

# A New Species of *Mindarus* (Hemiptera: Aphididae) on the Endangered Guatemalan Fir

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**ABSTRACT** A pestiferous species of *Mindarus* (Hemiptera: Aphididae: Mindarinae) presents challenges for the cultivation and conservation of the endangered Guatemalan fir, *Abies guatemalensis* Rehder. The aphid, *Mindarus guatemalensis* n. sp., is described.

**KEY WORDS** *Abies guatemalensis*, Guatemala, conservation, aphid

*Mindarus* is the monotypical genus of the aphid subfamily Mindarinae. The subfamily's position within the Aphididae is uncertain, with modern phylogenies either omitting it entirely (Martínez-Torres et al. 2001, Ortiz-Rivas et al. 2004) or failing to recover strong relationships (von Dohlen and Moran 2000). Species of *Mindarus* are known to feed only on *Abies* (true firs), *Picea* (spruces), and *Keteleeria* (closely related to *Abies* and restricted to Southeast Asia). They have been studied primarily because their feeding on growing tips causes current-year needles to become twisted and distorted. *Mindarus* are sometimes pestiferous, especially in Christmas tree farms (Nettleton and Hain 1982, Kleintjes et al. 1999, Fondren and McCullough 2003), and problems have also occurred in nurseries where feeding can influence the growth of seedlings and lead to significant economic impact (Ehler and Kinsey 1995).

Previously, it was thought that there were only two *Mindarus* species, each Holarctic in distribution: *M. abietinus* Koch on true firs and *M. obliquus* (Cholodkovsky) on spruces. As new, geographically restricted, species were discovered and described (e.g., *M. keteleerifoliae* Zhang in China, *M. japonicus* Takahashi in Japan, and *M. victoria* Essig in British Columbia), taxonomic understanding evolved. Voegtlin (1995) suggested there might exist a much higher, albeit cryptic, species diversity than previously thought, with *M. abietinus* and *M. obliquus* also being restricted geographically. Recent molecular work supports the hypothesis of Voegtlin (1995) (unpublished data; manuscripts in preparation).

To date, three species of *Mindarus* have been described from North America: *M. victoria* Essig (from British Columbia and Washington), *M. kinseyi* Voegtlin (from California, Oregon, and Washington), and *M. remaudierei* Voegtlin (from Mexico). In 1995, *Mindarus* was found in Guatemala on a previously unrecorded host: Guatemalan fir, *Abies guatemalensis* Rehder, which is endemic to the higher elevations of Honduras, Guatemala, El Salvador, and southern Mexico (Farjon 1990). *A. guatemalensis* is listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora and is protected in Guatemala. Continued harvesting threatens its extinction, although it is being cultivated in nurseries and Christmas tree plantations in an attempt to save it (Strandby Andersen et al. 2006). *Mindarus* was found to cause substantial damage to these firs, especially causing distortion of the growing shoots (Nielsen and Córdova 2007). With morphological examination and molecular barcoding, we have determined it to be an undescribed species.

## *Mindarus guatemalensis* New Species

All measurements are in micrometers.

**Apterous Vivipara.** *Head:* antennal tubercles absent; flagellomere III 232–356 (mean = 289,  $n = 8$ ); IV 106–157 (mean = 128,  $n = 8$ ); V 120–169 (mean = 144,  $n = 8$ ); VI 138–201 (mean = 173,  $n = 8$ ); VI base 114–161 (mean = 138,  $n = 8$ ); secondary antennal rhinaria lacking (but see discussion, below); longest seta on flagellomere III 13–23 (mean = 19,  $n = 8$ ); 5–8 setae on tip of processus terminalis; compound eyes present; rostrum extending to metacoxae; accessory setae on ultimate rostral segment (URS) absent; URS 73–81 (mean = 76,  $n = 8$ ). *Thorax:* profemur 344–462 (mean = 395,  $n = 8$ ); protibia 310–459 (mean = 390,  $n = 8$ ); protarsus II 122–148 (mean = 138,  $n = 8$ ); metafemur 399–532 (mean = 454,  $n = 8$ ); metatibia 444–595 (mean = 529,  $n = 8$ ); metatarsus II 142–167 (mean = 160,  $n = 8$ ); tarsus I triangular with four terminal setae and sensory peg; seta on mid-dorsal

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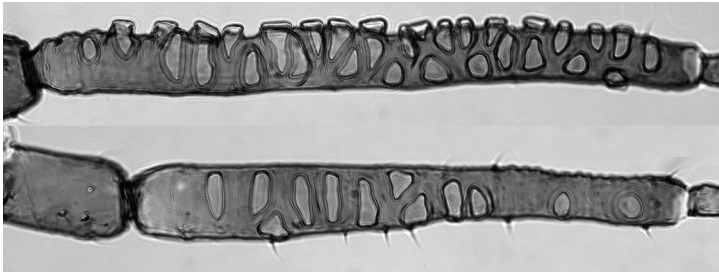


Fig. 1. Flagellomere III on left (top) and right (bottom) sides of alate specimen 412117.

aspect of metatibia 16–22 (mean = 19,  $n = 8$ ). *Abdomen*: wax gland plates typical in morphology, variable in size, with single seta on margin, on abdominal segment I 2, II 2, III 2–4, IV 2–4, V 2–4, VI 4, VII 4, VIII 2; seta on tergite V 11–18 (mean = 13,  $n = 8$ ); siphunculus sclerotized ring; dorsal abdominal setae located on sclerites; genital plate with two setae on anterior margin and 7–13 setae (mean = 9.9,  $n = 8$ ) variably placed but mostly aligned along posterior margin; cauda rounded and not protruding from margin of abdomen.

**Alate Vivipara.** *Head*: antennal tubercles absent; flagellomere III 219–548 (mean = 377,  $n = 34$ ); IV 111–242 (mean = 181,  $n = 34$ ); V 120–274 (mean = 200,  $n = 33$ ); VI 141–271 (mean = 215,  $n = 32$ ); VI base 122–237 (mean = 181,  $n = 32$ ); 9–33 (mean = 17,  $n = 33$ ) rhinaria on flagellomere III; longest seta on flagellomere III 12–21 (mean = 16,  $n = 34$ ); 4–7 setae on tip of processus terminalis; compound eyes present; rostrum extending to metacoxae; accessory setae on ultimate rostral segment (URS) absent; URS 58–88 (mean = 74,  $n = 34$ ). *Thorax*: profemur 315–533 (mean = 427,  $n = 33$ ); protibia 340–719 (mean = 574,  $n = 32$ ); protarsus II 108–172 (mean = 144,  $n = 31$ ); metafemur 342–562 (mean = 461,  $n = 32$ ); metatibia 491–894 (mean = 712,  $n = 31$ ); metatarsus II 119–190 (mean = 163,  $n = 31$ ); tarsus I triangular with four terminal setae and sensory peg; seta on mid-dorsal aspect of metatibia 15–28 (mean = 21,  $n = 31$ ); mesothoracic wing 2250–3350 (mean = 2900,  $n = 34$ ); media with single branch; stigma long, extending to wing tip. *Abdomen*: seta on tergite V 9–20 (mean = 15,  $n = 34$ ); broad sclerites cover large portion of each abdominal tergum, with setae located within wax glands on posterior margin of sclerites; tergite VI narrow; without setae or wax glands; genital plate with two setae on anterior margin and 7–14 setae (mean = 10.2,  $n = 27$ ) variably placed but mostly aligned along posterior margin; anal plate with two unsclerotized tubercles; cauda small and knobbed, without constriction basal to knob.

### Discussion

There is a large amount of morphological variation in the species, especially evident in the leg segment lengths and antennae. All but one apterous specimen had no rhinaria on flagellomere III, with the one exhibiting 8. We suspect it is a developmental aberration,

similar to alatoid adults and alate nymphs we have observed in other species. Flagellomere III in the alata varied considerably in length and in the number and size of the rhinaria. One specimen had a long third flagellomere with many rhinaria on one side (like *M. remaudierei*), and a short third flagellomere with few rhinaria on the other (as in most other *Mindarus* species) (Fig. 1).

**Diagnosis.** *M. guatemalensis* is known to overlap with congeneric species in neither geographic nor host range. *Mindarus* species are often morphologically cryptic, but this species is differentiable from others in lacking accessory setae on the ultimate rostral segment (URS, Fig. 2). Some individuals of other Nearctic species may lack accessory setae on the URS, but then they usually also lack compound eyes. Only rarely do apterous individuals of other Nearctic species both lack accessory setae and have compound eyes, but in no other species do the alatae also lack accessory setae.

The apterae of the new species have fewer wax gland plates than most other described Nearctic species (including second and third generation *M. kinseyi*) but more than the eastern Nearctic species

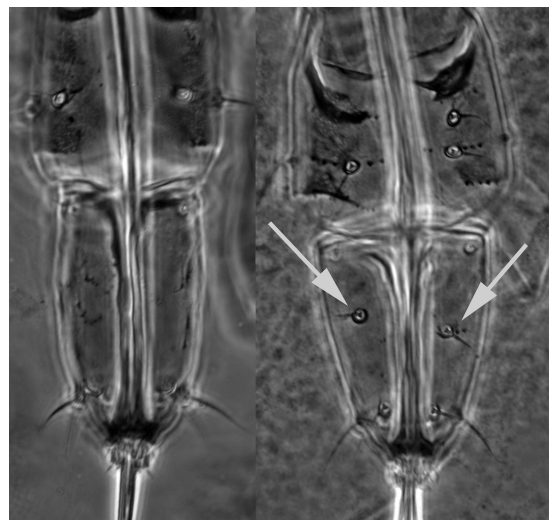


Fig. 2. Ultimate rostral segment of holotype (left) exhibiting the lack of secondary setae in *M. guatemalensis*. Typical URS morphology of other *Mindarus* species (right) with two accessory setae.



Fig. 3. Apterous viviparous holotype of *M. guatemalensis* Favret & Nielsen (specimen 411855).

called *M. abietinus* in previous literature (see fig. 7 in Voegtlin 1995). The wax gland plate pattern of the apterae of *M. guatemalensis* matches only the minimal end of the range for *M. kinseyi* fundatrices, which do not have compound eyes. A key to the *Mindarus* of North America will be published with future species descriptions.

**Biology.** Apart from its distribution and host, the biology of the species is not known to differ from other *Mindarus* species. A full discussion of its economic impact and natural enemies is given by Nielsen and Córdova (2007).

**Etymology.** The species is named for its type locality, Guatemala, and typical host, *A. guatemalensis*.

**Type Material Examined.** Unless otherwise specified, all material is deposited in the U.S. National Museum of Natural History (NMNH) Aphid Collection (Beltsville, MD). Numbers refer to databased catalog numbers unique to the NMNH Entomology Department. All specimens were collected by Nielsen. **Holotype:** (Fig. 3) Apterous vivipara, 399008, Guatemala, Quetzaltenango, Cabrican (15.11° x-91.66°, 2,621-m elevation), 13 June 2006. **Head:** flagellomere III 310; IV 124; V 145; VI 171; VI base 138; longest seta on flagellomere III 19; URS 79. **Thorax:** profemur 379; protibia 395; protarsus II 141; metafemur 454; metatibia 540; metatarsus II 163; seta on mid-dorsal aspect of metatibia 16. **Abdomen:** wax gland plates on abdominal segment I 2, II 2, III 2, IV 2, V 4, VI 4, VII 4, VIII 2; seta on tergite V 13. **Morphotype:** Alate vivipara, 399009, Guatemala, Huehuetenango, Concepción (15.6° x-91.7°), 21 June 2006. **Head:** flagellomere III 494; IV 221; V 245; VI 258; VI base 224; 18 rhinaria on flagellomere III; longest seta on flagellomere III 15; 6 setae

on tip of processus terminalis; URS 82. **Thorax:** profemur 492; protibia 673; protarsus II 150; metafemur 516; metatibia 814; metatarsus II 184; seta on mid-dorsal aspect of metatibia 22. **Abdomen:** seta on tergite V 13. **Paratypes:** apterous viviparae, 399010–399013, 399014 (at the Natural History Museum, London), 399015 (at the Illinois Natural History Survey, Champaign, IL), Guatemala, Quetzaltenango, Cabrican (15.11° x-91.66°, 2,621-m elevation), 13 June 2006. 399016, Guatemala, Quetzaltenango, Zunil, 14 June 2006. Alate viviparae, 399017–399020, Guatemala, Quetzaltenango, Zunil (14.76° x-91.47°, 2,628-m elevation), 14 June 2006. 399021–399022, Guatemala, Quetzaltenango, Carlos Rudy Plantation, 7 June 2006. 399023–399034, 399035 (at the Canadian National Collection, Ottawa), 399036 (at the Illinois Natural History Survey, Champaign), 399037 (at the Muséum National d'Histoire Naturelle, Paris), 399038 (at the Natural History Museum, London), Guatemala, Chimaltenango, Tecpán (14.83° x-90.48°, 2,483-m elevation), 15 June 2006. 399039–399045, Guatemala, Quetzaltenango, Cabrican (15.11° x-91.66°, 2,621-m elevation), 13 June 2006. 399046–399049, Guatemala, Huehuetenango, Concepción (15.6° x-91.7°), 21 June 2006.

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