

CHERMES FUNITECTUS DREYFUS AND THE HEMLOCK WOOLLY ADELGID (HEMIPTERA: ADELGIDAE)¹

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ABSTRACT: The valid scientific name for the hemlock woolly adelgid is affirmed to be *Adelges tsugae* Annand. A discrepancy between the names *Adelges funitectus* (Dreyfus) and *A. tsugae* in the historical literature is investigated and resolved. The generic (or subgeneric) name *Aphrastasia* should not be applied to *Adelges tsugae*, as this species is not closely related to *Adelges pectinatae* (Cholodkovsky), the type species of *Aphrastasia*. We propose *Annandina* subgen. nov. for *A. tsugae*.

KEY WORDS: *Adelges tsugae*, *Annandina* subgen. nov., Aphidomorpha, *Aphrastasia*, *Dreyfusia*, Sternorrhyncha

The hemlock woolly adelgid is an important pest in eastern North America. Introduced from Japan (Havill et al., 2006) it is responsible for widespread mortality of eastern and Carolina hemlocks, *Tsuga canadensis* (L.) Carrière and *T. caroliniana* Engelm. While curating our respective on-line resources, Aphids on the World's Plants and Aphid Species File (www.aphidsonworldsplants.info and aphid.speciesfile.org), we became aware of a discrepancy in the scientific nomenclature of the hemlock woolly adelgid. *Adelges tsugae* Annand 1924, described from Oregon, USA, is the more often used name (Havill and Footitt 2007), but *Adelges funitectus* (Dreyfus 1888), described from Europe, is generally considered a synonym and has nomenclatural priority (ICZN 1999; Blackman and Eastop 1994, Steffan 1972, Ghosh 1980, Favret et al., 2014). This adelgid is currently placed in the subgenus *Aphrastasia*.

The host of *Chermes funitectus*, as described by Dreyfus (1888) from material collected in Germany, was *Abies canadensis* Miller. Authors since then have explicitly assumed Dreyfus was referring to *Tsuga canadensis* (L.) Carrière (Marchal 1907, 1913, Börner 1908a, Cholodkovsky 1915). Many later references to *C. funitectus* as a valid name appear to be based solely on the insect's supposed association with *Tsuga* (Chrystal 1922, Annand 1928, Schneider-Orelli et al., 1929, Heinze 1962, Carter 1971, Steffan 1972). *Tsuga* species are native to eastern Asia and North America (Farjon 1990) but widely planted in Europe. It is remarkable that, if Dreyfus's (1888) record were indeed correct, it would be the first and only record of an adelgid on *Tsuga* in Europe. Since then, multiple authors have suggested that Dreyfus may have misidentified the host for his new

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species (Börner 1908a, Marchal 1913, Cholodkovsky 1915, Annand 1928), mistaking some true *Abies* species as *Tsuga canadensis*. An alternative theory is that a simple botanical misinterpretation might be the main cause of confusion: in botanical nomenclature, *Abies canadensis* is a synonym not of *Tsuga canadensis*, but of *Picea glauca* (Moench) Voss. (Brouillet et al., 2015, Earle 2015), a North American native planted in Europe. This latter theory is untenable, however, because *Picea* are the primary hosts on which adelgids form galls, whereas Dreyfus (1888) described stages found feeding on needles and hence secondary hosts. Therefore it seems likely that the original host was indeed a misidentified species of *Abies*, that *T. canadensis* is not the host of *A. funitectus*, and that *A. funitectus* is not a synonym of *A. tsugae*.

The name *Chermes funitectus* has been considered the possible synonym of at least four *Abies*-feeding nominal species other than *A. tsugae*. In his original description, Dreyfus (1888) acknowledged that his new species may in fact be *Chermes pectinatae* Cholodkovsky 1888: "Maybe it is identical with Cholodkovsky's *Chermes pectinatae*, since both live on the needles producing coarse-fibered fluff [wax]. In this case, the name *Chermes pectinatae* Cholodkovsky would correspond to both of them" (Dreyfus 1888, page 6). Cholodkovsky (1889) agreed, with the caveat that *C. funitectus* eggs do not overwinter and thus climate sensibilities may distinguish the two species. Cholodkovsky (1898) later suggested the possibility that *C. nordmannianae* Eckstein 1890 and *C. funitectus* might be synonyms, but he subsequently identified galls from *Picea orientalis* (L.) Link in the Caucasus as *C. funitectus*, apparently basing this solely on a comparison of alatae from these galls with pictures sent to him by Dreyfus of sexuparae collected on the secondary host in Germany (Cholodkovsky 1906). Marchal (1906) and Nüsslin (1907) posited *C. piceae* Ratzeburg 1844 as the senior synonym, although Marchal (1907) later defended the validity of *C. funitectus*, relegating only Cholodkovsky's (1906) interpretation of *C. funitectus* to synonymy. The same author then finally considered the offending nominal species a synonym of *Dreyfusia nuesslini* Börner 1908b (Marchal 1910, see also Cholodkovsky 1915). This last species is today a synonym of *Adelges nordmannianae* (Steffan 1972).

Therefore, based on historical accounts, *A. funitectus* is either 1) a junior synonym of *A. pectinatae*, 2) a junior synonym of *A. piceae*, 3) the senior synonym of *A. nordmannianae* (and *A. nuesslini*), or 4) valid on its own terms. Like *A. funitectus*, *A. pectinatae* feeds on the needles of *Abies* spp., but Cholodkovsky (1906, 1915) distinguished alatae of *C. funitectus* from those of *C. pectinatae* by differences in the relative lengths of the antennal segments: the fifth antennal segment is longer than the fourth in *A. funitectus*, whereas it is not in *A. pectinatae*. *Adelges piceae* feeds on the stems of *Abies* spp. and thus at first sight should not be the senior synonym of *A. funitectus*. *Adelges nordmannianae* does feed on the needles of *Abies* and also has alatae with the fifth segment longer than the fourth. It is the most likely candidate for synonymy, and the accounts of

C. funitectus provided by Chlodkovsky (1906, 1915) fit that species. Recent molecular evidence suggests that *A. nordmannianae* may be a junior synonym of the stem-feeding species *A. piceae* (Ravn et al., 2013). Given this possible synonymy, we prefer not to destabilize the nomenclature by placing the relatively well-defined *A. nordmannianae* as the junior synonym of the poorly defined *A. funitectus*: both may eventually be placeable as junior synonyms of *A. piceae*. When taken together, the problematic identity of the original host of *C. funitectus*, the inadequacy of the original description, and the uncertain connection with the adelgid galling *Picea orientalis* leave considerable room for doubt. Therefore, until a taxonomic revision can be completed to settle the relationships between the several nominal species, and in particular *A. (Dreyfusia) piceae* and *A. (Dreyfusia) nordmannianae*, we here consider *A. funitectus* a *nomen dubium* within the subgenus *Dreyfusia*.

Finally, *Chermes funitectus* was placed by Börner (1909), along with *C. pectinatae* as type species, in his genus *Aphrastasia* (now treated by most authors as a subgenus of *Adelges*). Molecular phylogenetic studies have shown that *A. tsugae* and *A. pectinatae* are not closely related, that the adelgids feeding on *Tsuga* in East Asia and North America form a monophyletic group, and that at least those indigenous to Japan and China are likely to be different species (Havill et al., 2006, 2007). With *A. tsugae* and *A. funitectus* now dissociated, we suggest that *A. tsugae* be removed from *Aphrastasia*. There being no other *Adelges* subgenus to accommodate it, and in recognition of the fact that Annand (1924) first described *A. tsugae* and noted its distinctive features, we propose placing it as type species in *Annandina* subgen. nov. (feminine gender).

The new subgenus is biologically distinct from the other *Adelges* subgenera: it is the only one to be found on *Tsuga*. It is also morphologically unlike any other subgenus in its distribution of sclerites and wax pores: in the first instar, the head and prothorax are each almost completely covered by two large dorsal sclerites each lined with wax pores along their median and lateral margins, four are found on the dorsal mesothorax, and six on the metathorax and first five abdominal segments; in the apterous adult, a single characteristic dorsal shield containing many small facets covers the head and prothorax. These and other distinguishing characters are discussed in Annand's (1924, 1928) treatments of *A. tsugae*. See also the key to Adelgidae by Binazzi (1984).

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