

Research article

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of the genus *Periphyllus* van der Hoeven, 1863
(Insecta: Hemiptera: Aphididae),
with identification keys including introduced species**Joanna Trela¹, Lukasz Junkiert² & Karina Wieczorek^{3,*}^{1,2,3}*Institute of Biology, Biotechnology and Environmental Protection, Faculty of Natural Sciences,
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Abstract. *Periphyllus* van der Hoeven, 1863 (Hemiptera: Aphididae: Chaitophorinae) is a Holarctic genus, with just three species native to Nearctic: *Periphyllus americanus* (Baker, 1917), *P. brevispinosus* Gillette & Palmer, 1930, and *P. negundinis* (Thomas, 1878). Males and oviparous females of *P. brevispinosus* and *P. negundinis* and males of *P. americanus* are described. Original keys to the identification of the known native and non-native sexual morphs of this genus, associated with maples in the Nearctic Region, are given.

Key words. Aphids, distribution, maple, sexuales.

INTRODUCTION

Periphyllus americanus (Baker, 1917) (American Maple Aphid), *P. brevispinosus* Gillette & Palmer, 1930 (Colorado Maple Aphid) and *P. negundinis* (Thomas, 1878) (Boxelder Aphid) are the only Nearctic species within the genus *Periphyllus* van der Hoeven, 1863 (Hemiptera: Aphididae: Chaitophorinae) (Blackman & Eastop 2019). Apterous and alate viviparous females of these species were extensively collected, described and reported by entomologists throughout the United States and Canada (Gillette & Palmer 1930; Knowlton 1947; Essig & Abernathy 1952; Palmer 1952; Richards 1972). However, the sexual morphs of these species seem to be extremely rarely collected and their detailed description is still lacking (Blackman & Eastop 2019). In particular, the male of *P. americanus* was shortly described, as *P. palmerae* Knowlton, 1947, the oviparous female of *P. brevispinosus* was mentioned by Palmer (1952), whereas the brief description of sexuales of *P. negundinis* was provided by Essig and Abernathy (1952).

In the present study, based on the specimens deposited in the Natural History Museum, London, UK, we re-describe or describe all known sexuales of Nearctic species of the genus *Periphyllus*, except the oviparous female of *P. americanus*, which remains unknown. In addition to

these three native species, three non-indigenous species of the genus *Periphyllus* are also distributed in North America: *P. californiensis* (Shinji, 1917), *P. lyropictus* (Kessler, 1886), and *P. testudinaceus* (Ferne, 1852). According to Footitt et al. (2006), although *P. aceris* (Linnaeus, 1761) has been recorded by numerous authors as introduced to North America, it seems that those records refer to other species. As *Periphyllus* is a highly polymorphic genus, we provide original keys to differentiate all known sexuales of native and non-native species of this genus, associated with maples in North America.

MATERIAL AND METHODS

The specimens were examined using a Nikon Ni-U light microscope equipped with a phase contrast system. The drawings of the morphological details were done free-hand on a Nikon Ni-U light microscope using a camera lucida. In each drawing, the left side represents dorsal view and the right side represents ventral view. On the dorsal side only dorsal setae are shown and on the ventral side only ventral setae are shown.

The measurements were done according to Blackman & Eastop (2019).

Abbreviations for morphological terms

BL	=	body length (from anterior border of the head to the posterior border of anal plate)
BW	=	greatest body width across middle of abdomen
ANT	=	antenna or its length
ANT I–VI	=	antennal segments I–VI or their lengths (ratios between antennal segments are simply given as e.g., ‘VI:III’)
LS ANT III	=	length of longest seta of ANT III
BD III	=	basal articular diameter of ANT III
BASE	=	basal part of the last antennal segment or its length
PT	=	processus terminalis of the last antennal segment or its length
ARS	=	apical segment of rostrum or its length
FEMORA III	=	hind femora length
TIBIA III	=	hind tibia length
HT II	=	second segment of hind tarsus or its length
ABD I–VIII	=	abdominal tergites I–VIII

Institutional abbreviations

NHMUK = Natural History Museum, London, UK

RESULTS***Periphyllus americanus* (Baker, 1917)**

Baker, 1917: 428

Fig. 1

This species is widely distributed in the United States and Canada on several species of maples (Blackman & Eastop 2019). Specifically, it is known in Colorado, Connecticut, Florida, Idaho, Maine, Massachusetts, New York, North Carolina, Pennsylvania, Utah, Washington and Wyoming (USA), and in British Columbia, New Brunswick, Nova Scotia and Quebec (Canada) and its recorded host plants are *Acer floridanum*, *A. glabrum*, *A. grandidentatum*, *A. pseudoplatanus*, *A. saccharinum*, *A. saccharum* (Essig & Abernathy 1952; Palmer 1952; Richards 1972; Smith & Parron 1978; Knowlton 1983).

Material examined. UNITED STATES, Utah, Ogden, 19 October 1958, G. F. Knowlton leg., 1 alate male.

Alate male (Fig. 1). Colour in life: unknown; mounted specimens with head, antennae, pronotum, sclerites, siphunculi and genitalia dark. Legs dark with basal part of femur slightly paler. Body 2.92 mm long and 1.02 mm width. Head with 4–6 pairs of long fine, pointed setae 0.16–0.22 mm long (Fig. 1a). ANT 6-segmented, 2.12–

2.15 mm long (Fig. 1b), reaching ABD VI, 0.71–0.73 × BL. ANT IV 1.50–1.56 ANT V; ANT V always shorter than ANT VI; PT 2.76–3.00 × BASE; other antennal ratios: VI:III 0.70–0.71, V:III 0.47–0.48, IV:III 0.72–0.74. ANT I with 4–8 setae, ANT II with 3–4 setae, ANT III 0.67–0.70 mm long with 11–13 setae (7–8 long pointed setae and 4–5 thick pointed setae), ANT IV 0.50–0.51 mm long with 5–6 setae (3–4 long pointed setae and 1–2 thick pointed setae), ANT V 0.32–0.34 mm long with 1 setae, BASE 0.12–0.13 mm long with 2 setae, PT 0.36 mm long with 3 apical setae. ANT setae: fine, pointed, up to 0.1 mm long; thick, pointed up to 0.025 mm long. ANT III setae 0.01–0.10 mm long. LS ANT III 2.5 × BD III. The whole ANT III–V covered by rounded secondary rhinaria: ANT III with 59–63 rhinaria, ANT IV with 18–32 rhinaria, ANT V with 8 rhinaria. Rostrum reaching hind coxae. ARS 0.13 mm long, 0.18–0.19 × ANT III and 0.76–0.81 × HT II, with 4 accessory setae (Fig. 1c). Legs with numerous, fine and pointed setae, 0.05–0.23 mm long. FEMORA III 0.90 mm long. TIBIA III 1.30 mm long with numerous short spinules distributed on distal 1/3 of tibiae. HT II 0.16–0.17 mm long. Empodial setae spatulate; first tarsal chaetotaxy 5:5:5 (Fig. 1d). Fore wings with normal venation (Fig. 1e). Abdominal tergites membranous, with large fused spinal sclerites, pleural sclerites very small, irregularly placed, marginal sclerites oval. Abdominal setae 0.07–0.22 mm long; marginal sclerites with 4–5 setae (0.1–0.2 mm long), pleural sclerites with 0–1 setae (0.11–0.17 mm long), spinal sclerites with 4–5 setae (0.07–0.22 mm long) (Fig. 1f). Siphunculi 0.17 mm long and 0.18–0.19 width, truncate, reticulated on the whole length, with developed flange and coalescent with each marginal sclerite of ABD VI (Fig. 1g). Cauda 0.08 mm long, broadly rounded, with 8 setae (4 long and 4 short setae) 0.06–0.13 mm long (Fig. 1h). Genitalia well developed, strongly sclerotized with roundish, lobate parameres, covered by numerous spine-like setae. Basal part of phallus rectangular, shortened, with numerous short spinules (Fig. 1i).

***Periphyllus brevispinosus* (Gillette & Palmer, 1930)**

Gillette & Palmer, 1930: 546–547

Figs 2–3

This species is known western North America on *Acer glabrum* (Blackman & Eastop 2019); specifically, it has been recorded from Colorado, Idaho, Oregon, Utah, Washington, and Wyoming (USA) and Alberta and British Columbia (Canada) (Essig & Abernathy 1952; Palmer 1952; Richards 1972; Smith & Parron 1978; Knowlton 1983).

Material examined. UNITED STATES, Colorado, Skyway, 15 September 1956, on *Acer glabrum*, Hottes & H.R.L. leg., 2 alate males, 4 oviparous females, BM 1984 340.

Alate male (Fig. 2). Colour in life: unknown; mounted specimens with head, pronotum, sclerites, siphunculi and genitalia dark. Legs light dark with basal part of femur and middle part of tibiae slightly paler. ANT I–VI dark with ANT III–IV slightly paler at base. Body 2.25–2.37 mm long and 0.80–0.87 mm width. Head with

4–6 pairs of long fine, pointed setae 0.09–0.16 mm long (Fig. 2a). ANT 6-segmented, 2.00 mm long (Fig. 2b), almost reaching ABD VII, about $0.84 \times \text{BL}$. ANT IV 1.30–1.40 ANT V; ANT V about as long as ANT VI; PT 2.30–2.41 \times BASE; other antennal ratios: VI:III 0.62–0.65, V:III 0.45–0.49, IV:III 0.65–0.69. ANT I with 7 se-

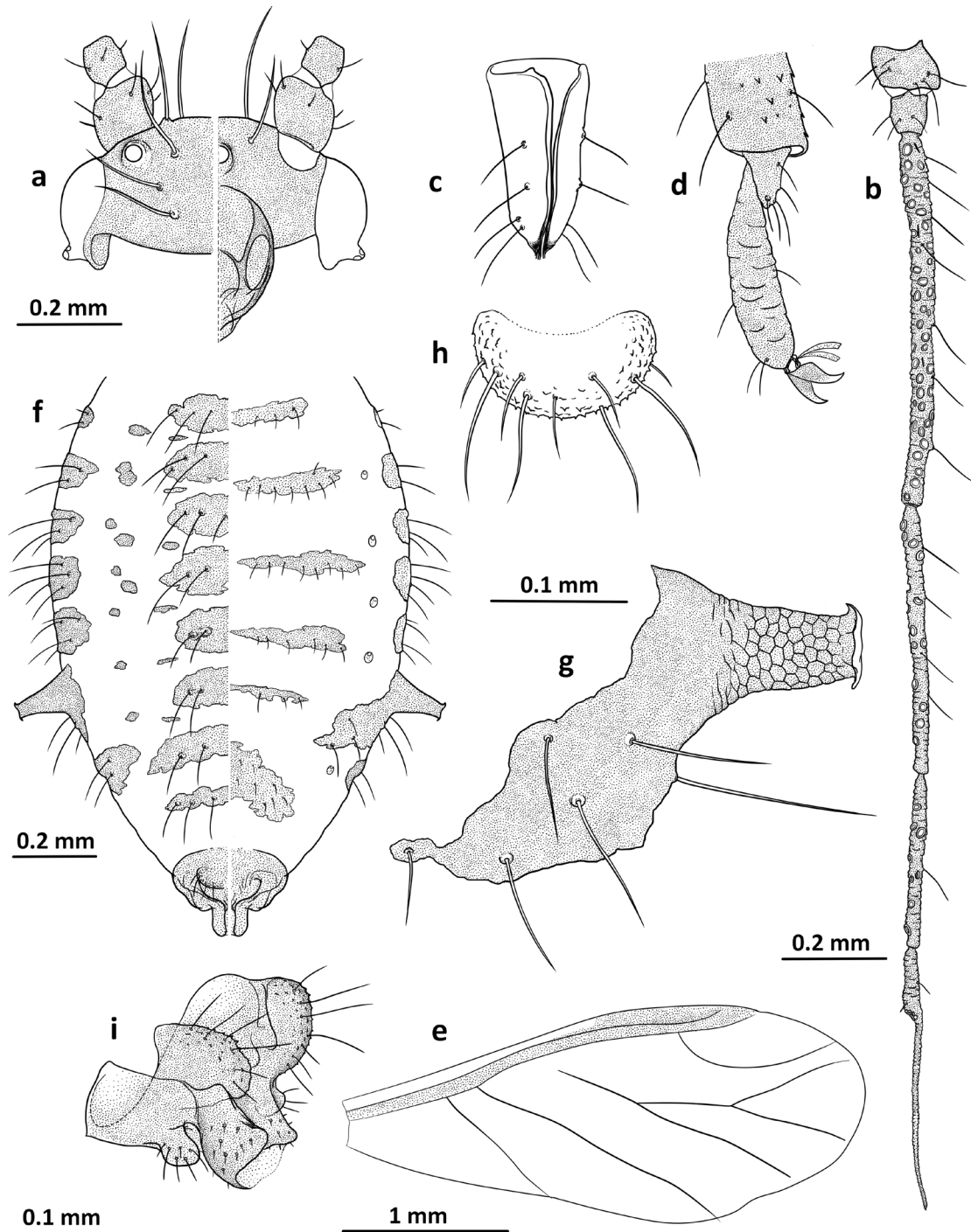


Fig. 1. *Periphyllus americanus* (Baker, 1917), alate male. a. Head. b. Antenna. c. Apical segment of rostrum. d. Hind tarsus. e. Fore wing. f. Abdomen. g. Siphunculus. h. Cauda. i. Genitalia.

tae, ANT II with 7 setae, ANT III 0.63–0.69 mm long with 7–10 setae, ANT IV 0.41–0.48 mm long with 5–7 setae, ANT V 0.31–0.34 mm long with 3–5 setae, BASE 0.12–0.13 mm long with 2 setae, PT 0.29–0.30 mm long with 3 apical setae. ANT setae fine, pointed, 0.03–0.07 mm long. LS ANT III $1.75\text{--}2.33 \times$ BD III. The whole ANT

III–V covered by rounded secondary rhinaria: ANT III with 25–43 rhinaria, ANT IV with 13–23 rhinaria, ANT V with 13–18 rhinaria. Rostrum reaching middle coxae. ARS 0.11 mm long, $0.15\text{--}0.17 \times$ ANT III and $0.64\text{--}0.68 \times$ HT II, with 4 accessory setae (Fig. 2c). Legs with numerous fine and pointed setae 0.02–0.09 mm long. FEM-

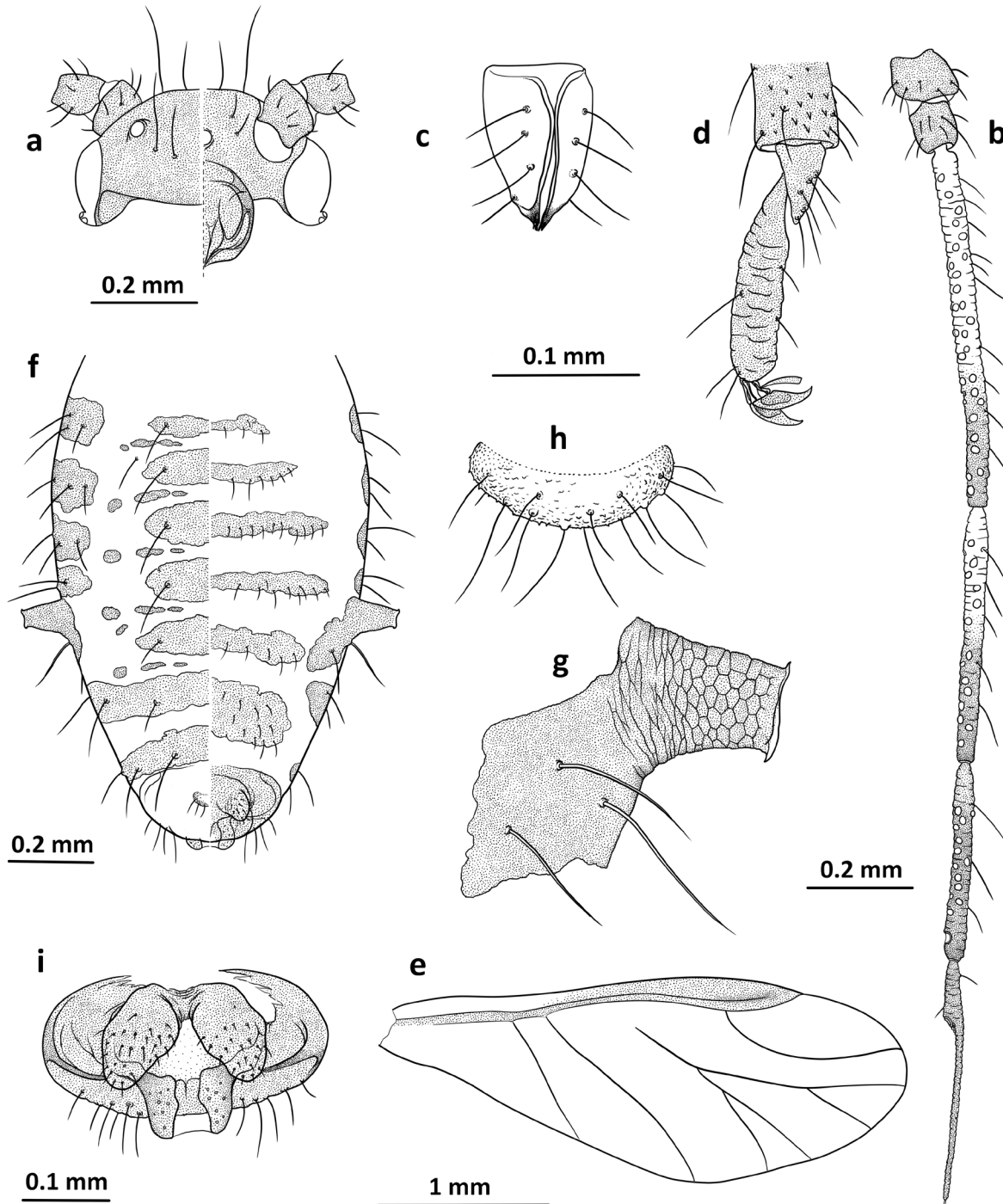


Fig. 2. *Periphyllus brevispinosus* Gillette & Palmer, 1930, alate male. **a.** Head. **b.** Antenna. **c.** Apical segment of rostrum. **d.** Hind tarsus. **e.** Fore wing. **f.** Abdomen. **g.** Siphunculus. **h.** Cauda. **i.** Genitalia.

ORA III 0.73–0.77 mm long. TIBIA III 1.02–1.05 mm long. HT II 0.16–0.17 mm long. Distal part of tibiae with many short spinules; empodial setae spatulate; first tarsal chaetotaxy 5:5:5 (Fig. 2d). Fore wings with normal venation (Fig. 2e). Abdominal tergites membranous,

with large fused spinal sclerites, pleural sclerites very small, irregularly placed, marginal sclerites oval; sclerites on ABD VII–VIII fused in cross bars. Abdominal setae 0.06–0.18 mm long; marginal sclerites with 2–5 setae (0.09–0.18 mm long), pleural sclerites with 0–1

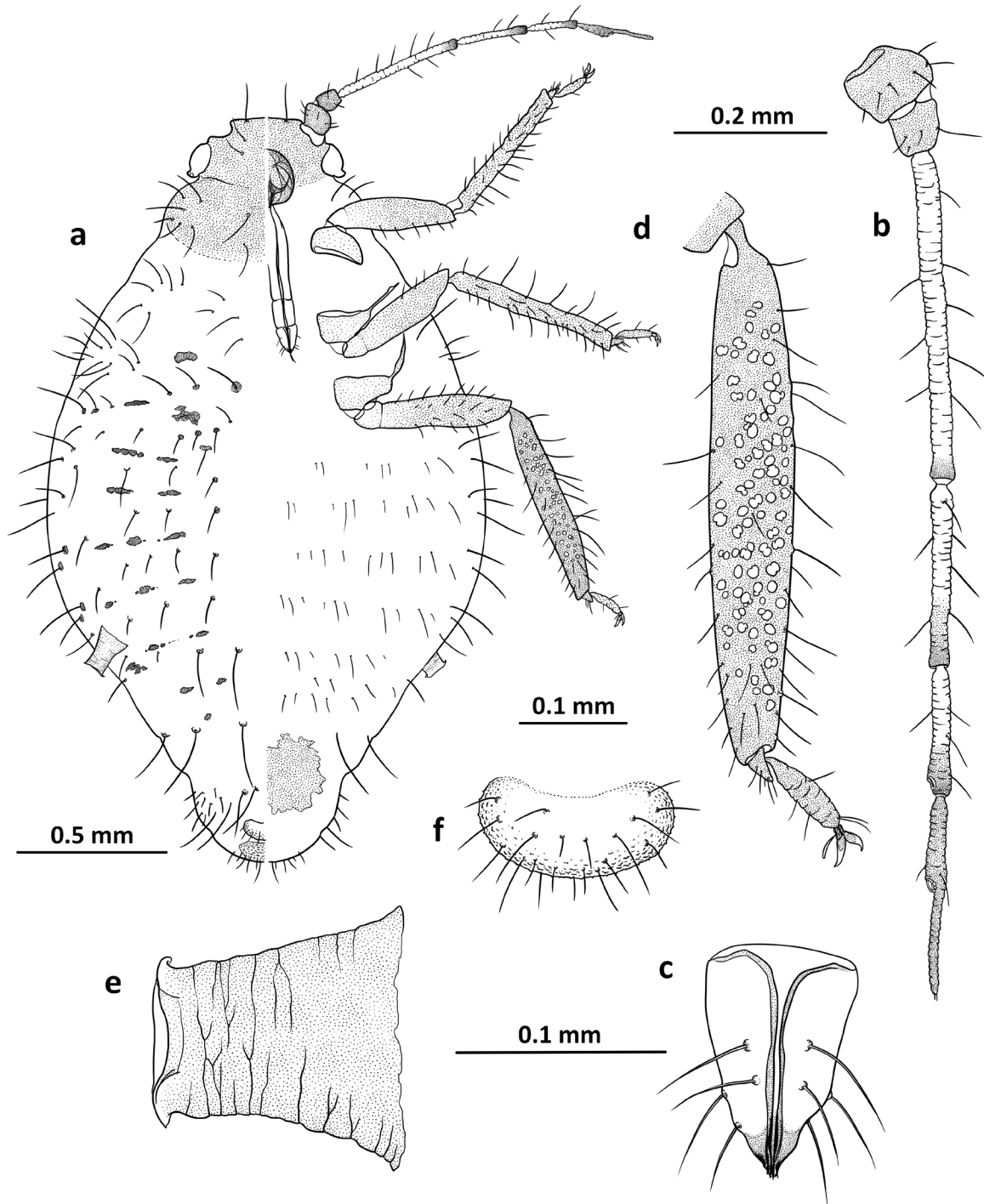


Fig. 3. *Periphyllus brevispinosus* Gillette & Palmer, 1930, oviparous female. **a.** General view. **b.** Antenna. **c.** Apical segment of rostrum. **d.** Hind tibia with pseudosensoria and tarsus. **e.** Siphunculus. **f.** Cauda.

setae (0.07–0.13 mm long), spinal sclerites with 2–3 (0.06–0.17 mm long) setae. Siphunculi 0.11–0.13 mm long and 0.11 width, truncate with developed flange, reticulated, except at base where reticulation transforms into flattened cells and coalescent with each marginal sclerite of ABD VI (Fig. 2g). Cauda 0.06–0.07 mm long, broadly rounded, with 14–15 setae 0.05–0.10 mm long (Fig. 2h). Genitalia well developed, strongly sclerotized with roundish, lobate parameres, covered by numerous spine-like setae. Basal part of phallus triangular, shortened, with numerous short spinules (Fig. 2i).

Oviparous female (Fig. 3). Colour in life: unknown; mounted specimens with head, legs, sclerites and siphunculi dusky. ANT dusky with apices of ANT III–V and ANT VI dark. Body 2.32–2.60 mm long and 1.40–1.55 mm width, pear-shaped (Fig. 3a). Head with 4 pairs of fine, pointed setae 0.06–0.19 mm long. ANT 6-segmented, 1.27–1.40 mm long (Fig. 3b), reaching ABD III–IV, $0.48\text{--}0.59 \times \text{BL}$. ANT IV $1.20\text{--}1.56$ ANT V; ANT V always shorter than ANT VI; PT $0.92\text{--}1.16 \times \text{BASE}$; other antennal ratios: VI:III $0.54\text{--}0.67$, V:III $0.35\text{--}0.50$, IV:III $0.50\text{--}0.65$. ANT I with 4–8 setae, ANT II with 3–5 setae, ANT III $0.40\text{--}0.48$ mm long with 7–9 setae, ANT IV $0.24\text{--}0.28$ mm long with 3–6 setae, ANT V $0.16\text{--}0.20$ mm long with 3–4 setae, BASE $0.12\text{--}0.14$ mm long with 2 setae, PT $0.13\text{--}0.15$ mm long with 3 apical setae. ANT setae fine, pointed, $0.03\text{--}0.07$ mm long. LS ANT III $1.25\text{--}2.33 \times \text{BD III}$. Rostrum almost reaching hind coxae. ARS $0.10\text{--}0.11$ mm long, $0.20\text{--}0.25 \times \text{ANT III}$ and $0.66\text{--}0.76 \times \text{HT II}$ with 4 accessory setae (Fig. 3c). Legs with numerous fine and pointed setae, $0.03\text{--}0.10$ mm long. FEMORA III $0.39\text{--}0.59$ mm long. TIBIA III $0.70\text{--}0.80$ mm long. HT II $0.13\text{--}0.16$ mm long. Hind tibiae with 69–150 8-shaped pseudosensoria distributed on the whole length of tibiae. Distal part of tibiae with few short spinules; empodial setae spatulate; first tarsal chaetotaxy 5:5:5 (Fig. 3d). Abdominal tergites membranous. Abdominal setae $0.05\text{--}0.20$ mm long; marginal sclerites with 2–5 setae ($0.05\text{--}0.20$ mm long), pleural and spinal sclerites with 3 setae ($0.05\text{--}0.15$ mm long). Siphunculi $0.11\text{--}0.12$ mm long and $0.12\text{--}0.13$ mm width, truncate, with weakly visible 2–3 rows of reticulations which at base transform into flattened cells and well-developed flange (Fig. 3e). Cauda $0.09\text{--}0.10$ mm long, broadly rounded, with 20–25 pointed setae (Fig. 3f).

***Periphyllus negundinis* (Thomas, 1878)**

Thomas, 1878: 10

Figs 4–5

Periphyllus negundinis is the most widely distributed in North America among Nearctic species of *Periphyllus* (Blackman & Eastop 2019); it has been recorded from Alabama, Arizona, California, Colorado, Connecticut, Delaware, District of Columbia, Florida, Illinois, Indiana,

Iowa, Kansas, Louisiana, Maine, Maryland, Michigan, Minnesota, Missouri, Mississippi, Montana, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, South Carolina, South Dakota, Texas, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming (USA); Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec and Saskatchewan (Canada) and Mexico (Mexico), being its main host plants *Acer negundo* (Essig & Abernathy 1952; Palmer 1952; Richards 1972; Smith & Parron 1978; Knowlton 1983); also collected from *A. pseudoplatanus* (Palmer 1952).

Material examined. CANADA, Manitoba, Winnipeg, 25 September 1963, on *Acer negundo*, A. G. Robinson leg., 1 oviparous female, BM 1964 630; 1 October 1964, on *Acer negundo*, A. G. Robinson leg., 2 apterous males, BM 1965 33.

Apterous male (Fig. 4). Colour in life: dark green (Essig & Abernathy 1952); mounted specimens with body pale with dusky sclerites; head, pronotum and genitalia dark. Antennae dark with basal part of ANT III paler. Legs dark with basal part of femora slightly paler. Body $1.60\text{--}1.72$ mm long and $0.82\text{--}0.85$ mm width. Head with 6–8 pairs of long fine, pointed setae $0.10\text{--}0.13$ mm long (Fig. 4a). ANT 6-segmented, $1.20\text{--}1.27$ mm long (Fig. 4b), reaching ABD IV, $0.70\text{--}0.79 \times \text{BL}$. ANT IV the same or slightly longer than ANT V; ANT V always shorter than ANT VI; PT $1.81\text{--}2.20 \times \text{BASE}$; other antennal ratios: VI:III $0.70\text{--}0.83$, V:III $0.51\text{--}0.55$, IV:III $0.54\text{--}0.72$. ANT I with 4–5 setae, ANT II with 3–4 setae, ANT III $0.35\text{--}0.36$ mm long with 7–8 setae, ANT IV $0.19\text{--}0.26$ mm long with 3–4 setae, ANT V $0.18\text{--}0.20$ mm long with 2–3 setae, BASE $0.09\text{--}0.11$ mm long with 2 setae, PT $0.19\text{--}0.20$ mm long with 3 apical setae. ANT setae fine, pointed, $0.02\text{--}0.13$ mm long. LS ANT III $3.25\text{--}4.00 \times \text{BD III}$. The whole ANT III–V covered by rounded secondary rhinaria: ANT III with 16–23 rhinaria, ANT IV with 6–11 rhinaria, ANT V with 3–4 rhinaria. Rostrum reaching hind coxae. ARS $0.12\text{--}0.13$ mm long, $0.34\text{--}0.36 \times \text{ANT III}$ and $0.75\text{--}0.76 \times \text{HT II}$, with 4 accessory setae (Fig. 4c). Legs with numerous fine and pointed setae $0.06\text{--}0.16$ mm long. FEMORA III $0.57\text{--}0.58$ mm long. TIBIA III $0.77\text{--}0.81$ mm long. HT II $0.16\text{--}0.17$ mm long. Distal part of tibiae with few short spinules; empodial setae spatulate; first tarsal chaetotaxy 5:5:5 (Fig. 4d). Abdominal tergites membranous, with large, fused spinal sclerites, pleural sclerites smaller than spinal, irregularly placed, fused, marginal sclerites oval. Abdominal setae $0.03\text{--}0.21$ mm long; marginal sclerites with 4–7 setae ($0.03\text{--}0.21$ mm long), pleural sclerites with 1–3 setae ($0.08\text{--}0.15$ mm long), spinal sclerites with 2–6 setae ($0.07\text{--}0.14$ mm long) (Fig. 4a). Siphunculi

0.17–0.18 mm long and 0.07–0.12 mm width, stump-shaped with 2 rows of reticulation and developed flange (Fig. 4e). Cauda 0.04–0.05 mm long, broadly rounded, with 10 setae (Fig. 4f). Genitalia well developed, strongly sclerotized with roundish, lobate parameres, covered by numerous spine-like setae. Basal part of phallus hook-shaped, shortened, with numerous short spinules (Fig. 4g).

Oviparous female (Fig. 5). Colour in life: mottled green, becoming darker as eggs mature within body (Essig &

Abernathy 1952); mounted specimens with body pale with apices of ANT IV–V, ANT VI, tarsi and HTII dark. Body 2.55 mm long and 1.20 mm width, egg-shaped (Fig. 5a). Head with 5–7 pairs of fine, pointed setae 0.12–0.20 mm long. ANT 6-segmented 1.30–1.35 mm long (Fig. 5b), reaching ABD III–IV, $0.50\text{--}0.52 \times \text{BL}$. ANT IV slightly longer than ANT V; ANT V always shorter than ANT VI; PT $2.27 \times \text{BASE}$; other antennal ratios: VI:III 0.58–0.69, V:III 0.55–0.61, IV:III 0.58–0.69. ANT I with 6–8 setae, ANT II with 4–5 setae, ANT III 0.36 mm long with 8–10 setae, ANT IV 0.21–0.25 mm long with 3–4

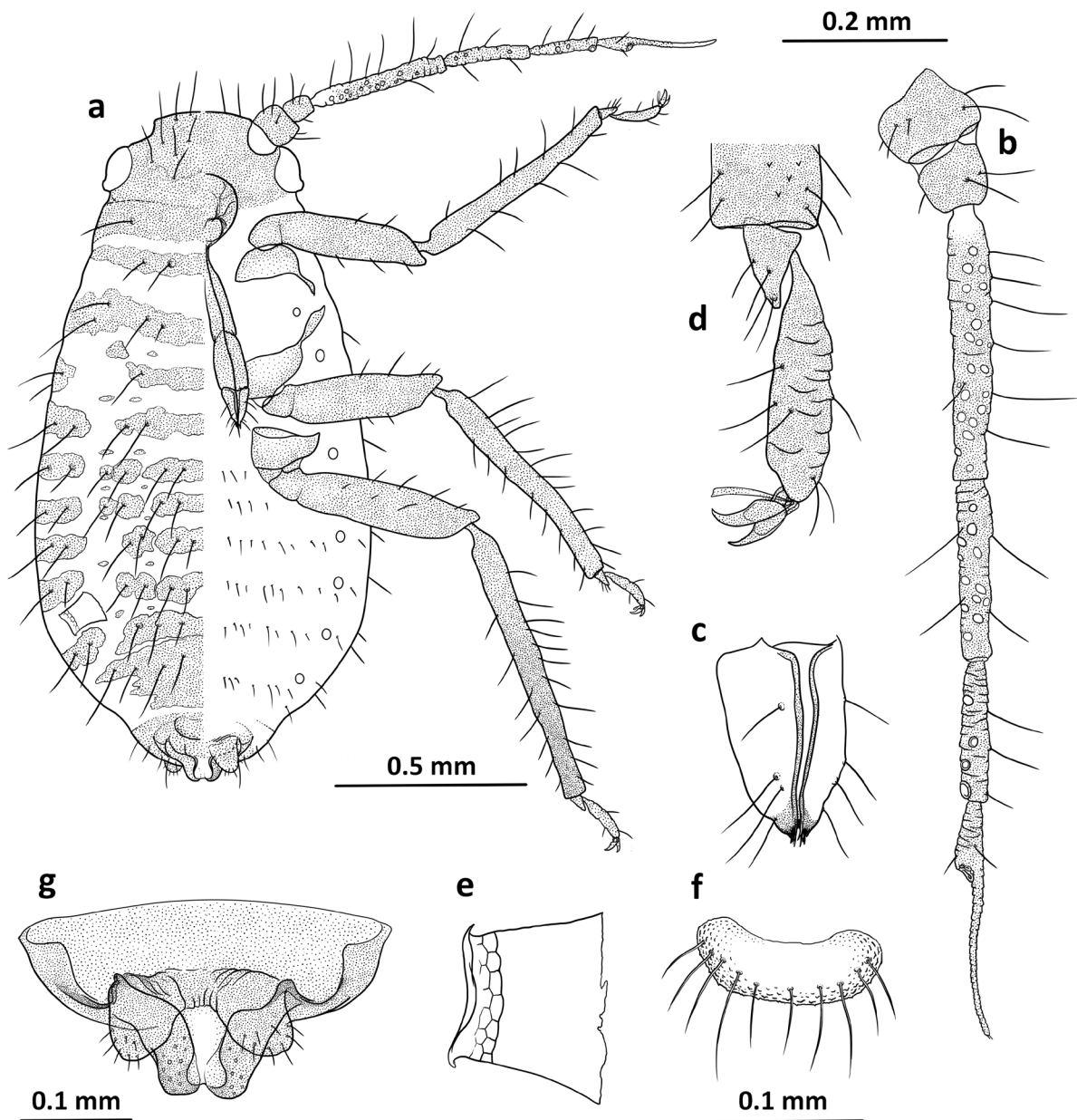


Fig. 4. *Periphyllus negundinis* (Thomas, 1878), apterous male. **a.** General view. **b.** Antenna. **c.** Apical segment of rostrum. **d.** Hind tarsus. **e.** Siphunculus. **f.** Cauda. **g.** Genitalia.

setae, ANT V 0.20–0.22 mm long with 3–4 setae, BASE 0.11 mm long with 2 setae, PT 0.25 mm long with 3 apical setae. ANT setae fine, pointed, 0.02–0.12 mm long. LS ANT III $3 \times$ BD III. Rostrum reaching middle coxae. ARS 0.13 mm long, $0.36 \times$ ANT III and $0.72\text{--}0.76 \times$ HT II with 4 accessory setae (Fig. 5c). FEMORA III 0.64 mm long. TIBIA III 0.89–0.90 mm long. HT II 0.17–0.18 mm long. Legs with numerous fine and pointed setae 0.04–0.15 mm long. Hind tibiae with 120–130 rounded pseudosensoria, sometimes fused and distributed on the whole

length of tibiae except basal and distal part. Distal part of tibiae with few short spinules; empodial setae spatulate; first tarsal chaetotaxy 5:5:5 (Fig. 5d). Abdominal tergites membranous. Abdominal setae numerous, fine, regularly placed all over abdomen, 0.06–0.22 mm long. Siphunculi 0.10 mm long and 0.15–0.16 mm width, stump-shaped, with 3–4 rows of reticulations and well-developed flange (Fig. 5e). Cauda 0.08 mm long broadly rounded, with 12 setae 0.05–0.15 mm long (Fig. 5f).

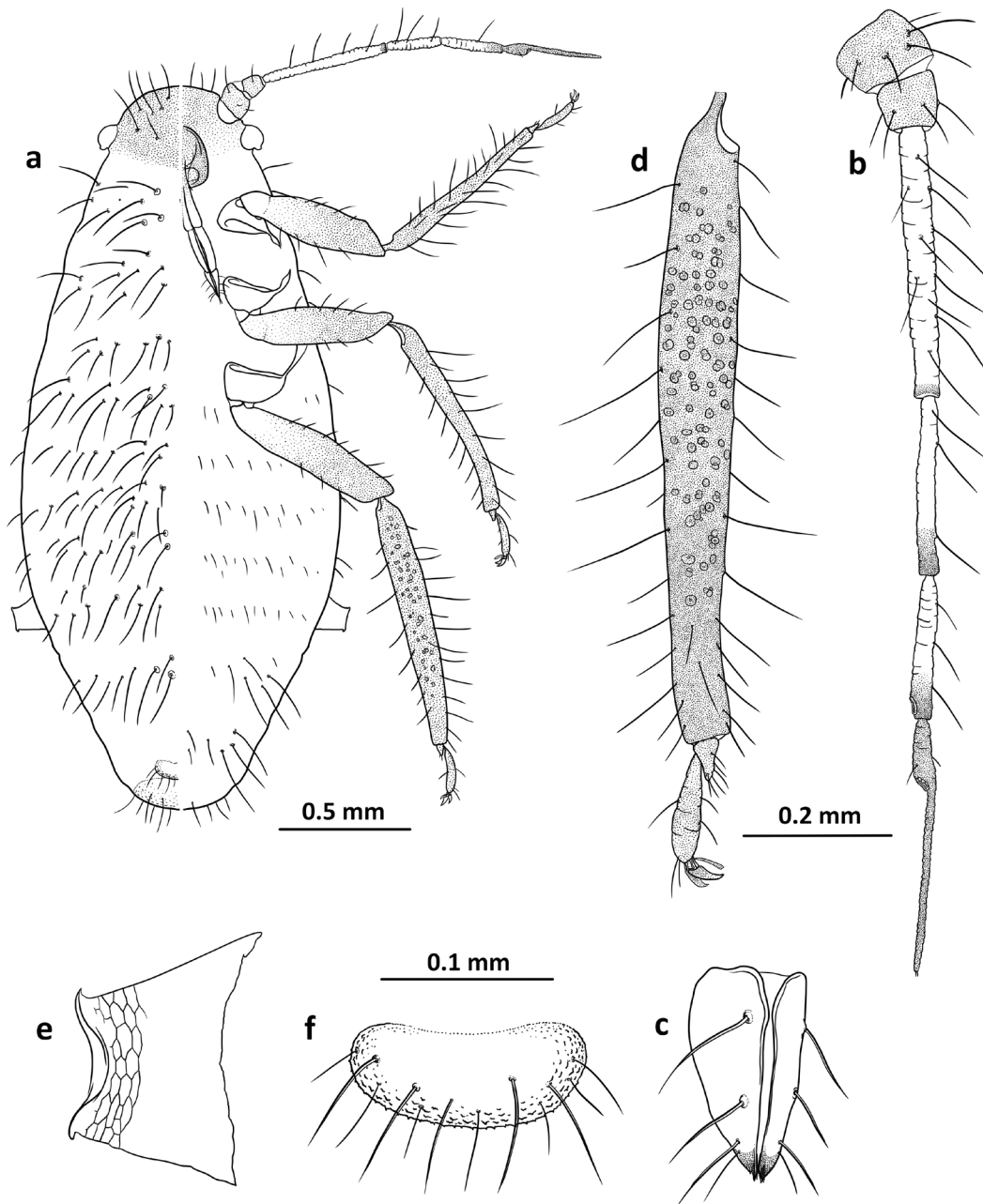


Fig. 5. *Periphyllus negundinis* (Thomas, 1878), oviparous female. **a.** General view. **b.** Antenna. **c.** Apical segment of rostrum. **d.** Hind tibia with pseudosensoria and tarsus. **e.** Siphunculus. **f.** Cauda.

Key to males of species of *Periphyllus* (native and introduced) known from the Nearctic

1. Apterous *P. negundinis*
– Alate **2**
2. Hind tibiae uniformly dark **3**
– Hind tibiae pale, dusky or dark only on base and apex **4**
3. Siphunculi reticulated on the whole length, PT 2.76–3.00 × BASE *P. americanus*
– Siphunculi reticulated on apical 2/3, imbricated to wider base, PT > 3.0 × BASE *P. californiensis*
4. Hind tibiae pale or dusky. Cauda helmet-shaped
..... *P. lyropictus*
– Hind tibiae dark on base and apex, pale at middle part. Cauda broadly-rounded **5**
5. PT 2.30–2.41 × BASE *P. brevispinosus*
– PT 5.70–5.90 × BASE *P. testudinaceus*

Key to oviparous females of the species of *Periphyllus* (native and introduced) known from the Nearctic

1. Cauda helmet-shaped *P. lyropictus*
– Cauda broadly rounded **2**
2. PT 0.92–2.60 × BASE **3**
– PT 3.00–3.50 × BASE *P. testudinaceus*
3. Body pear-shaped and dusky with dark ANT VI and apices of ANT III–V *P. brevispinosus*
– Body egg-shaped and pale with dark tarsi, hind tibiae, ANT VI, and apices of ANT IV–V **4**
4. Siphunculi pale. On *Acer negundo* or *A. pseudoplatanus* *P. negundinis*
– Siphunculi dark. On Asian ornamental maples
..... *P. californiensis*

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