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Supporting Online Material for  
A Fossil Bee from Early Cretaceous Burmese Amber

G. O. Poinar Jr. and B. N. Danforth\*

\*To whom correspondence should be addressed. E-mail: [bnd1@cornell.edu](mailto:bnd1@cornell.edu)

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## Supporting Online Material

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#### Phylogenetic affinities of Melittospecidae

Phylogenetic studies of extant bees and their closest living wasp relatives (*S1,S2*) have established that bees arose from within a group of predatory wasps (referred to as the “Sphecidae” [*S3*], the “sphecoid wasps” [*S2*], or the “Spheciformes” [*S4*]) sometime during the Cretaceous (*S4,S5*). The monophyletic group including bees and closely-related wasp families (Heterogynaidae, Ampulicidae, Sphecidae and Crabronidae) is referred to as Apoidea (*S1,S2,S4*).

Analysis of the available morphological data indicates that *Melittosphex burmensis* represents an extinct lineage of Apoidea sister to the extant bee families (Fig. S1). The seven extant bee families are united by a total of 14 synapomorphies (*S4*), some of which are present and visible on the fossil specimen: (a) plumose hairs, (b) posterior strigil absent, (c) mid-femoral/tibial brush for cleaning foreleg present, (d) bristles on outer surface of tibia weak or absent, (e) weakly developed basitibial plate, and (f) cleft tarsal claws. *Melittosphex burmensis* bears several character states that resemble some extant groups of bees. However, the possession of two mid-tibial spurs and a slender hind basitarsus are groundplan features of the apoid wasps (*S4*) and these characters suggest that *Melittosphex* is not a member of any currently recognized bee family. Bees and crabronid wasps share eight synapomorphic characters (*S2*). We can assess two of these characters in the fossil and both support the placement of *Melittosphex* within the

clade including bees and Crabronidae. First, the fossil lacks abdominal cerci, which is a synapomorphy of Crabronidae + bees. Second, the fossil has a well-developed pygidial plate (Fig. 1A). Presence of a pygidial plate in females is a synapomorphy of Crabronidae + bees (S2). While the fossil specimen is a male, the presence of the pygidial plate in males is often associated with its presence in females (S4), thus supporting the view that the female of *Melittosphex* had a pygidial plate. Autapomorphic features of the fossil include the large, clearly tridentate mandibles, the gracile, slender hindlegs, and posterolateral tubercles on the propodeum (Fig. 1A).

**Fig. S1 (caption)** – Phylogenetic affinities of Melittosphecidae. Relationships among extant Apoidea based on (S2). Characters uniting nodes are as follows. **Node 1** (synapomorphies of Crabronidae + (Melittosphecidae + extant bees): (a) male cerci absent, (b) pygidial plate present (Melo [S2] lists six additional characters that cannot be seen in the fossil). **Node 2** (synapomorphies of Melittosphecidae + extant bees): (a) plumose hairs, (b) posterior strigil absent, (c) mid-femoral/tibial brush for cleaning foreleg present, (d) bristles on outer surface of tibia weak or absent, (e) weakly developed basitibial plate, (f) cleft tarsal claws (Michener [S4] lists additional bee synapomorphies that cannot be seen in the fossil). **Node 3** (synapomorphies of extant bees): (a) reduction from two to one mid-tibial spurs, (b) expanded hind basitarsus.

**Supplementary References**

- S1. O. Lomholdt, *Entomol. Scandinav.* **13**, 185 (1982).
- S2. G.A.R. Melo, *Scientific Papers, Univ. Kansas Nat. Hist. Mus.* **14**, 1 (1999).
- S3. R.M. Bohart, & A.S. Menke, *Sphecid Wasps of the World* (University of California Press, Berkeley, CA, 1976).
- S4. C.D. Michener, *The Bees of the World* (The John Hopkins University Press, Baltimore, MD, 2000).
- S5. D. Grimaldi, M.S. Engel. *Evolution of the Insects* (Cambridge University Press, Cambridge, 2005).

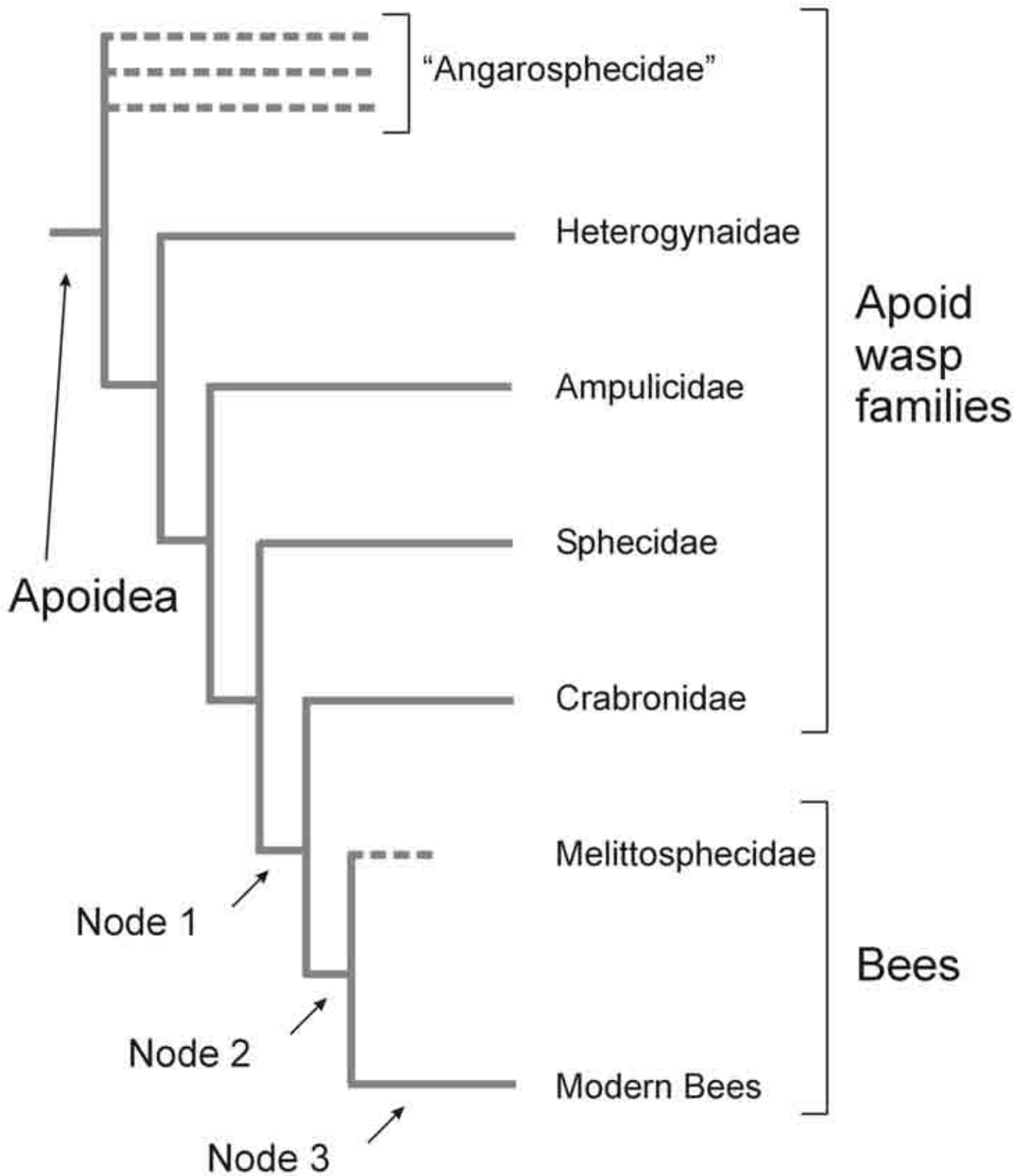


Fig. S1