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ANTENNAL AND OTHER CHARACTERS USEFUL IN IDENTIFICATION OF THE APHIDOIDEA (HOMOPTERA)

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Abstract.—Aphids, adelgids, and phylloxerans are soft-bodied insects that damage ornamental plants and agricultural crops by sucking plant sap or through the transmission of plant viruses. Identification, even to family, of these insects can be difficult. This article contains information on antennal characters that are useful in recognition of the developmental forms of aphids, adelgids, and phylloxerans.

Key Words: Aphids, adelgids, phylloxerans, antennae, morphs

Homopterous insects are an interesting and diverse group. The structure of the piercing-sucking mouthparts distinguishes members of the Homoptera from other insects (Blackman 1974). Identification at family level can be a challenge because there are few characters that separate homopterous families.

The Aphidoidea contains three families: Aphididae (aphids), Adelgidae (adelgids), and Phylloxeridae (phylloxerans or phylloxerids). The subfamilies in the Aphididae are given family status by some workers (Heie 1987, Foottit and Richards 1993). Members of the Aphidoidea often have complex life cycles, including variable successions of morphologically different developmental forms (morphs) and alternation of hosts between a primary host (often a woody plant) and a secondary host (usually an herbaceous plant). Aphids are found on a broad range of plant families, adelgids are limited to conifers, and phylloxerans are found on deciduous plants. For a discussion of and keys to aphidoid immatures, see *Immature Insects* (Stoetzel 1991).

Most aphidoid morphs have piercing-sucking mouthparts, but some sexual forms (sexuales) have rudimentary or vestigial mouthparts. Many species have wax glands. Aphids are distinctive in having paired cornicles (siphunculi) located on the fifth or sixth abdominal segments, but some lack these structures. Cornicles have many shapes and sizes and are known to emit an alarm pheromone (Nault et al. 1973, Dixon 1985). The ninth abdominal tergite is modified into a cauda (tail) that is variable in shape and size.

Identification, even to family, of some of the forms in the Aphidoidea can be difficult. This article contains information on antennal characters that is useful in recognition of the variable forms in the Aphidoidea. As in all insects, the antennae in the Aphidoidea consist of two, round, basal segments called the scape and pedicel and a usually multisegmented and elongated flagellum. The scape and pedicel are without special characters, but the flagellum is distinctive and provides characters for distinguishing among the aphidoid families and between the Aphidoidea and other insects.

APHIDIDAE
(Fig. 1)

Most aphids have 4-, 5-, or 6-segmented antennae. Rarely, in *Dasyaphis* (Takahashi 1965) and *Nipponaphis* (Miyazaki 1987), the flagellum is one segmented with two primary sensoria and a faint distinction between base and unguis. The basal two segments, the scape and pedicel, are without differences. The flagellum is distinctive in possessing primary and often secondary sensoria (rhinaria) and an ultimate segment divided into a base and unguis (processus terminalis or terminal process). The presence of one primary sensorium on the ultimate segment at the juncture of the base and the unguis and another primary sensorium on the distal or apical portion of the penultimate segment is distinctive. No other insect taxon displays these antennal characters. When present, secondary sensoria can be found on one or all of the ultimate 2–4 antennal segments of adults. Secondary sensoria do not occur on antennae of immatures. Antennal sensoria are variable in shape (circular, oval, annular, irregular) and size and are olfactory in function (Dunn 1978, Shambaugh et al. 1978, Bromley and Anderson 1979). The similarity of the primary sensoria with secondary sensoria in some species, especially in the Pemphiginae, make it difficult to determine the division of the ultimate antennal segment into a base and unguis.

Stem mothers (fundatrices) are nearly always wingless, usually have 5-segmented antennae (Fig. 1A), and may have secondary sensoria on the last 3 segments. Their immature stages have 4- or 5-segmented antennae. Wingless females (apterae) and their immature stages usually have 5- or 6-segmented antennae (Fig. 1B). Winged females (alatae) usually have 5- or 6-segmented antennae (Fig. 1C) and usually have secondary sensoria on one or more of the terminal segments. Their immature stages usually have 5- or 6-segmented antennae. Egg-laying females (oviparae) are usually wingless and usually have 5- or 6-segmented antennae (Fig. 1D). Their immature stages usually have 5- or 6-segmented antennae. Males are winged or wingless, usually have 5- or 6-segmented antennae (Fig. 1E), and usually have many secondary sensoria on all flagellar segments. Their immature stages usually have 5- or 6-segmented antennae. The antennae of all the morphs of *Myzus persicae* (Sulzer), the green peach aphid, are illustrated in Fig. 1.

ADELGIDAE
(Fig. 2)

Adelgids have 3-, 4- or 5-segmented antennae. The basal two segments, the scape and pedicel, are without differences. The flagellum differs in all forms. Adelgids have a complex life cycle that often spans two years. Most species alternate hosts between *Picea* spp. (spruce), and a specific species but any of a number of species of other conifer genera. Some species do not have a secondary host but complete their development on spruce. Some species do not return to spruce but remain on the non-spruce coniferous host (Annand 1928, Carter 1971).

Wingless females (Fig. 2A) and their immature stages have 3-segmented antennae and could be confused with phylloxerans except for the presence of 4 or 5 abdominal spiracles, an abundance of wax glands usually arranged in plates, and the presence of a sclerotized ovipositor in the adults. Winged females (Fig. 2B) have 5-segmented antennae. Each of the terminal three segments has a large sensorium. No other insect displays these antennal characters. Egg-laying females (oviparae) (Fig. 2C) are wingless. They and their immature stages have 4-segmented antennae with the third segment longer than the fourth. The wingless males and their immature stages have 4-segmented antennae (Fig. 2D) with the third segment longer than the fourth. The antennae of all the morphs of *Adelges cooleyi* (Gillette), the Cooley spruce gall adelgid, are illustrated in Fig. 2.

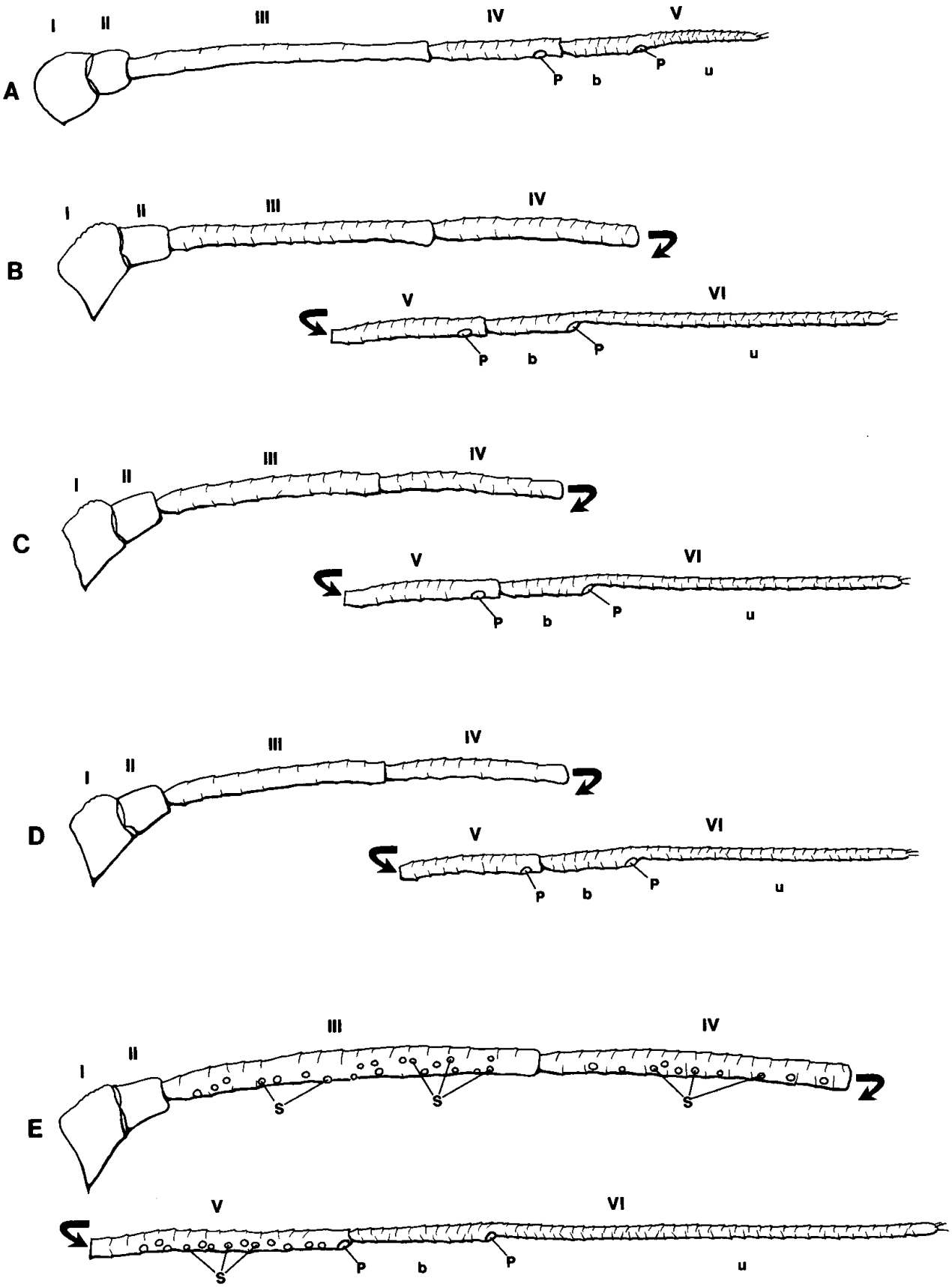

Fig. 1. Aphididae antennae, *Myzus persicae*. A, Stem mother or fundatrix. B, Wingless female or aptera. C, Winged female or alata. D, Egg-laying female or ovipara. E, Male. Abbreviations: P = primary sensorium; S = secondary sensorium; b = base of ultimate antennal segment; u = unguis portion of ultimate antennal segment.

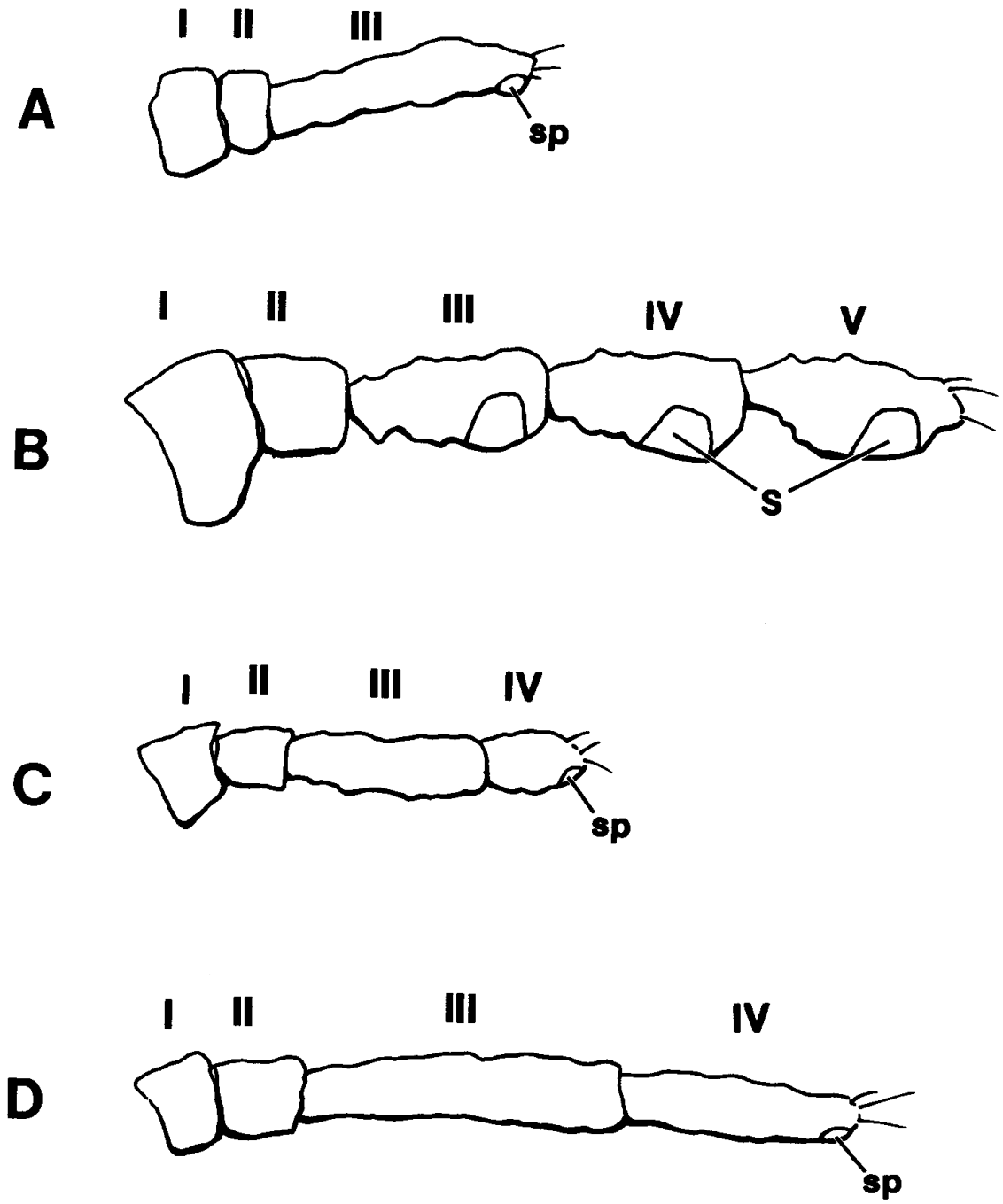

Fig. 2. Adelgidae antennae, *Adelges cooleyi.* A, Wingless female or aptera. B, Winged female or alata. C, Egg-laying female or ovipara. D, Male. Abbreviations: S = sensorium; sp = sensory peg.

PHYLLOXERIDAE
(Fig. 3)

Phylloxerids have 3-segmented antennae. The basal two segments, the scape and pedicel, are without differences. In all species the flagellum ends in a sensory peg or sensorium that differs in size and location. Some winged adult females have one or two additional sensoria on the flagellum. In *Phylloxera notabilis* Pergande, winged females have what appear to be 4-segmented antennae because the sensorium on the third segment usually is divided into two elongate masses, but the constriction between these areas is not articulated. The most studied species of phylloxeran is *Daktulosphaira vitifoliae* (Fitch), the grape phylloxeran, a worldwide pest of *Vitis.* Most species of phylloxerans develop on species of *Carya* where they produce galls on leaves

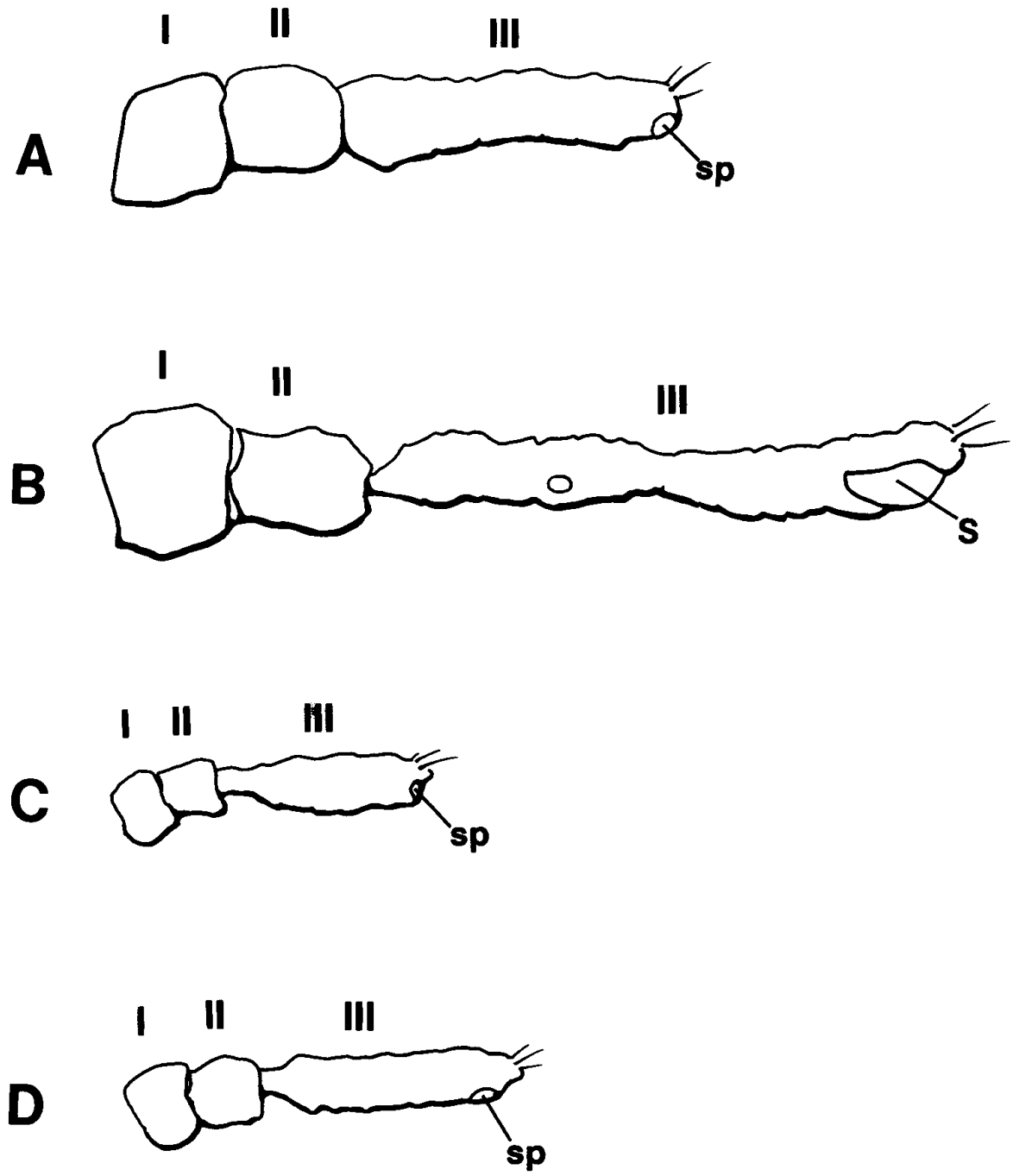

Fig. 3. Phylloxeridae antennae, *Phylloxera devastatrix*. A, Stem mother or fundatrix. B, Winged female or alata. C, Egg-laying female or ovipara. D, Male. Abbreviations: S = sensorium; sp = sensory peg.

and stems (Pergande 1904, Stoetzel 1981). Some species have been shown to alternate between species of *Carya* and *Quercus* or *Castanea* (Stoetzel 1985a).

Wingless and winged females and their immature stages have 3-segmented antennae (Figs. 3A, 3B) and could be confused with adelgids except that adults have a vulva instead of a sclerotized ovipositor and lack the wax glands and plates found in most adelgids. Egg-laying females (oviparae) have vestigial mouthparts and are wingless. They and their immature stages have 3-segmented antennae (Fig. 3C). Males have vestigial mouthparts and are wingless. They and their immature stages have 3-segmented antennae (Fig. 3D). The immatures of the sexuales are unique in that they are pupiform larvae which do not feed or move except for undulating motions dur-

ing molting (Stoetzel 1985b). The antennae of all the morphs of *Phylloxera devastatrix* Pergande, the pecan phylloxera, are illustrated in Fig. 3.

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