News release

Fossils reveal a 100-million-year-old relationship between feathered dinosaurs and feather-feeding beetles

- **Amber fragments preserve remains of feathers and larvae related to modern feather-feeding beetles in intimate contact**
- **The feathers belonged to a theropod dinosaur from the Early Cretaceous (about 105 million years ago)**
- **The fossils show that symbiotic relationships comparable to those of modern birds and feather-feeding beetles existed between their ancestors**

New fossils in amber have revealed that beetles fed on the feathers of dinosaurs about 105 million years ago, showing a symbiotic relationship of one-sided or mutual benefit. The study has been published this week in *Proceedings of the National Academy of Sciences of the United States of America**.

The main fossil amber piece studied, from the Spanish locality of San Just (Teruel), contained larval moults of small beetle larvae tightly surrounded by portions of downy feathers. The feathers belonged to an unknown theropod dinosaur, either avian ("bird-like") or non-avian, as both types of theropods lived during the Early Cretaceous and shared often indistinguishable feather types. However, the studied feathers did not belong to modern birds since the group appeared about 30 million years later in the fossil record, during the Late Cretaceous.

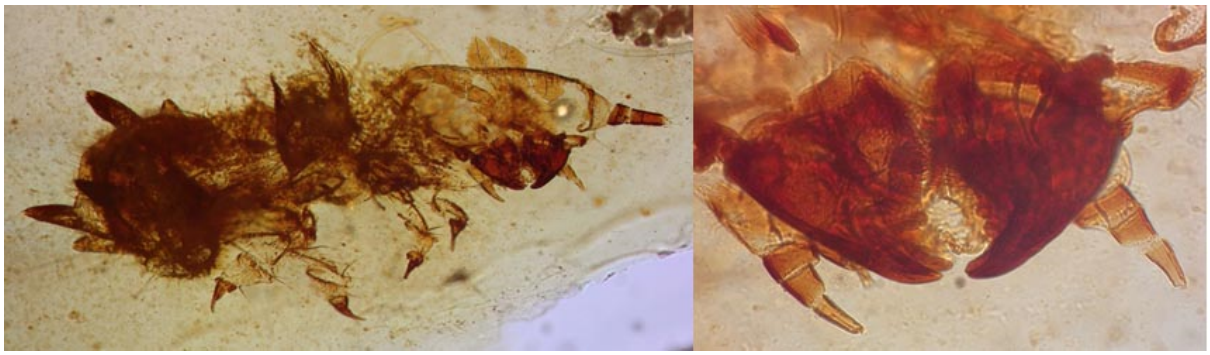
Vertebrates and arthropods have coexisted for more than 500 million years, and their interactions throughout deep time are thought to have critically shaped their evolutionary history, leading to coevolution. In modern ecosystems, examples of these diverse and complex ecological relationships include ticks infesting cattle, frogs capturing insects with acrobatic tongues, and barnacles growing on the skin of whales. Nevertheless, evidence of arthropod-vertebrate relationships is extremely rare in the fossil record.

In this new study, the larval moults preserved in the amber were identified as related to modern skin beetles, or dermestids. Dermestid beetles are infamous pests of stored products or dried museum collections, feeding on organic materials that are hard for other organisms

to digest such as natural fibres. However, dermestids also play a key role in recycling organic matter in the natural environment, and often inhabit the nests of birds and mammals, where feathers, hair, or skin accumulate.

“In our samples, some of the feather portions and other remains – including minute fossil faeces, or coprolites – are in intimate contact with the moults attributed to dermestid beetles and show occasional damage and/or signs of decay. This is hard evidence that the fossil beetles almost certainly fed on the feathers and that these were detached from its host,” explains Dr Enrique Peñalver, from the Geological and Mining Institute of Spain of the Spanish National Research Council (CN IGME-CSIC) and lead author of the study.

“The beetle larvae lived −feeding, defecating, moulting− in accumulated feathers on or close to a resin-producing tree, probably in a nest setting. A flow of resin serendipitously captured that association and preserved it for millions of years.”



Isolated moult of the feather-feeding beetle larva found in the Spanish amber outcrop of Rábago/El Soplao, with detail of its powerful mandibles (right). Length of the moult is less than two millimetres (Image credit: CN IGME-CSIC).

“It is unclear whether the feathered theropod host also benefitted from the beetle larvae feeding on its detached feathers in this plausible nest setting,” says Dr Ricardo Pérez-de la Fuente, from Oxford University Museum of Natural History and co-lead author of the study. “However, the theropod was most likely unharmed by the activity of the larvae since our data show these did not feed on living plumage and lacked defensive structures which among modern dermestids can irritate the skin of nest hosts, even killing them.”

“Three additional amber pieces each containing an isolated beetle moult of a different maturity stage but assigned to the same species were also studied, allowing a better understanding of these minute insects than what is usually possible in palaeontology,” says Dr David Peris, from the Botanical Institute of Barcelona (CSIC-Barcelona City Council) and co-author of the study. The most impressive, complete specimen was found in the amber deposit of Rábago/El Soplao in the northern Spain, roughly of the same age as San Just.

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See also: https://www.ox.ac.uk/news/2023-04-19-fossils-reveal-100-million-year-old-relationship-between-feathered-dinosaurs-and

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Notes

- (*) The paper "Symbiosis between Cretaceous dinosaurs and feather-feeding beetles" is published as open access in the journal *Proceedings of the National Academy of Sciences of the United States of America* (=PNAS). DOI: https://doi.org/10.1073/pnas.2217872120.

- The international and multidisciplinary team comprised researchers from the Geological and Mining Institute of Spain of the Spanish National Research Council (CN IGME-CSIC), the Botanical Institute of Barcelona (IBB-CSIC), the University of Barcelona and the Institute for Research on Biodiversity (IRBio), the Complutense University of Madrid, the 'Parque de las Ciencias' of Andalusia, the Autonomous University of Madrid, and the Royal Academy of Exact, Physical and Natural Sciences (Spain); the American Museum of Natural History and the Natural History Museum of Los Angeles County (United States of America); the Senckenberg Research Institute (Germany); and Oxford University Museum of Natural History (United Kingdom).

- Funding bodies: the project CRE, funded by the Spanish AEI/FEDER, UE Grant CGL2017-84419, the project PGC2018-094034-B-C22 (MCIU/AEI/FEDER, UE), the project CGL2014-52163, funded by the Spanish Ministry of Economy, Industry, and Competitiveness, the Secretary of Universities and Research of the Government of Catalonia and European Social Fund (2021FI_B2 00003), and the *Consejería de Industria, Turismo, Innovación, Transporte y Comercio* of the *Gobierno de Cantabria* through the public enterprise EL SOPLAO S.L.

About Oxford University Museum of Natural History

Founded in 1860 as the centre for scientific study at the University of Oxford, the Museum of Natural History now holds the University's internationally significant collections of entomological, geological and zoological specimens. Housed in a stunning Pre-Raphaelite-inspired example of neo-Gothic architecture, the Museum's

growing collections underpin a broad programme of natural environment research, teaching and public engagement.

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