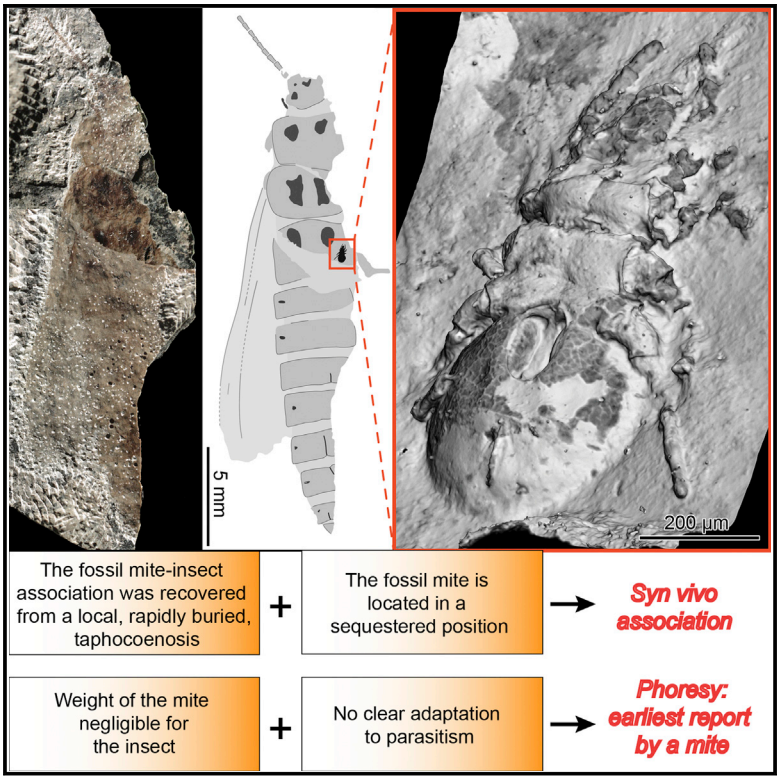
Report

Current Biology

A Carboniferous Mite on an Insect Reveals the Antiquity of an Inconspicuous Interaction

Graphical Abstract



Highlights

- A 0.8-mm mite is reported as being located on a 320-Ma-old extinct insect
- This oribatid belongs to a new family extending the record of Mixonomata by 250 Ma
- Relevant aspects, including fossil preservation, suggest a phoretic association
- This case reveals the antiquity of such interactions in mite evolution

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In Brief

Robin et al. report on a fossil mite located on a 320-Ma-old insect. Based on preservation of the associated insects and on the morphology and position of the mite, the authors assume a syn vivo, phoretic association. This is the earliest case of symbiosis between a mite and a larger animal, revealing the antiquity of such interactions.

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A Carboniferous Mite on an Insect Reveals the Antiquity of an Inconspicuous Interaction

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SUMMARY

Symbiosis [1], understood as prolonged interspecific association, is as ancient as the eukaryotic cell [2, 3]. A variety of such associations have been reported in the continental fossil record, albeit sporadically. As for mites, which as a group have been present since the Devonian (ca. 390 mya) [4, 5] and are involved in a tremendous variety of modern-day symbioses, reported associations are limited to a few amber-preserved cases [6–11], with the earliest instance in the Cretaceous (ca. 85 mya) [11]. As a consequence, the antiquity and origin of associations involving small-sized mites and larger animals are poorly understood. Here we report, recovered from the Carboniferous Xiaheyan locality (ca. 320 mya), an oribatid mite located on the thorax of an extinct relative of grasshoppers, crickets, and katydids [12]. The mite was investigated using several methods, including phase-contrast tomography. The detailed morphological data allowed the placement of the mite in a new family within Mixonomata, whose fossil record is thus extended by ca. 250 Ma. Specimen and abundance distribution data derived from the fossil insect sample indicate that specimens from the corresponding excavation site were buried rapidly and were sub-autochthonous, indicating a syn vivo association. Moreover, the mite is located in a sequestered position on the insect. The observed interaction best fits the definition for phoresy, in which the benefit is transport and protection for the mite. This discovery demonstrates that this association, a trait shared by representatives of the most speciose mite taxa, arose very early during mite evolution.

RESULTS

Herein we report a new insect specimen belonging to *Miamia maimai* Béthoux et al., 2012, one of the archaeorthopteran species very common in the Xiaheyan locality. The specimen is unique in that a mite occurs on it (Figures 1, 2, and 3).

Systematic Paleontology

Material

Specimen CNU-NX1-171 (Capital Normal University, Beijing, China; curator D.R.), composed of two slabs exposing an insect and a mite, the latter located on the insect metathorax nearby the hindwing insertion point. The mite is three-dimensionally preserved and is split along a dorsoventral plane.

Type Locality

Xiaheyan, Tupo Formation (Ningxia, China), Dragon-0 excavation site.

Stratigraphic Age

Namurian, Late Carboniferous [13].

The Host Insect

Insecta Linnaeus, 1758.
Archaeorthoptera Béthoux and Nel, 2002.
Genus *Miamia* Dana, 1864.
Miamia maimai Béthoux et al., 2012 (Figure 1).
Specimen Description. See Supplemental Experimental Procedures.
Taxonomy. Despite its comparatively mediocre preservation, the insect individual can be reasonably identified. The stoutness of thoracic segments, the slightly concave anterior wing margin, the narrow area between the anterior wing margin and the posterior subcostal vein (forewing), and the faintness of wing veins all are traits reported in *M. maimai* [12]. The size matches as well. Finally, the species accounts for more than 45% of all determinable individuals collected from Dragon-0.

The Associated Mite

Chelicerata Heymons, 1901.
Acari Leach, 1817.
Oribatida Dugès, 1834.