

**A New Species of *Aphis* in Minnesota
(Hemiptera: Aphididae) on Narrow-Leaved Purple
Coneflower, *Echinacea angustifolia***

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Abstract

Aphis echinaceae, n. sp. is described from specimens collected in Douglas County, Minnesota, on *Echinacea angustifolia* (DC.). The aphid is illustrated with biometric data for alate and apterous vivipara. Its short cauda and siphunculi, and presence of secondary sensoria on antennal segments III, IV, and V in both morphs makes this *Aphis* morphologically similar to *A. debilicornis* (Gillette and Palmer), *A. lugentis* Williams and *A. caliginosa* Hottes and Frison, and root feeding aphids of the subgenus *Pseudoprotaphis* Kadyrbekov and genus *Protaphis* Börner. A diagnosis is provided.

Echinacea is a North American genus well known because some of its members have medicinal properties (Miller and Yu 2004). *Echinacea angustifolia* DC (Asteraceae), is widely distributed in central plains of the U.S. and Canada (USDA-NRCS 2008). The most common genus of aphids living on Asteraceae is *Uroleucon* spp. The only species recorded from *Echinacea purpurea* are *Macrosiphum* spp. and *Uroleucon leonardi* (Olive) (Blackman and Eastop 2006). In 2004 aphids were observed feeding on *E. angustifolia* during an ecological study of this native prairie plant in Minnesota, USA (H. H. Hangelbroek, personal communication). Specimens collected during this study are in the genus *Aphis* but could not be identified using the revision of *Aphis* species that feed on Asteraceae in Minnesota by Cook (1984) or a recent interactive online key to the *Aphis* species of the Midwest (Lagos and Voegtlin 2008). *Aphis* is one of the largest genera within the family Aphididae with approximately 100 species described in the U.S. (Remaudière and Remaudière 1997). *Aphis* species are difficult to discriminate from each other because of the high variation within the characters. Extensive morphological data (Lagos 2007) and molecular analysis (D. M. L., unpublished data) show this aphid to be an undescribed species. This new species is very similar in appearance to species placed in the subgenus *Protaphis* that are primarily root feeders in North America. Kadyrbekov (2001) elevated *Protaphis* to generic level and created another subgenus, *Pseudoprotaphis*. Appropriate placement of taxa in this group will ultimately depend on additional molecular and biological data.

Materials and Methods

Aphid collections: Aphids were found during a study of the ecology and evolution of remnant populations of *E. angustifolia* in prairies of western Minnesota. They were collected by hand from flowers and leaves of host plant between July and August of 2004, and one collection was made in 2008. The aphid collections from 2004 were stored in 70% ethanol and all of them were

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mounted in balsam on slides. The aphid collection from 2008 was stored in 95% ethanol for further molecular studies and some specimens from this collection were also mounted on slides.

Morphometrics: Photographs of the mounted specimens were taken using a Leica DM 2000 digital camera and SPOT software. This software was used to take all the measurements for this study. All measurements are in millimeters. Morphological characters examined are: length of ultimate rostrum segment (URS), ratio of VI: base of last antennal segment (B) and processus terminalis (Pt), length of longest hair on antennal segment III (LHIII), length of second segment of hind tarsus (HT2), length of siphunculi, length of cauda, number of accessory hairs of URS (the six hairs on the tip were not counted), number of secondary sensoria of the antennal segments: III, IV, and V, number of hairs on tergite VIII, presence of additional marginal tubercles on all abdominal segments II, III, IV, dorsal sclerites on abdomen, pre and post-siphuncular sclerites. Color pattern of hind trochanter, hind tibia, siphunculi and cauda. For each character the range is given and the mean is in parenthesis.

Aphis echinaceae New Species.

Diagnosis. *Aphis echinaceae* is differentiable from others by the following set of characters. The alate and apterous viviparae have strongly tuberculated and numerous secondary sensoria on antennal segments III, IV, and V. Cauda and siphunculi are approximately equal in length. Marginal tubercles only on abdominal segments I and VII. Marginal tubercle on VII does not have reticulation. Post-siphuncular sclerite is always present. Alate viviparae without dorsal markings on abdomen, while apterae have small transverse sclerites on I and II; III lacks sclerites; IV and V share two big sclerites, which split in the middle.

Material examined: Alate viviparae (n=21 specimens). Color on slide: Head and thorax dark. Antennal segments, first and second darker than the other segments. Femora dusky or dark on distal half. Coxae dark. Trochanters paler than coxae. Tibiae pale, darkening near distal tip. Tarsi dusky or dark. Cauda dusky. Siphunculi dark. Marginal sclerites, sub-genital plate, and post-siphuncular sclerite dusky. Size: *Body*: 1.5–2 (1.7).



Fig. 1. Types of antennae of alate viviparous. (A) *A. caliginosa*, (B) *A. debilicornis*, (C) *A. echinaceae*, (D) *A. lugentis*, (E) *A. (Protaphis) middletonii*. Thomas.

Head: Antennal segments (Fig. 1C): III 0.30–0.37 (0.33), IV 0.13–0.17 (0.15), V 0.13–0.16 (0.14), B 0.10–0.14 (0.12), Pt 0.20–0.24 (0.22). Pt 1.6–2.1 (1.9)×B. LHIII 0.006–0.011 (0.008). Secondary sensoria: III 15–23 (19), IV 5–11 (7), V 2–5 (3). Secondary sensoria strongly tuberculated restricted to the internal margin. URS 0.12–0.14 (0.13), with 2 accessory hairs. URS 1–1.2×HT2. Rostrum reaches the hind coxae. **Thorax:** Hind tibia 0.68–0.88 (0.77). HT2 0.11–0.14 (0.12). **Abdomen:** Cauda 0.08–0.11 (0.10), with 8–13 hairs, triangular with rounded tip. Siphunculi 0.09–0.13 (0.11), imbricated with reduced flange. Siphunculi is 1–1.4 times the length of the cauda. Pre-siphuncular sclerite absent. Post-siphuncular sclerite present. Diameter of marginal tubercles on abdomen: I 0.020–0.034 (0.027), VII 0.028–0.041 (0.035). Marginal tubercles on abdominal segments II, III, and IV absent. Dorsum of abdomen with small transverse sclerites on VI, VII and VIII. Abdominal tergite VIII with 2–4 hairs. Sub-genital plate with 2–6 hairs on anterior margin.

Holotype: Fig. 2, specimen #237172. Body 1.5, URS 0.13, with 2 hairs. III 0.36, IV 0.17, V 0.14, B 0.13, Pt 0.21, LHIII 0.0078, Secondary sensoria on III 23, IV 7, V 5, Hind tibia 0.82, HT2 0.13, Tubercle I 0.025, Tubercle VII 0.034, siphunculi 0.13, cauda 0.10, with 9 hairs, abdominal tergite VIII with 2 hairs, sub-genital plate with 3 hairs on anterior margin.

Apterous viviparae (n=18 specimens). Color on slide: Head dark. Antennal segments: first, second, fifth and base of last antennal segment dusky; the other segments pale or slightly dusky. Coxae and trochanters dusky. Femora slightly dusky half distally, near basal tips pale. Tibiae pale, darkening near distal tip. Tarsi slightly dusky. Cauda and siphunculi dark. Post-siphuncular sclerite dusky. Marginal sclerites pale. Sub-genital plate dusky. Living aphids are a light yellow green. Size. **Body:** 1.5–2 (1.8). **Head:** Antennal segments: III 0.24–0.33 (0.29), IV 0.12–0.16 (0.15), V 0.13–0.18 (0.15), B 0.11–0.13 (0.12), Pt 0.17–0.24 (0.21). Pt 1.4–2.0 (1.8)×B. LHIII 0.008–0.013 (mean=0.009). Secondary sensoria present on: III 2–15 (6), IV 3–10 (5), V 1–5 (3). Secondary sensoria strongly tuberculated. URS 0.13–0.15 (0.14), 2 accessory hairs. URS 1–1.2×HT2. **Thorax:** Hind tibia 0.65–0.82 (0.73). HT2 0.12–0.14 (0.13). **Abdomen:** Cauda 0.09–0.12 (0.10) with 7–11 (9) hairs, triangular. Siphunculi 0.09–0.14 (0.12), imbricated with flange. Siphunculi is 1–1.4 times the length of the cauda. Pre-siphuncular sclerite absent. Post-siphuncular sclerite present. Diameter of marginal tubercles on abdomen: I 0.021–0.031 (0.025), VII 0.022–0.037 (0.030). Marginal



Fig. 2. Alate viviparous holotype of *A. echinaceae* (Specimen # 237172).

tubercles on abdominal segments II, III, and IV absent. Dorsum of abdomen with small transverse sclerites on I and II; III without sclerites; IV and V share two big sclerites, which split in the middle, and the last abdominal segments VII and VIII have small transverse sclerites. Dorsal sclerotization is shown in Fig. 3C. Abdominal tergite VIII with 3–5 hairs. Sub-genital plate with 2–3 hairs. Cuticle reticulated.

Biology: First field collections were made between July and August of 2004. The aphids were found on the underside of the flower head and leaves. No sexual morphs were collected; therefore its complete life cycle is unknown. This aphid is attended by ants that often build a shelter over the aphid colony or part of a colony when found on the leaf surface.

Etymology: This species is named for its host plant, *Echinacea*.

Type material: All examined materials are deposited in the U.S. Illinois Natural History Survey (INHS). **HOLOTYPE:** Alate viviparous (Fig. 2), 237172, Landfill west, Douglas County, MN, 20-VII-04, on *E. angustifolia*, J. Stevens. **PARATYPES:** 2 alate vivipara, 7 apterous vivipara, 237173 and 238265 (at the National Museum of Natural History, Betsville, MD), 238264 and 238266 (at the Canadian National Collection of Insects, Arachnids, and Nematodes), same data. MINNESOTA: 2 alate vivipara, 1 apterous viviparous, 237167, 238270, Douglas County, Highway 27, 19-VII-04, S. Pimm; MINNESOTA: 2 alate viviparous, 238269, Douglas County, North of golf course, 20-VII-04, S. Pimm; MINNESOTA: 8 alate vivipara, 1 apterous viviparous, 237168, 237170, 237171, 237179, 238273, 238274, Douglas County, NRRX, 20-VII-04, H. Hangelbroek; MINNESOTA: 1 alate viviparous, Douglas County, North of Golf course, 20-VII-04, S. Pimm; MINNESOTA: 5 alate vivipara, 3 apterous vivipara, 237176, 238267, 237268, Douglas County, Yellow Orchard Hill West, 21-VII-04, S. Wagenius; MINNESOTA: 2 alate vivipara, 237181, Douglas County, East Riley, 21-VII-04, J. Stevens; MINNESOTA: 2 alate vivipara, 2 apterous vivipara, 237180, 238272, Douglas County, Steffanson Prairie Preserve, 24-VII-04, S. Pimm; MINNESOTA: 4 alate vivipara, 2 apterous vivipara, 237177, 237178, 238271, Douglas County, Aanenson, 24-VII-04, J. Stevens; MINNESOTA: 2 alate vivipara, 2 apterous vivipara, 237174, 237175, Douglas County, Yellow Orchard Hill West, 24-VII-04, A. Forney; MINNESOTA: 5 alate vivipara, 3 apterous vivipara, 238280-238282, Douglas County, Aanenson, 15-VIII-04, S. Pimm; MINNESOTA: 3 alate vivipara, 1 apterous viviparous, 238278, 238279, Douglas County, Highway 27, 18-VIII-04, H. Hangelbroek; MINNESOTA: 4 alate vivipara, 4 apterous vivipara, 238275-238277, Douglas County, NRRX, 19-VIII-04, S. Pimm; Other collection: MINNESOTA: 11 apterous vivipara, 238283-238287, Wagenius property in Solem township, NW of microwave tower, SW 1/4 SE 1/4 sec. 5, T127 N., R40 W., 7-VIII-08, S. Wagenius.

Discussion

This species is morphologically similar to *A. debilicornis* (Gillette and Palmer), *A. lugentis* Williams, *A. caliginosa* Hottes and Frison, and species in subgenus *Pseudoprotaphis* Kadyrbekov and genus *Protaphis* Börner (Fig. 3). They share the following characters: short siphunculi as long as cauda, and presence of secondary sensoria on antennal segments III, IV and V of alates and apterae. *A. echinaceae* is different from *A. caliginosa* because the last species has smooth secondary sensoria restricted to antennal segment III (Fig. 1A), and its apterous viviparous morph does not have secondary sensoria. It can be discriminated from *A. debilicornis* by the presence of strong tuberculation of secondary sensoria on antennal segments III, IV and V (Fig. 1B), never with marginal tubercles on abdominal segments II-IV, and marginal tubercles on VII are not reticulated in apical view. Figure 4 shows images of marginal tubercles of apterous viviparae of some closely related *Aphis* species. *Aphis echinaceae* can be separated from *A. lugentis*, which has scattered secondary sensoria on antennal segments III and IV (Fig. 1D), hind tibia dark throughout and its

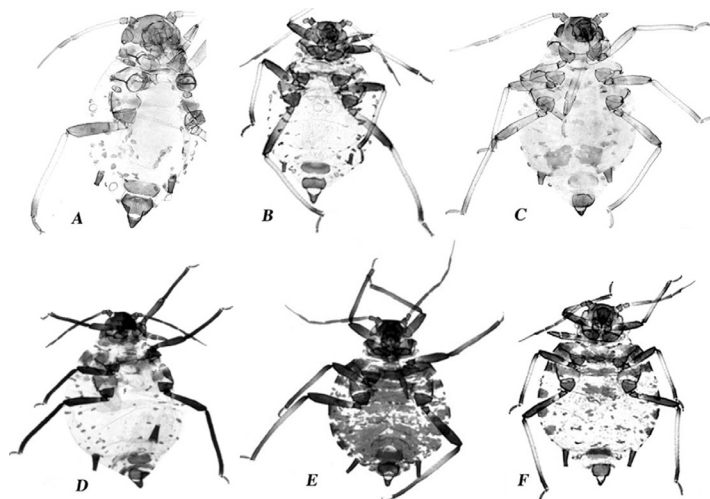


Fig. 3. Apterous vivipara. (A) *A. caliginosa*, (B) *A. debilicornis*, (C) *A. echinaceae*, (D) *A. lugentis*, (E) *A. (Protaphis) knowltoni* Hottes & Frison, (F) *A. (Protaphis) middletonii* Thomas.

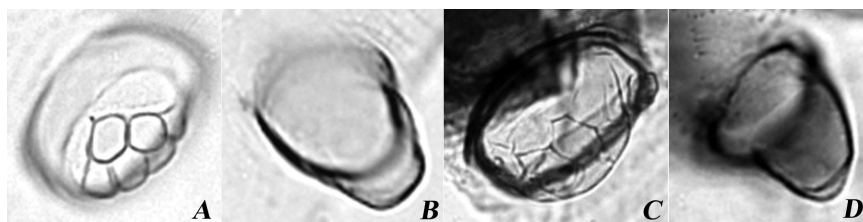


Fig. 4. Tubercles on abdominal segment VII of apterous viviparous. (A) *A. debilicornis*, (B) *A. echinaceae*, (C) *A. (Protaphis) knowltoni*, (D) *A. lugentis*.

apterous morph does not have dorsal sclerite on abdomen (Figs. 3C and 3D). *A. echinaceae* can be separated from *Pseudoprotaphis* because its apterous morph does not have the dorsal sclerotization pattern described by Kadyrbekov (2001). However, other morphological characters match such as processus terminalis is 1.6-2.1, and 1.4-2.0 of base of antennal segment VI of alate and apterous respectively, as well the number of hairs on cauda (8-13, 7-11 hairs on alate and apterous respectively). It is not in *Protaphis* because species within this genus have short processus terminalis, which is 0.8-1.1 of base of antennal segment VI. Since *A. echinaceae* cannot be placed in either the genus *Protaphis* or subgenus *Pseudoprotaphis* it is classified within the subgenus *Aphis*.

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