

**EVIDENCE FOR THE GENERIC PLACEMENT OF THE GHOST MOTH  
*KORSCHTELLELLUS FUSCONEBULOSA* (DE GEER, 1778)  
 (LEPIDOPTERA: HEPIALIDAE) AND COMMENTS ON THE MONOPHYLY OF  
*KORSCHTELLELLUS* BÖRNER, 1920**

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**ABSTRACT** - The taxonomic placement of *Pharmacis fuscanebulosa* (De Geer, 1778), within a monophyletic *Korscheltellus* Börner, 1920, is supported by the uniquely shared presence of a curved and spatulate mesosome in the male genitalia of *K. gracilis* (Grote, [1865]), *K. lupulina* (Linnaeus, 1758), and *K. fuscanebulosa*. A sister-species relationship between *K. gracilis* of North America and *K. fuscanebulosa* is supported by the uniquely shared presence of a tooth along the dorsal vincular margin, a lateral costal tooth on the valve.

### INTRODUCTION

The taxonomy and systematics of ghost moth genera are poorly resolved, and many genera lack cladistic evidence to support their monophyly. Comprehensive phylogenetic treatments are primarily limited to regional faunas (Nielsen and Robinson, 1983; Dugdale, 1994) or to individual genera (*Fraus* Walker, 1856, see Nielsen and Kristensen, 1989; *Phymatopus* Wallengren, 1869, see Wagner, 1985). All other genera are currently delineated by their distinctiveness, or the overall appearance of external features or genitalia.

Preliminary morphological studies are currently being developed to resolve systematic relationships among the genera of Hepialidae (Grehan, 2010, 2011, 2012; Mielke and Grehan, 2012) and in this process I examined a web page by Chris Lewis illustrating the genitalia of British Hepialidae (<http://britishlepidoptera.weebly.com/hepialidae-genitalia.html>). Two of the illustrated species showed a distinct genitalic similarity even though they were placed in different genera by De Freina and Witt (1990) and Nielsen et al. (2000) as *Pharmacis fuscanebulosa* (De Geer, 1778) and *Korscheltellus lupulina* (Linnaeus, 1758). There was no supporting evidence presented and I was further intrigued when I observed the same genitalic similarity in *K. gracilis* (Grote, [1865]) of North America.

The placement of *Phalaena fuscanebulosa* De Geer, 1778, in *Pharmacis* by De Freina and Witt (1990) and Nielsen et al. (2000) contrasts

with its placement in *Korscheltellus* Börner, 1920, by Viette (1949) who objected to Hübner's (1816) inclusion of *P. fuscanebulosa* (as *Bombyx vellea* [Hübner, 1808]) in the genus *Pharmacis* Hübner [1820] because of unspecified genitalic differences. Viette (1949) instead regarded the genus *Korscheltellus*, as created by Börner (1920) for *Noctua lupulina* Linnaeus, 1758, to be valid and applicable to *P. fuscanebulosa* as well.

Although the European *K. fuscanebulosa* closely resembles *K. gracilis* of North America, Wagner (1988) noted that the generic placement of *K. gracilis* was problematic because these two species together share similarities with the European genus *Pharmacis* as well as *K. lupulina*. Wagner (1988) called attention to *K. gracilis*, *K. fuscanebulosa*, and *K. lupulina* all sharing simple and elongate valves, a horn-like valvellar process, a free *processus momenti* (intermediate plate of Nielsen and Kristensen, 1989) positioned in the same plane and below the tegumen, a hat-shaped juxta constricted near the vincular margin, a tongue-like mesosome, and a triangular or rounded, dorsally projecting acrosternite.

A morphological similarity between *K. gracilis* and *Pharmacis carna* ([Denis and Schiffmüller], 1775) identified by Wagner (1988) was the shared presence of small circular to irregular windows surrounded by a ring of smooth cuticle in the medial forewing scales. This was contrasted with the condition in *K. lupulina* where one or more windows are

surrounded by quadrangular areas of raised cuticle. However, Wagner (1988) also noted that there were occasional specimens of *K. gracilis* that showed a condition intermediate between *K. lupulina* and *P. carna* (although fig. 13 illustrates a specimen of *K. gracilis* where the pattern is virtually identical to *K. lupulina*).

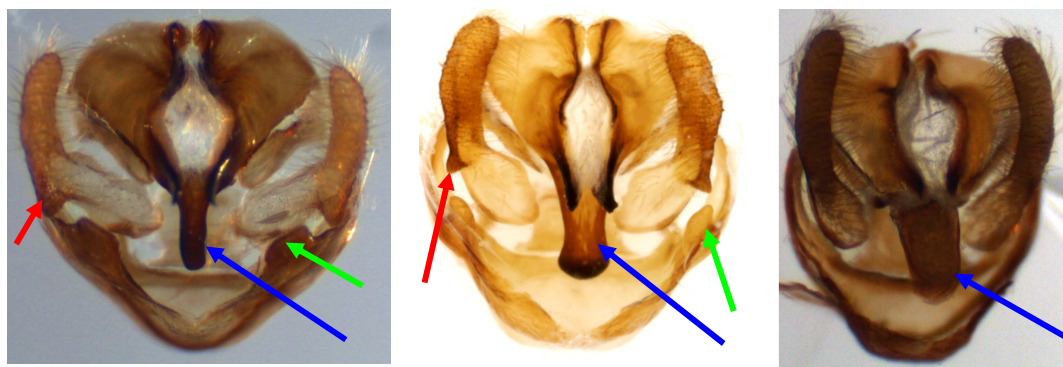
The contrasting similarities in genitalia and wing scale window formation led Wagner (1988) to conclude that although the genus *Korscheltellus* was provisionally valid, it was not possible to definitively assign *gracilis* to either *Korscheltellus* or *Pharmacis*, and that it was possible that in the future *Korscheltellus* would be subordinate to *Pharmacis*.

#### MONOPHYLY OF *KORSCHTELLELLUS*

Variability in scale window formation in *K. gracilis* renders this character ambiguous as an indicator of relationship, particularly in the absence of a broad comparison of scale ultrastructure for all Hepialidae and other Exoporia. In contrast, a survey of the male

genitalia in almost all hepialid genera by the author (JRG), supplemented by additional published illustrations for other Exoporia and an unpublished illustration for *Mnesarchaea* (G. W. Gibbs, personal communication), allows for a cladistic pattern of similarity to be recognized in the genitalia to support the monophyly of *K. gracilis*, *K. fusconebulosa*, and *K. lupulina*.

As noted by Wagner (1988), all three species of *Korscheltellus* share the presence of a curved, spatulate or tongue-like mesosome (Fig. 1). In comparison with all other exoporian genera, this derived feature is corroborated as being unique to the genus *Korscheltellus* and therefore confirmed as an unequivocal apomorphy. At least some of the other similarities among the *Korscheltellus* species listed by Wagner (1988) may also be uniquely shared, but this will require future confirmation. The mesosome of *K. gracilis* is fused laterally to the pseudotegumen, but in *K. lupulina* it was found to be fused with the trulleum and not with the pseudotegumen.



**Fig. 1.** Male genitalia of *Korscheltellus* species showing spatulate mesosome (blue arrow), vincular condyle (green arrow), and costal tooth (red arrow): (a) *K. gracilis* (M147), (b) *K. fusconebulosa*, (c) *K. lupulina* (M230). Image of *K. fusconebulosa* courtesy of Chris Lewis. Bracketed numbers refer to dissection codes by the author.

Some individuals of *K. gracilis* and *K. fusconebulosa*, especially females, are nearly indistinguishable externally (Wagner, 1988). The two species also appear to share two unique genitalic features: a condyle on the dorsal margin of the vinculum at the basal articulation with the valve, and a sub-basal costal tooth on the valve (Fig. 1). These two features support a sister-species relationship for the two species with *K. lupulina* as the basal taxon (Fig. 2).

Nielsen et al. (2000) listed seven species in *Pharmacis* Hübner, [1820]. In five of those species for which genitalic illustrations are published (Kristal et al., 1994), the spatulate mesosome is absent. These include *Bombyx carna* [Denis and Schiffermüller], 1775, the type species of *Pharmacis*. The absence of a spatulate mesosome in these species supports the taxonomic decision by Viette (1949) and Wagner (1988) to accept the validity of *Korscheltellus* as distinct from *Pharmacis*. This genus is a monophyletic entity with respect to

the spatulate mesosome uniquely shared by its three constituent species. The North American species, *K. gracilis*, ranges from Canada to the southern Appalachians in eastern North America, and west to Alberta in the north of its range (Wagner, 1988). The eastern boundary of the European *K. lupulina* is uncertain (De Freina

and Witt, 1990) whereas *K. fusconebulosa* ranges across Europe and northern Asia, including Japan (Ueda, 1978; De Freina and Witt, 1990). Whether the widespread range of *K. fusconebulosa* represents a single species or several species requires future assessment.

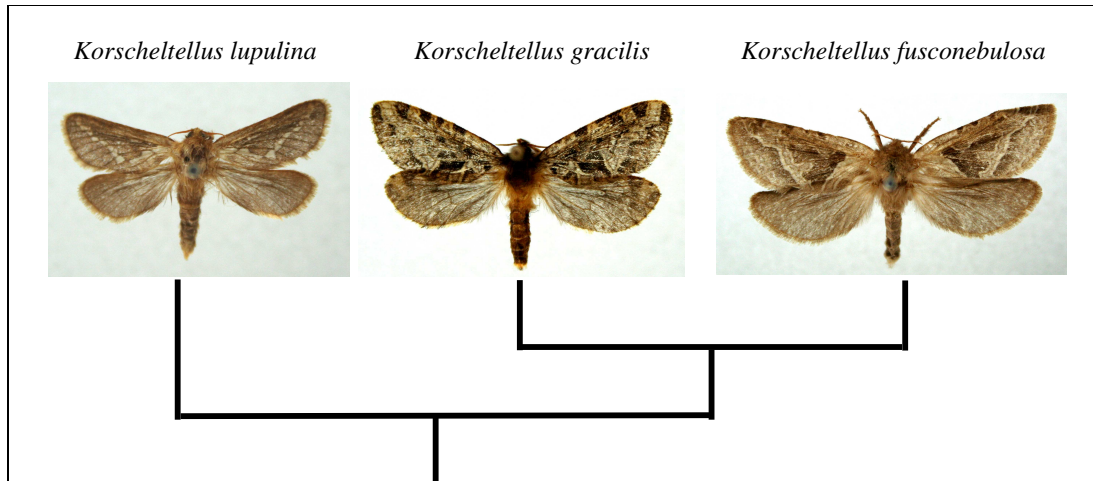


Fig. 2. Phylogenetic relationships within *Korscheltellus* based on two proposed derived character states supporting a closer relationship between *K. gracilis* of North America and *K. fusconebulosa* of Eurasia than either has to the European *K. lupulina*. See text for details.

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