental, synthesis, theoretical).

(*e.g.*, Carrol *et al.*, 2003; Dexter *et al.*, 2014; Ritter *et al.*, 2017, 2023b; Krause *et al.*, 2010; see Suppl. Inf. 1 for a complete list). The first studies conducted in Uruguay were related to archaeological shell middens, aiming to identify differences between natural and anthropogenic mollusk accumulations (*e.g.*, Beovide & Martínez, 2014). Over time, actualistic taphonomy studies began to develop with paleontological objectives, primarily focusing on marine mollusks (Rojas & Martínez, 2020). This disciplinary divide highlights a significant bias in South American actualistic taphonomy: archaeological studies have primarily focused on terrestrial environments and vertebrates, whereas paleontological research has largely been restricted to marine mollusks. Bias in archaeological research primarily results from disciplinary scope, as it focuses on the sphere of human activity and the materials represented in the archaeological record. This specialization limits a broader understanding of taphonomic processes across diverse settings.

Environments. The dominance of terrestrial environments in actualistic taphonomic research (70.8%) is primarily driven by the contributions of archaeologists and vertebrate paleontologists. This strong focus likely reflects both the accessibility of terrestrial sites and a historical emphasis on understanding fossilization processes in vertebrate remains and archaeological contexts. However, this bias constrains insights into taphonomic dynamics in other environments. Despite their extensive fossil record, marine settings account for only 16.2% of studies, with estuarine and lagoonal environments even less represented. Logistical challenges in conducting long-term coastal observations

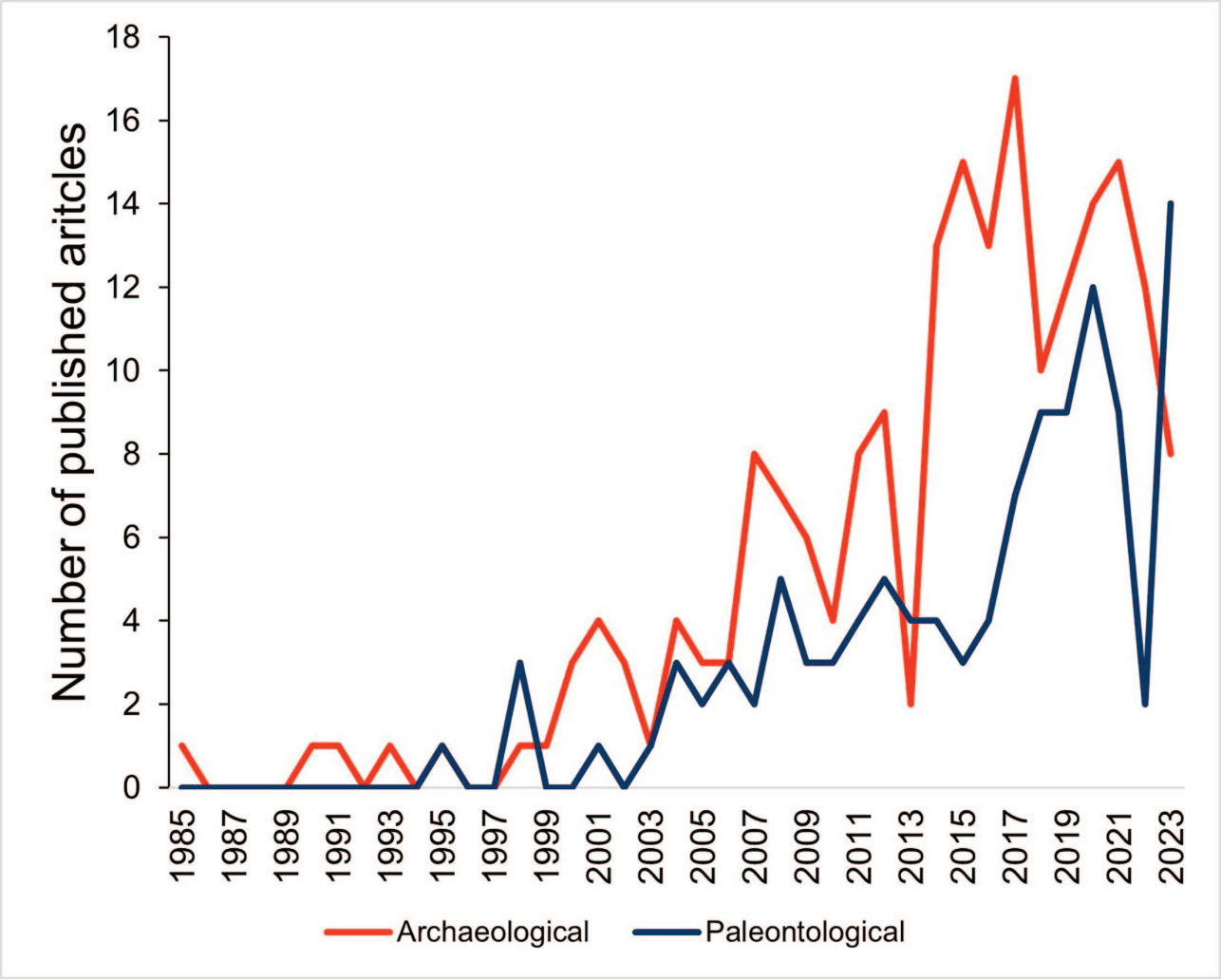

Figure 6. Number of actualistic taphonomy studies published per year from 1985 to 2023, categorized by research objective (archaeological or paleontological).

may contribute to this imbalance. Since 2006, freshwater actualistic taphonomy has gained traction (8.4%), indicating a growing interest in depositional and post-mortem processes in riverine and lacustrine systems (*e.g.*, Erthal *et al.*, 2011; De Francesco *et al.*, 2020; Hassan *et al.*, 2020; see Suppl. Inf. 1 for a complete list), though its representation remains low compared to terrestrial studies. Moreover, geographic disparities exist, with marine and estuarine studies concentrated along the Atlantic coast. Meanwhile, actualistic taphonomy along the Pacific, especially in Chile, has developed differently, underscoring the need for expanded research in underrepresented coastal regions. The geological difference between the relatively stable Atlantic coast and Chile's tectonically active Pacific coast may have shaped the divergent development of actualistic taphonomy in these regions.

Study type and disciplinary focus. The predominance of field-based naturalistic research (68.4%) reflects the discipline's foundational emphasis on observing taphonomic processes *in situ*. Studies on taphonomic patterns, taphofacies, live-dead fidelity, and time-averaging have been pivotal. Experimental studies, initiated in 1991, increased markedly after 2009, likely due to technological advancements and interdisciplinary collaborations enabling more refined methodologies. The emergence of synthesis studies in 2007 suggests a maturation of the field, where comprehensive reviews and meta-analyses became possible. These studies likely played a crucial role in integrating diverse

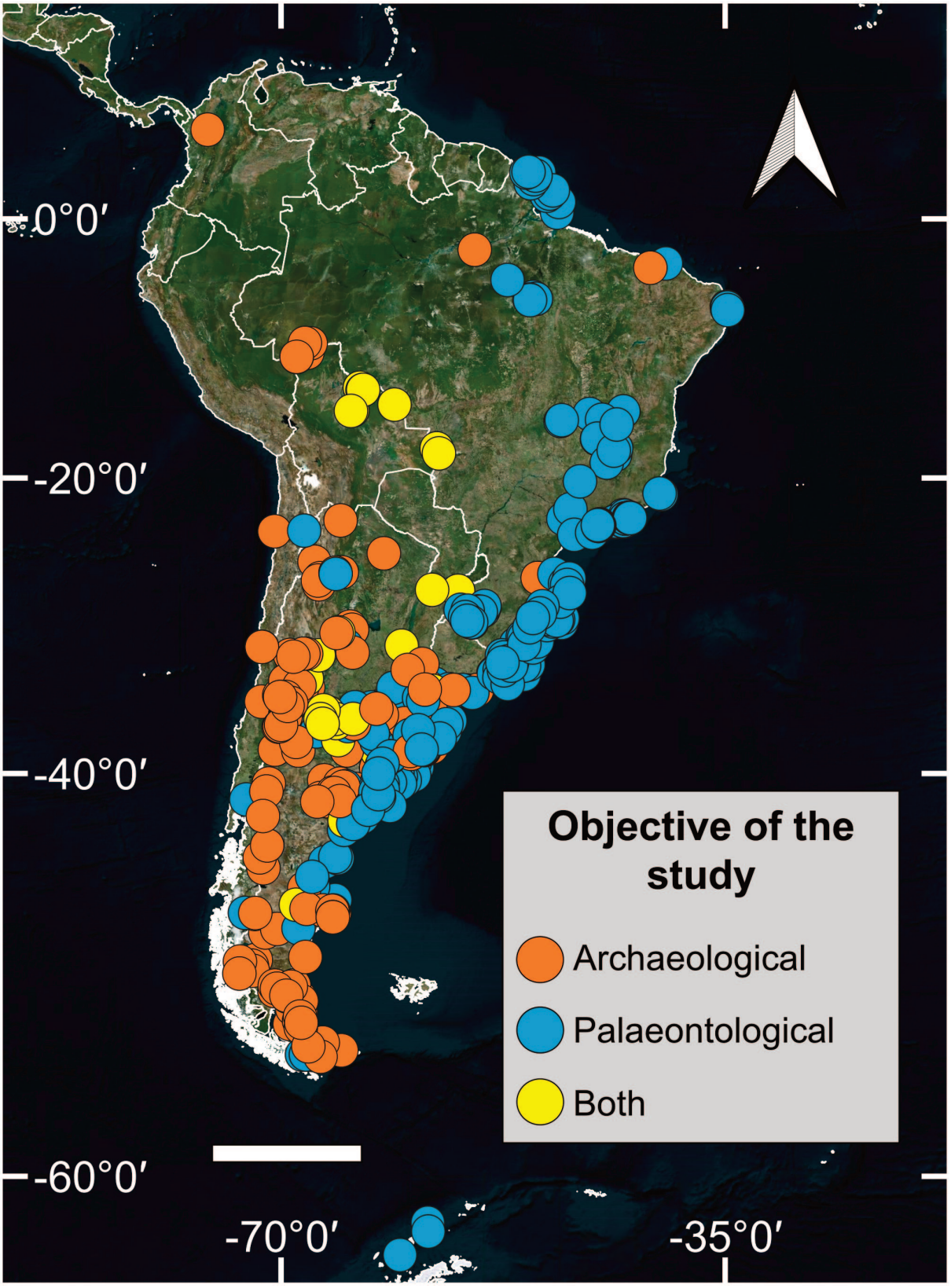

Figure 7. Map of South America showing the locations of all actualistic taphonomy study sites, differentiated by research objective (archaeological or paleontological). Scale bar= 1000 km. (Satellite image Bing, QGIS, accessed July 2025).

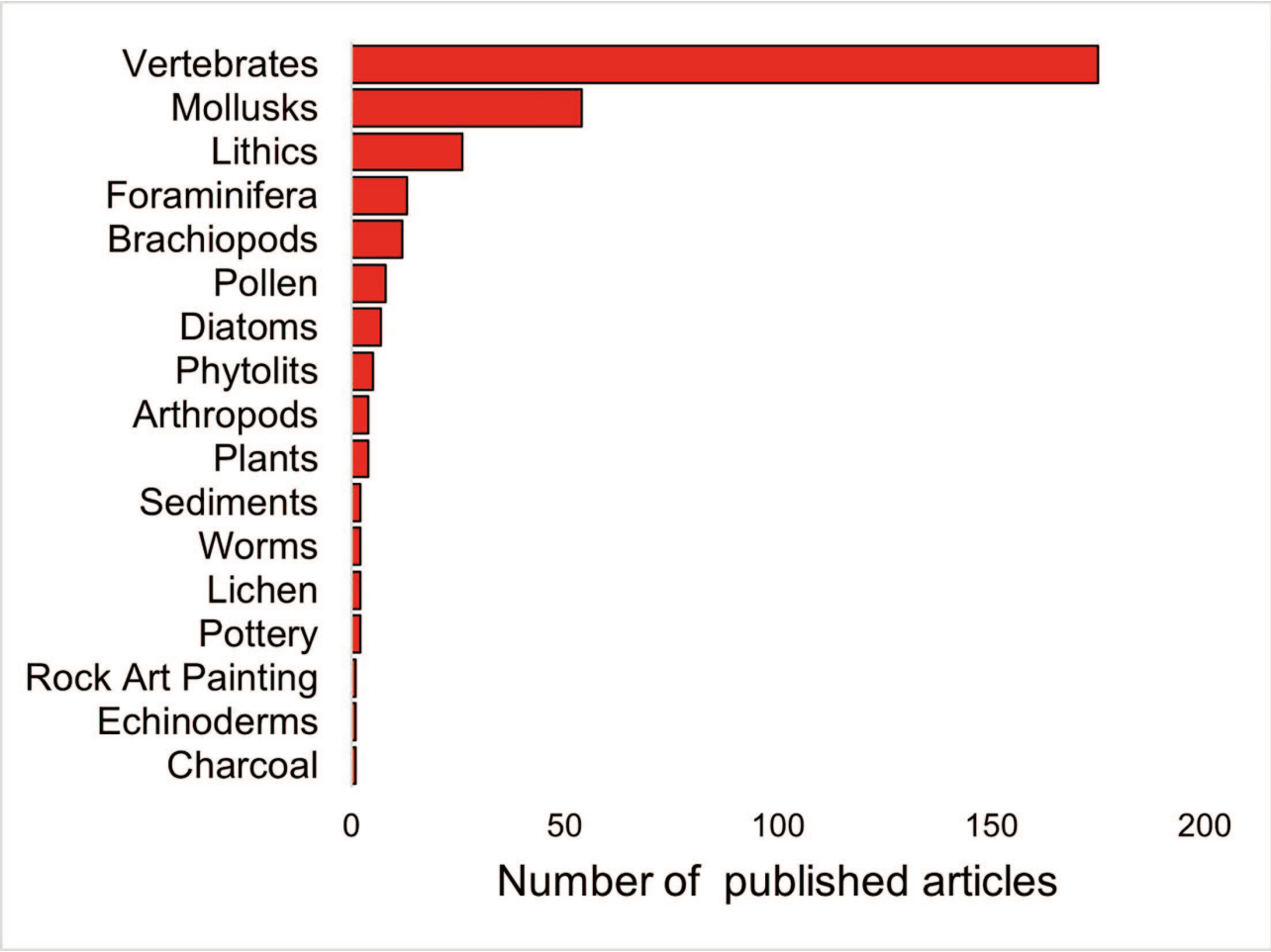

Figure 8. Total number of actualistic taphonomy studies published for each type of taphonomic indicator.

lines of evidence, identifying research gaps, and setting new directions for actualistic taphonomy. The rise of theoretical studies since 2016 indicates a conceptual shift, emphasizing broader frameworks for interpreting taphonomic data.

Archaeological applications have played a pioneering role in shaping South American actualistic taphonomy. Taphonomic analyses have been crucial in distinguishing natural from anthropogenic accumulation processes, improving the explanations of the patterns exhibited by the archaeological record, and reinforcing the field's deep integration with archaeology. In contrast, paleontological applications grew rapidly after 2015, reflecting an increasing interest in applying taphonomic principles to the fossil record. This shift likely results from new research questions, methodological advancements, and a growing recognition of taphonomy's relevance in paleoecology and evolutionary studies.

Taphonomic indicators. Vertebrates dominate actualistic taphonomic studies due to their central role in archaeology and paleontology. The extensive vertebrate fossil record and its significance in reconstructing past environments and human-animal interactions reinforce its prominence. Similarly, the significant presence of lithics underscores the relevance of stone artifact taphonomy in archaeological research, where identifying natural and anthropogenic modifications is essential (Borrazzo, 2016). Mollusks, primarily from marine contexts, rank second, highlighting their importance in studies of shell accumulations, live-dead fidelity, and environmental reconstructions. While vertebrates and mollusks are well represented, other indicators, such as foraminifera, brachiopods, pollen, diatoms, and phytoliths, remain understudied. Even less

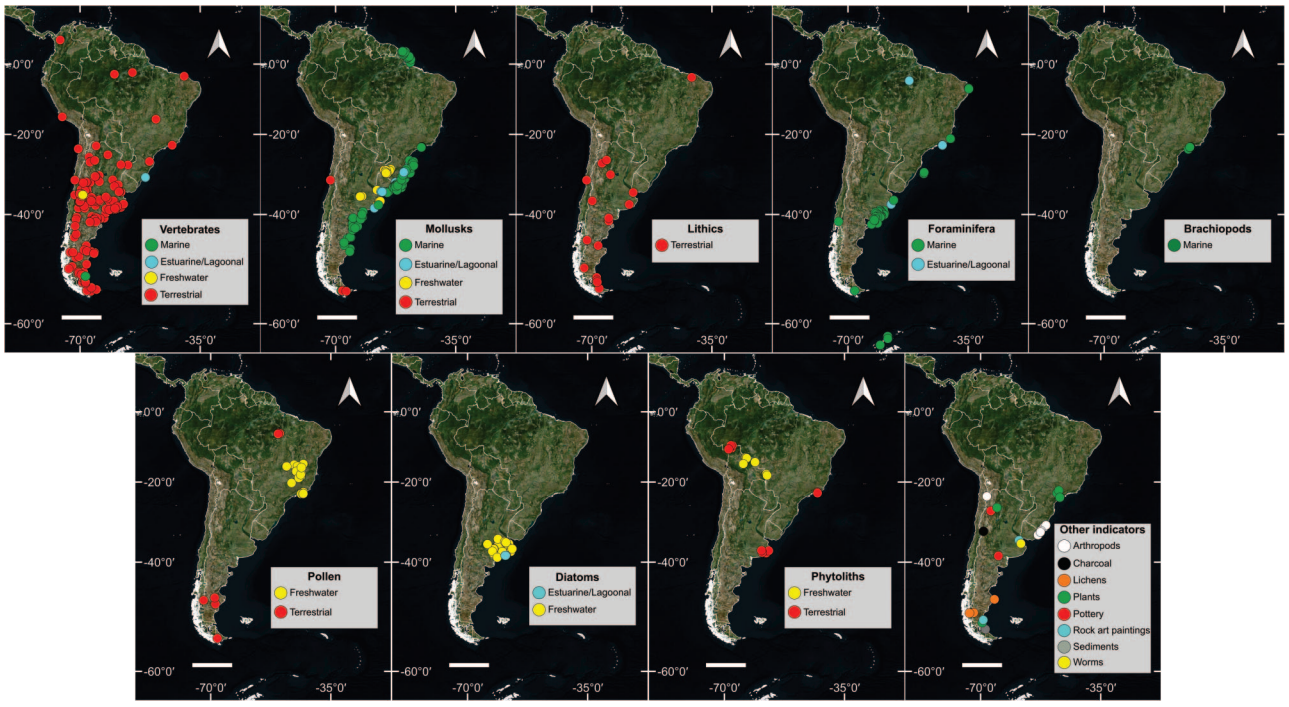

Figure 9. Composite map of South America showing the geographical distribution of each taphonomic indicator. Each panel displays the sites where a given indicator was studied, differentiated by environment type (marine, estuarine, freshwater, terrestrial). Scale bar= 1000 km. (Satellite image Bing, QGIS, accessed July 2025).

explored are plants, arthropods, lichens, worms, sediments, echinoderms, charcoal, pottery, and rock art paintings. These indicators are critical for paleoenvironmental reconstructions, human land use studies, and refining chronological frameworks. Yet, their limited representation suggests that actualistic taphonomy has not fully incorporated a broader range of materials, potentially overlooking key processes affecting different substrates.

Publications. The interdisciplinary nature of South American actualistic taphonomy is evident in its dissemination across 92 journals. The prominence of *Palaios* as the leading publication venue underscores its historical role in shaping taphonomic research, particularly in moving beyond Efremov's (1940) initial framework, which focused on fossil record incompleteness, toward recognizing taphonomic signatures as paleoenvironmental tools (Parsons-Hubbard *et al.*, 2011). *Palaios* was established in 1986, which not only coincides with the emergence of actualistic taphonomy in South America but also suggests that the continent was actively engaging with the broader global movement in this field. The presence of *Quaternary International* as the second most common outlet highlights the relevance of actualistic taphonomy in Quaternary studies, particularly in understanding recent paleoenvironmental changes. Similarly, the significant representation of *Intersecciones en Antropología* reinforces the strong connection between taphonomic research and archaeology in Argentina. Notably, 40.5% of articles are published in archaeological journals, underscoring the discipline's integration with archaeology, particularly in identifying the imprint of natural and anthropogenic processes on the archaeological record. However, the lower representation of taphonomic research in strict paleontological journals suggests that, despite its importance, actualistic taphonomy remains underutilized in mainstream paleontological discourse. Greater incorporation of taphonomic principles into fossil assemblage studies, stratigraphic interpretations, and evolutionary analyses could help bridge this gap and foster a more holistic understanding of past environments. The predominance of English as the publication language (69.7%) further reflects a strong orientation toward international visibility and scholarly integration beyond regional boundaries.

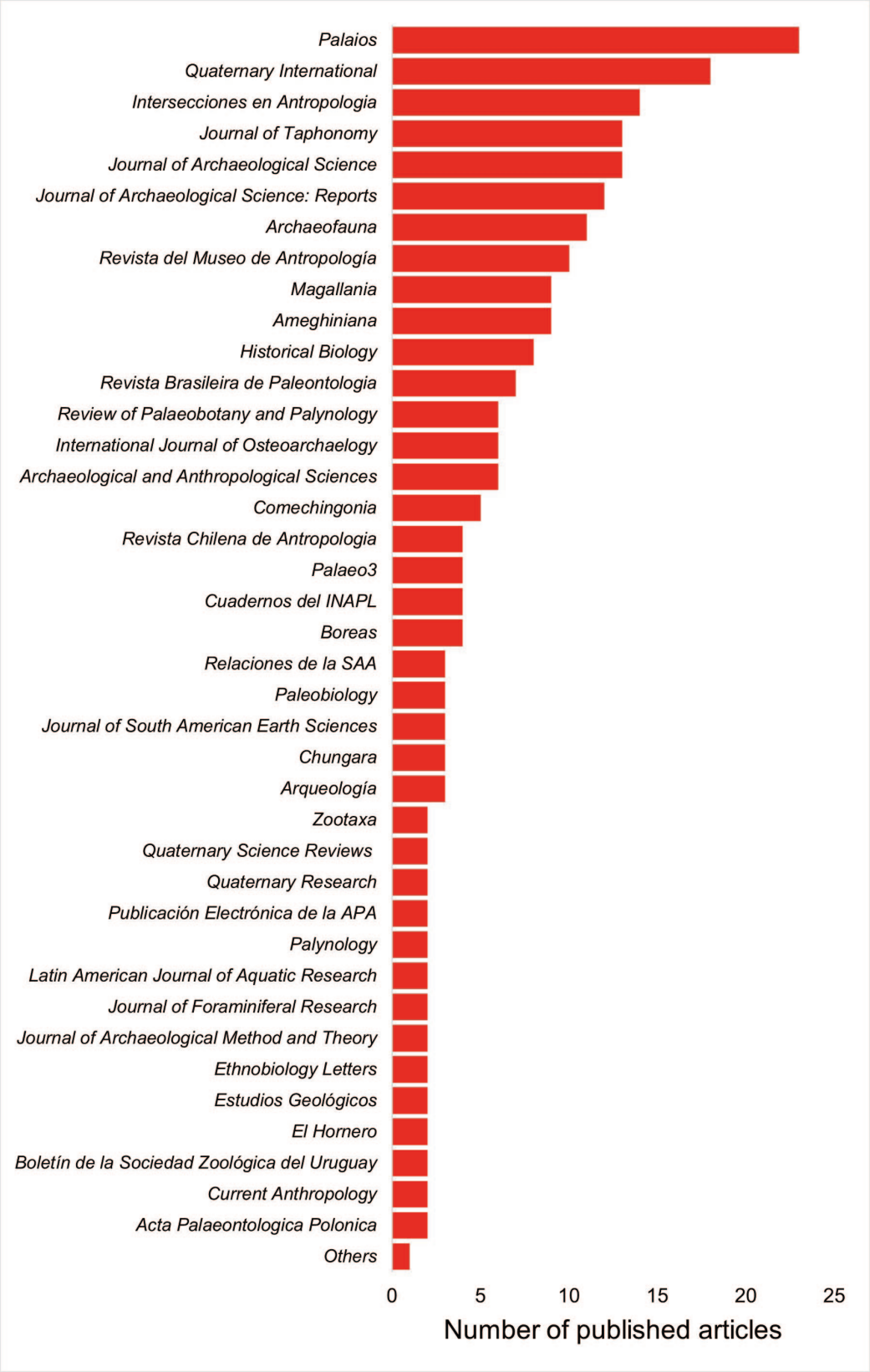

Figure 10. Total number of actualistic taphonomy studies published in each scientific journal.

Limitations and future directions. While this review provides a comprehensive overview of actualistic taphonomy in South America, several methodological and structural limitations must be acknowledged. First, the predominance of publications in English (69.7%), followed by Spanish (29.7%) and Portuguese (0.6%), reflects a language bias that may hinder the visibility and accessibility of research conducted locally. The dominance of English-language journals can create barriers for researchers aiming to publish in their native languages (for a discussion of this idea, see Bortolus, 2012), especially given the limited number of indexed journals in the region specializing in taphonomic or actualistic studies.

Another limitation stems from the dependence on keyword-based searches. Several potentially relevant studies, particularly those dealing with actualistic neoichnology or experimental observations of preservation processes, may not have identified themselves explicitly as "actualistic taphonomy" and were thus not retrieved. This highlights a broader disciplinary challenge: the field remains loosely defined in some contexts, and many researchers conducting relevant work may not use standardized terminology, limiting both discoverability and synthesis efforts.

Regarding publication venues, the concentration of papers in a few key journals—*Palaios*, *Quaternary International*, and *Intersecciones en Antropología*—reveals a narrow publishing landscape. Notably, few papers appear in mainstream paleontological journals, suggesting that actualistic taphonomy is still underrepresented in core paleontological discourse.

Geographically, the field is dominated by contributions from Argentina and Brazil, pointing to regional disparities in infrastructure, research funding, and academic traditions. Studies are often disconnected, with limited continuity or integration across research teams, which hinders the development of sustained, programmatic research lines. Future efforts should focus on strengthening regional collaborations, standardizing terminology, encouraging the inclusion of actualistic taphonomy in a broader array of journals, and expanding the scope of the discipline to include underrepresented areas such as plant taphonomy and neoichnology. Addressing these limitations will enhance the field's cohesion, visibility, and scientific impact.

CONCLUSION

Considering the patterns identified, we advocate for a coordinated regional agenda to strengthen actualistic taphonomy in South America. This should include the systematic exploration of underrepresented environments (such as estuarine, lagoonal, and tropical systems), the incorporation of neglected taxonomic groups (*e.g.*, plants, arthropods, and microbial communities), and the integration of experimental approaches across diverse ecological contexts. Expanding interdisciplinary collaborations, particularly between archaeology, paleontology, ecology, and conservation sciences, will be key to consolidating the field. Furthermore, establishing open-access databases and long-term monitoring programs can foster comparative studies and meta-analyses, enabling broader insights into taphonomic processes and their paleoenvironmental significance. In this regard, South America has the potential to not only fill global knowledge gaps but also to contribute conceptually to developing a more inclusive and ecologically grounded taphonomy.

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