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FAILPOLLEN: A global repository for negative results in palaeopalynology☆

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ABSTRACT

Non-productive pollen analyses are a routine outcome of palaeopalynological research. Most, however, never become part of the formal scientific record. As a result, valuable information on archive suitability, pollen preservation, and the practical limitations of the pollen proxy is frequently lost, leaving an incomplete representation of the empirical experience accumulated by the discipline. Here we present FAILPOLLEN, a community initiative designed to document, preserve, and disseminate non-productive and non-interpretable pollen records. The repository provides a standardized workflow for data submission, editorial curation, and public access, together with the contextual metadata required to understand why pollen analyses failed. This work aims to encourage the palaeopalynological community to contribute non-productive datasets, thereby expanding the collective evidence base available for future research. FAILPOLLEN is designed as an open, FAIR-compliant resource: all records are freely accessible and released under a CC-BY 4.0 license to maximize reuse and interoperability with existing pollen databases.

1. Introduction

The published palaeopalynological record is dominated by successful pollen sequences. Yet a substantial proportion of field and laboratory effort produces samples that are sterile, contain pollen in concentrations too low for robust statistical treatment, or preserve assemblages too poorly to support reliable palaeoenvironmental interpretation. These outcomes are a routine component of palaeopalynological research and reflect the inherent variability in the capacity of natural and archaeological archives to preserve pollen under different environmental and taphonomic conditions (Bryant and Holloway, 1983; Dimbleby, 1985; Faegri et al., 1989; Moore et al., 1991; Campbell, 1999; Carrión et al., 1999, 2009).

Most non-productive palynological studies, however, never become part of the formal scientific record in a visible, standardized, and reusable form. Instead, they remain scattered among field notebooks, laboratory records, internal reports, or simply in the memories of researchers. The published literature therefore provides an incomplete picture of pollen recoverability and archive suitability, even though pollen preservation has long been recognized as a fundamental factor controlling the quality of palaeoenvironmental reconstruction and neglecting it may itself bias palaeoecological interpretation (Carrión et al., 2009; Zhang et al., 2017).

Although the mechanisms responsible for pollen sterility vary among archive types, they are generally associated with taphonomic processes that affect pollen preservation before, during, or after deposition (Fig. 1). A synthesis of non-productive palaeopalynological records from the Iberian Peninsula showed that unsuccessful pollen recovery is most frequently linked to oxidation, repeated wetting and drying cycles, sediment reworking, high-energy depositional environments, salinity, diagenetic alteration, and, in some cases, anthropogenic disturbance of deposits (Carrión et al., 2009).

These processes act with different intensity depending on the nature of the archive and its depositional history, but oxidation consistently

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emerged as the most recurrent factor associated with pollen destruction (Fig. 1). Lakes and peatlands commonly lose pollen through oxidation, water-level fluctuations, sediment dilution, or salinity-related processes, whereas caves and archaeological deposits are more frequently affected by complex post-depositional alteration, including bioturbation, mineral precipitation, and diagenesis. In coprolites, digestive processes and fossilization may provide additional mechanisms of pollen degradation (Fig. 1). Consequently, non-productive pollen records rarely represent random analytical failures; rather, they reflect the interaction between depositional environments, taphonomic history, and sampling conditions. Recognizing these mechanisms is therefore essential for interpreting unsuccessful pollen analyses and underpins the rationale for

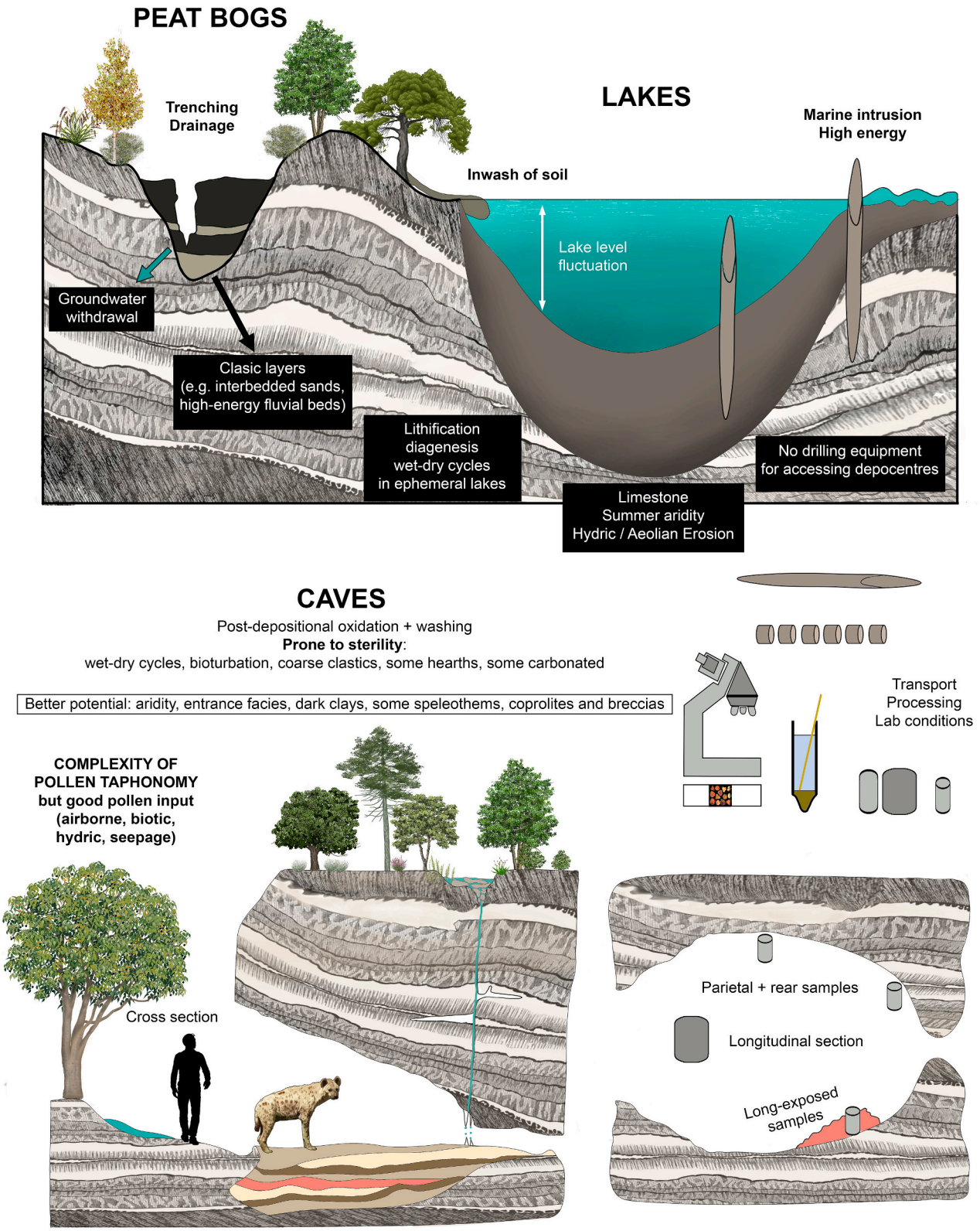

Fig. 1. Scheme of the main causes of sterility in the Iberian Peninsula as applied to peat bogs, lakes and cave systems. Redraw from Carrión et al., 2009.

documenting them in a standardized way.

Accordingly, this paper presents the conceptual basis, data model, submission and curation workflow, and current scope of FAILPOLLEN, and discusses its role as a complementary infrastructure for preserving and enabling the reuse of non-productive palaeopalynological records.

2. What does a negative result actually mean?

In many scientific disciplines, the discussion of negative results revolves around publication bias. When null or non-significant outcomes remain unpublished, reviews and meta-analyses may overestimate the strength of experimental effects (Easterbrook et al., 1991; Sandercock, 2011). This broader tendency has been discussed for decades as a systematic preference for positive findings (Greenwald, 1975; Fanelli, 2012). However, palaeopalynology exhibits a fundamentally different situation. Here, a negative result rarely falsifies a hypothesis or demonstrates the absence of an environmental signal. More often, it documents the inability of a particular archive, under specific environmental, taphonomic, sampling, or analytical conditions, to preserve an interpretable pollen record (Bryant and Holloway, 1983; Carrión et al., 2009; Xu et al., 2016). Failure to recover palynomorphs, or the recovery of pollen in concentrations too low for robust interpretation, thus provides evidence about the behavior and limitations of the pollen proxy itself.

The systematic omission of such observations creates a form of disciplinary bias whereby palaeopalynology preserves only part of its empirical experience. Successful records become part of the collective memory of the discipline, whereas unsuccessful attempts often disappear once individual research projects have ended. This hidden body of evidence represents lost opportunities for methodological learning, encourages repeated sampling of contexts informally known to be unfavorable, and contributes to an unrealistically optimistic view of archive suitability and proxy performance. In other words, the discipline learns primarily from its successes, while much of its experience of failure remains invisible. Although this situation differs from the classical "file drawer problem", it shares an important consequence: potentially informative negative observations are systematically excluded from the accumulated scientific record. It is therefore conceptually related to broader discussions on publication bias and the scientific value of negative findings (Rosenthal, 1979; Ioannidis, 2005; Bik, 2024).

3. FAILPOLLEN: Preserving the invisible evidence

Palynology and palaeoecology have greatly benefited from collaborative data infrastructures. Resources such as NEOTOMA, the European Pollen Database (EPD), and the Eurasian Modern Pollen Database (EMPD) have demonstrated the enormous scientific value of preserving, standardizing, and sharing pollen records through community-curated databases, thereby facilitating regional synthesis, large-scale comparison, and long-term data reuse (Hicks and Grönlund, 1994; Fyfe et al., 2009; Davis et al., 2013, 2020; Williams et al., 2018; Herbert et al., 2024). These initiatives have also become exemplary community resources for palaeoecological research (Giesecke et al., 2016; Davis et al., 2020). However, they necessarily begin where an interpretable pollen record already exists (Fig. 2). The earlier stage of research—the stage at which samples prove sterile, severely degraded, or otherwise unsuitable for interpretation—remains largely undocumented. Consequently, one important component of palaeopalynological knowledge still lacks an appropriate infrastructure.

To address this gap, we developed FAILPOLLEN (https://www.failpollen.com/), a community initiative for documenting non-productive and non-interpretable pollen records. FAILPOLLEN extends the philosophy of community-curated palaeoecological databases to a category of evidence that has largely remained outside existing infrastructures (Fyfe et al., 2009; Williams et al., 2018; Herbert et al., 2024) and aligns with broader efforts to increase the visibility of negative findings across science (Ioannidis, 2005; Curry et al., 2025).

The initiative has four main objectives: (i) to provide a permanent repository for non-productive and inconclusive pollen records that would otherwise be lost; (ii) to standardize the metadata required to describe and interpret these records; (iii) to preserve them in a curated, searchable, and publicly accessible resource; and (iv) to complement existing palaeoecological infrastructures by documenting evidence that normally disappears before formal data deposition becomes possible. As the initiative develops, its metadata and data structures can progressively be aligned with those of established palaeoecological repositories, facilitating interoperability and future data exchange. The immediate priority, however, is simply to ensure that failed pollen analyses become part of the long-term scientific record instead of disappearing at the end of individual projects.

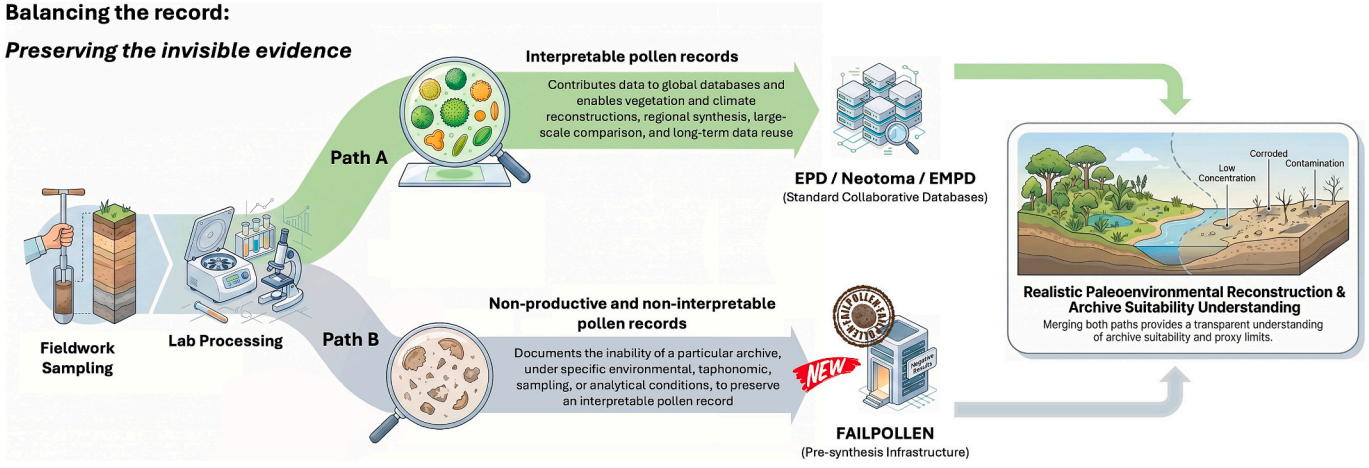

Fig. 2. Conceptual workflow showing the complementary role of FAILPOLLEN within the palaeoecological data ecosystem. Samples yielding an interpretable pollen signal are usually archived in standard collaborative databases (e.g., EPD, Neotoma, EMPD), whereas information on non-productive or non-interpretable samples is typically lost. FAILPOLLEN preserves these records as a curated, searchable, pre-synthesis resource. Integrating both pathways (A and B) enables a realistic understanding of archive suitability and supports robust palaeoenvironmental reconstruction. AI Google Gemini was used for an initial draft of Fig. 2, which was subsequently modified, adapted, and completed by the authors using image editing software.

4. Platform design and workflow

FAILPOLLEN has been designed as a community resource for documenting, curating, and disseminating non-productive pollen records. The system comprises a public interface for data exploration and a submission environment through which contributors can add new records. Together, these components support the complete workflow from data submission to public dissemination. The public portal (https://www.failpollen.com/) provides access to validated records through an interactive map and individual record pages. The emphasis is on geographical exploration, allowing users to identify where non-productive pollen records have been documented and to examine their environmental, taphonomic, and methodological context. Each record includes the essential metadata required to understand why an interpretable pollen record could not be obtained, including site location, archive type, sample context, and a description of the limiting factors.

Contributors submit new records through a standardized online form (https://www.failpollen.com/contribute.php). The submission process captures not only the analytical outcome but also the contextual information required to interpret it, including archive characteristics, sampling strategy, laboratory observations, and explanatory comments. Optional images may also be included where they help document the record. All submissions undergo editorial review before publication. This curation step allows records to be checked for completeness and internal consistency, metadata to be standardized where necessary, and publication status to be assigned. The objective is to maintain data quality while preserving the open and collaborative character of the initiative.

Beyond data submission and curation, FAILPOLLEN also recognizes that long-term sustainability depends on active community participation. For this reason, future developments will include mechanisms to acknowledge contributors, including annual reports documenting repository growth, contributor participation, and emerging patterns in the accumulated records. Such reports will provide a permanent record of the initiative while recognizing the collective effort required to preserve evidence that would otherwise remain invisible.

5. Repository structure

Each FAILPOLLEN record combines basic site metadata with information on archive types, depositional environments and sampling strategies. Additional fields allow contributors to include chronological information, descriptive notes, references, photographs, and other supporting documentation (Table 1). Together, these metadata provide the contextual information required to understand why an interpretable pollen record could not be obtained, while maintaining a standardized structure that facilitates comparison among records. As the repository grows, this standardized data model will support comparisons across archive types, depositional environments, geographical regions, and sampling strategies.

Table 1
Metadata fields recorded for each submitted record, distinguishing mandatory entries from optional contextual information.

Required information	Optional information
• Researchers • Main researcher email • Main researcher ORCID • Email display authorization (Y/N) • Site name • Country (selection list) • Latitude N-S (0–90; decimal) • Longitude E-W (0–180; decimal) • Elevation (m a.s.l.) • Sampling method (selection list) • Sample type (selection list) • Sample context (selection list) • Authorization for publication under a CC-BY 4.0 license (Y/N)	• Notes on chronology • Sample notes • Site description • Related papers and funding • Upload up to 4 images

The submission form collects the name, institutional email address, and ORCID identifier of the main researcher for each contributed record, in order to ensure traceability and proper attribution of the data. Public display of the contact email is optional and requires explicit authorization from the contributor at the time of submission. The processing of these personal data is governed by the platform's privacy policy, available at website, in accordance with the EU General Data Protection Regulation (GDPR).

6. Scientific implications

The long-term value of FAILPOLLEN lies not only in preserving non-productive pollen records, but also in enabling questions that cannot be addressed through isolated observations. In this respect, the project complements existing community-curated palaeoecological infrastructures by documenting a component of empirical evidence that has traditionally remained unavailable for synthesis (Williams et al., 2018; Herbert et al., 2024).

The availability of this information may also improve research planning. Knowledge that particular archives or depositional settings have repeatedly yielded non-productive results allows researchers to make better-informed decisions when designing sampling campaigns and allocating analytical effort. Although uncertainty can never be eliminated, access to previous unsuccessful experiences reduces unnecessary duplication of effort and helps place new investigations within a broader empirical context.

Finally, FAILPOLLEN has the potential to influence how palaeopalynology is taught and practiced. Training often relies on well-preserved pollen sequences and successful palaeoenvironmental reconstructions, whereas routine research also involves sterile samples, poorly preserved assemblages, low pollen concentrations, and other ambiguous outcomes. Making these records accessible exposes students and early-career researchers to a more realistic representation of everyday analytical practice and encourages a more critical understanding of archive selection, preservation, and proxy performance. More broadly, it contributes to a research culture in which unsuccessful outcomes are recognized as valuable scientific observations rather than discarded experiences.

7. Limitations and future directions

As a newly established community initiative, FAILPOLLEN has several limitations. Its current coverage depends on voluntary contributions and is therefore uneven across regions, archive types, and research communities. At present (August 2026), approximately 97% of the 237 available records originate from the Iberian Peninsula, reflecting the present stage of development of the initiative rather than the true geographical distribution of non-productive pollen records (Carrión et al., 2009). In addition, terminology used to describe non-productive outcomes may vary among laboratories, making continued refinement of classifications and editorial guidelines an important aspect of future development. Some retrospective records recovered from unpublished notes or legacy datasets may also lack complete contextual information.

These limitations are typical of community-curated scientific infrastructures during their early stages of growth and are expected to diminish as participation broadens. Future development will focus on expanding the contributor network, refining metadata standards, strengthening search and filtering capabilities, enabling metadata export, and increasing interoperability with established

palaeoecological databases.

Perhaps the most important long-term prospect lies in the analytical potential of the accumulated dataset. Although individual non-productive records are primarily valuable as contextual observations, sufficiently large collections of standardized records may eventually support quantitative analyses of the factors associated with unsuccessful pollen recovery. Relationships between non-productivity and factors associated with unsuccessful pollen recovery could then be explored systematically, providing new insights into the practical limits of the pollen proxy. As the repository grows, FAILPOLLEN may evolve from a platform that preserves otherwise lost observations into a research resource capable of generating new knowledge about the conditions under which pollen analyses succeed—or fail. Ultimately, its value will depend not only on the number of records it contains, but on its ability to transform individual unsuccessful observations into collective scientific knowledge.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work, the authors used ChatGPT as a generative AI tool to assist with language refinement, and improvement of clarity and readability. After using this tool, the authors reviewed, verified, and edited the content as needed and take full responsibility for the content of the published article. AI Google Gemini was used for an initial draft of Fig. 2, which was subsequently modified, adapted, and completed by the authors using image editing software.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The individual non-productive pollen records described in this study are openly available through the FAILPOLLEN repository at https://www.failpollen.com/, where they can be consulted via the interactive map together with the full contextual metadata (site location, archive type, sampling and taphonomic information) required for their interpretation. As FAILPOLLEN is itself the data repository presented in this article, no additional external dataset accompanies this manuscript beyond the records hosted on the platform.

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