

Electronic Supplementary Material for:

**Specialized proteinine rove beetles shed light on insect-fungal associations in the Cretaceous**

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### **Detailed Systematic Placement of *Vetuproteinus* and Comparison with Extant Genera:**

Currently, the beetle family Staphylinidae is organized into four groups of families (the Omaliine group, Tachyporine group, Oxyteline group, and Staphylinine group), and two basal subfamilies Apateticinae and Trigonurinae, which are suggested to be a sister group to the remaining four major groups mentioned above [1]. With respect to these groupings, the new genus *Vetuproteinus* can be easily separated from the Tachyporine, Oxyteline, and Staphylinine groups by its overall body habitus, relatively long elytra, and each abdominal segment having only one pair of paratergites. *Vetuproteinus* shares several characters with some members of Apateticinae and Trigonurinae, for example, a more or less ovoid body, relatively long elytra (covering at least abdominal tergite III), and (Trigonurinae only) each abdominal segment III–VII with only one pair of paratergites. However, the new genus differs significantly from these two modern subfamilies by lacking rows of punctures on the elytra and having 4-segmented meso- and metatarsi (protarsi unknown; all tarsi are 5-segmented in Apateticinae and Trigonurinae). The close affinity of *Vetuproteinus* with some genera of the Omaliine group of subfamilies is well supported by a number of characters in combination: ovoid body shape; relatively long elytra covering tergite III; contiguous pro- and metacoxae; broadly exposed protrochantins; each abdominal segment with one pair of paratergites; and an apparent defensive gland anteriorly on sternite VIII [2]. The Omaliine group is currently composed of 10 extant subfamilies (though it too may be paraphyletic): Dasycerinae, Empelinae, Glypholomatinae, Micropeplinae, Microsilphinae, Neophoninae, Omaliinae, Proteininae, Protopselaphinae, and Pselaphinae [2,3]. The new genus cannot be confused with Dasycerinae and Empelinae on the basis of its body form and shorter elytra not covering the whole abdomen. It is also easily separated from Micropeplinae by bearing 11-segmented, slightly clavate antennae (rather than 9-segmented as in Micropeplinae) and lacking sculpture of ridges and pits on the dorsal surface; from Glypholomatinae and Neophoninae by lacking 9 or 10 rows of punctures on each elytron and having much shorter elytra; from Protopselaphinae and Pselaphinae by having a broader body, transverse pronotum, 4-segmented (not 3-segmented) meso- and metatarsi, and lacking foveae on the body; from Microsilphinae by having loosely clubbed antennae, 4-segmented maxillary palpi (not 5-segmented), relatively short elytra exposing five tergites, and 4-segmented (not 5-segmented) meso- and metatarsi. Among all the 32 modern subfamilies, the new genus exhibits a number of similarities to some genera of the two remaining subfamilies: Omaliinae and Proteininae. *Vetuproteinus* can be easily separated from nearly all genera of Omaliinae by the absence of paired ocelli on the vertex of the head, the 4-segmented tarsi, and from many by the distinctly clavate antennae. It can be separated from the ocelli-lacking omaliine genera (e.g., some species of *Eusphalerum* Kraatz and *Pycnoglypta* Thomson) by lacking wing-folding patches on abdominal tergum V and having 4-segmented meso-

and metatarsi, and by the relatively short abdominal intersegmental membranes apparently lacking microsclerites. By process of elimination, we therefore place the new genus in Proteininae by its general habitus, acuminate maxillary palpomere 4, absence of paired ocelli, and short abdominal intersegmental membranes without a pattern of minute sclerites. Adults of modern Proteininae are easily recognized by their broad bodies, abdomen with six visible sterna, only one pair of paratergites on abdominal segments III–VII, intersegmental membranes short and without brick-wall-like pattern of sclerites, and spiracles on segments 4–6 nonfunctional, reduced or absent; antennae inserted under the sides of the frons so the insertion is not visible from above; notch present (in dorsal view) between antennal insertion and eye; procoxae transverse, subconical, protrochantins broadly exposed; hind coxae transverse and excavate posteriorly; paired ocelli absent (one median ocellus in *Metopsia* Wollaston), and by the presence of a well-developed omaliine-type defensive gland in the abdomen [2,4]. Most characters of *Vetuproteinus* fit the delimitation of Proteininae well. However, two characters (well-exposed antennal insertions and absence of notch between antennal insertion and eye) differ significantly from those of modern Proteininae (see below). Most modern Proteininae (all members of the tribes Anepiini, Austrorhysini, Nesoneini, and Proteinini, excluding only the basal tribe Silphotelini) have the mesothoracic spiracle surrounded by a large sclerotised peritreme, which is triangular in shape and superficially similar to an omaliine-type postcoxal process of the pronotum but not fused to the hypomeron. In *Vetuproteinus*, among one of the most interesting features is the well-developed pronotal hypomeron with a subtriangularly produced process, which, within Proteininae, is found only in the small Southern Hemisphere tribe Silphotelini, where it is present but relatively smaller. Thus, it would be plausible to attribute *Vetuproteinus* to the modern tribe Silphotelini based on this structure of the pronotal hypomeron, and indeed *Vetuproteinus* will key out directly to Silphotelini in the key to tribes of Proteininae in Newton and Thayer [2]. However, this condition of the pronotal hypomeron resembles the state present in some related subfamilies of the Omaliine group and may be a plesiomorphy within Proteininae [2] and thus does not provide strong evidence of a direct close relationship of these genera.

Modern Silphotelini contains two described genera, *Alloproteinus* Steel and *Silphotelus* Broun [5]. In superficial appearance, *Vetuproteinus* is closer to *Alloproteinus* than to *Silphotelus* based on the relatively short elytra; *Silphotelus* is very convex and has long elytra covering the whole abdomen, while *Alloproteinus* has much shorter elytra exposing four or five abdominal segments [5]. But *Vetuproteinus* shares with *Silphotelus* an acuminate maxillary palpomere 4, 4-segmented tarsi, and more or less developed metacoxal plates. However, *Vetuproteinus* lacks the two derived characteristics of Silphotelini identified in the phylogenetic analysis of the Omaliine group by

Newton and Thayer [2]: male tergite IX divided along dorsal midline (state 98-1, also shared by many other groups), and the double lateral carinae of the pronotum (an autapomorphy unique to the tribe). In addition, *Vetuproteinus* differs from all modern Proteininae, including *Alloproteinus* and *Silphotelus*, by the presence of dorsally exposed antennal insertions, slightly clavate antennae, maxillary palpomere 4 shorter than palpomere 3, larger post-coxal process of the pronotum, longer abdominal intersegmental membranes, and the enlarged protruding galea, which is covered with an oval plate of projections at its apex and closely resembles structures known as “spore brushes” in various fungus-feeding staphylinids and other beetles. Among these characteristics, some (reduced notch, larger post-coxal process, longer intersegmental membranes) resemble conditions in related subfamilies and are probably symplesiomorphies within Proteininae [2], suggesting a sister-group relationship between *Vetuproteinus* and the remaining Proteininae, while the exposed antennal insertions and presence of the “spore brush” are unique in Proteininae and unusual in the Omaliine group. In our opinion this combination of plesiomorphic and highly derived features in comparison to other Proteininae justifies the proposal of a new tribe, Vetuproteinini trib. nov., for *Vetuproteinus*.

### Supplementary references

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