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An analysis of the genus *Aleyrodes* Latreille
(Hemiptera: Sternorrhyncha: Aleyrodidae) in California,
with three synonymies

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An analysis of the genus *Aleyrodes* Latreille (Hemiptera: Sternorrhyncha: Aleyrodidae) in California, with three synonymies

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Abstract. Based on the examination of an extensive series of specimens and available type material, three out of the six species of *Aleyrodes* Latreille (Hemiptera: Sternorrhyncha: Aleyrodidae) described from California, *A. diasemus* Bemis, 1904, *A. essigi* Penny, 1922, and *A. osmaroniae* Sampson, 1945, are **newly synonymized** under *A. spiraeoides* Quaintance, 1900. The species of *Aleyrodes* reported from California are keyed and diagnosed based on characters from puparia and male genitalia, and character variability is documented and illustrated.

Key words. Whiteflies, taxonomy, puparium, adult, variability, *Aleyrodes amnicola*, *Aleyrodes diasemus*, *Aleyrodes essigi*, *Aleyrodes osmaroniae*, *Aleyrodes proletella*, *Aleyrodes pruinosus*, *Aleyrodes spiraeoides*.

Resumen. Basado en el examen de una extensa serie de especímenes y material tipo disponible, tres de las seis especies de *Aleyrodes* Latreille (Hemiptera: Sternorrhyncha: Aleyrodidae) descritas de California, *A. diasemus* Bemis, 1904, *A. essigi* Penny, 1922 y *A. osmaroniae* Sampson, 1945, son **aquí sinonimizadas** con *A. spiraeoides* Quaintance, 1900. Las especies de *Aleyrodes* registradas de California son incluidas en una clave y diagnosticadas basándose en caracteres de puparia y genitalia del macho, y la variabilidad de los caracteres es documentada e ilustrada.

Palabras clave. Moscas blancas, taxonomía, pupario, adulto, variabilidad, *Aleyrodes amnicola*, *Aleyrodes diasemus*, *Aleyrodes essigi*, *Aleyrodes osmaroniae*, *Aleyrodes proletella*, *Aleyrodes pruinosus*, *Aleyrodes spiraeoides*.

ZooBank registration. urn:lsid:zoobank.org:pub:EE1FB0AE-45B7-40D6-8B6F-4B2509A08FDC

Introduction

Thirty-five species are currently included worldwide under *Aleyrodes* Latreille, of which nine are reported from the United States (Evans 2007; Hernández-Suárez et al. 2012). From these, six were described based on specimens from California: *Aleyrodes spiraeoides* Quaintance, 1900, *A. amnicola* Bemis, 1904, *A. diasemus* Bemis, 1904, *A. pruinosus* Bemis, 1904, *A. essigi* Penny, 1922, and *A. osmaroniae* Sampson, 1945, and the introduction of a seventh species, the European *A. proletella* (Linnaeus, 1758), was reported for this state in 2001 (Penrose 2001). Three of these species, *A. diasemus*, *A. essigi*, and *A. osmaroniae*, were never recorded again after their original descriptions. There are no published keys allowing for the identification of all species in this genus, and their status in California is unclear. In order to evaluate their morphological characters and determine their degree of intraspecific variation, identify reliable diagnostic characters, and provide identification means for the species of this genus recorded from California, an analysis of a large series of specimens and of available type material was undertaken, and the ensuing results are presented here.

Materials and Methods

Over 1,000 specimens were examined and are listed under each species account. Collection acronyms are as follows:

BME Bohart Museum of Entomology, University of California, Davis, California, U.S.A.

CAS California Academy of Sciences, San Francisco, California, U.S.A.

CSCA California State Collection of Arthropods, Sacramento, California, U.S.A.

USNM United States National Collection of the National Museum of Natural History, Smithsonian Institution, housed at the United States Department of Agriculture, Beltsville, Maryland, U.S.A.

Puparia (fourth instar nymphs) and adults were slide-mounted in Canada balsam according to the procedure described in Wilkey (1962) as modified by Hodges and Evans (2005).

Morphological characteristics were examined at 10–60× under a Nikon eclipse 80i compound microscope with phase contrast illumination, fitted with an ocular micrometer used for measurements and a Leica MC 190 HD digital camera used to take microphotographs. Montaged images were stacked using Helicon Focus, and background editing and plate construction were done in Adobe Photoshop 2020 and Microsoft Visio 2208. Color photographs were taken in the laboratory from samples submitted to the Plant Pest Diagnostics Center of the California Department of Food and Agriculture, field collected specimens, or specimens from the CSCA dry collection with a WILD M5 microscope fitted with a phototube and camera back, a Nikon SMZ1500 microscope fitted with a Leica MC 190 HD digital camera, and a Zeiss Discovery.V20 microscope fitted with a Leica MC 170 HD digital camera. Figures are not to scale.

Measurements are given in Table 1 in micrometers (μm) and are based on ten specimens of each species that were selected to encompass the full range of distribution, hosts, and variability of each species. Qualitative characters found to be diagnostic were checked in all available specimens.

Host plants recorded for each species in California are provided in Table 2 and are arranged by family.

Names in synonymic lists include name combination changes, synonyms, and change in name spellings, and are arranged chronologically. References cited under each name are also arranged chronologically and are not exhaustive; only references that provide new information are included and references that only repeat previously published information are excluded.

Results

Examination of an extensive series of specimens and available type material revealed no differences between each of three species of *Aleyrodes* described from California, *A. diasemus*, *A. essigi*, and *A. osmaroniae*, and *A. spiraeoides*, and they are here considered junior subjective synonyms (see New Synonymies section under the account for *A. spiraeoides*).

The morphology of the four species of *Aleyrodes* recognized here as occurring currently or historically in California is very uniform; all of these share puparia (Fig. 13–28) which have a crenulated margin not modified at the thoracic and caudal clefts, defined dorsal anteromedial depressions, abdomen with eight subequal segments lacking median tubercles, vasiform orifice (Fig. 33–41) elongate-cordate about as wide as long with clearly defined postero-lateral margin and with an exposed spinulose lingula, a trapezoidal operculum covering only the anterior half of the vasiform orifice, and chaetotaxy including anterior and posterior marginal setae and dorsal setae pairs including cephalic, caudal, first and eighth abdominal, sometimes meso- and metathoracic, and 12 submarginal. No consistent differences among the species were found in the shape of puparium, vasiform orifice, operculum, lingula, abdominal segments, marginal area, and length of setae. The setae are usually very short, but in some specimens of all four species (noted under specimens examined in square brackets) the caudal pair, or caudal pair and additional setal pairs, can be longer, even longer than the vasiform orifice. Puparia of *A. prolella* and *A. spiraeoides* are on average slightly smaller than those of *A. amnicola* and *A. pruinosus*, but their size ranges overlap (Table 1). Adults of all four species have two diffuse black spots on each forewing (e.g., Fig. 5, 8), and no specific differences were found in the morphology of their antennae, wing and body color pattern, number of leg bristles and brushes, or ovipositor. Adult females form a white, circular wax ring outside of and concentric to

Table 1. Measurements (in μm) of *Aleyrodes* species found in California. For each character, averages and standard deviations are shown above, and ranges below. L: length; W: width; VO: vasiform orifice.

	<i>A. amnicola</i> Bemis	<i>A. proletella</i> (L.)	<i>A. pruinus</i> Bemis	<i>A. spiraeoides</i> Q.
Puparium				
L	1,265 \pm 136 1,050–1,500	1,030 \pm 115 850–1,200	1,243 \pm 65 1,125–1,330	1,116 \pm 127 900–1,320
Maximum W	932 \pm 127 752–1135	813 \pm 98 650–917	896 \pm 58 805–980	832 \pm 111 580–950
L/ W	1.36 \pm 0.06 1.26–1.46	1.27 \pm 0.05 1.18–1.33	1.39 \pm 0.04 1.34–1.45	1.34 \pm 0.13 1.14–1.55
VO L	83 \pm 5 70–92	69 \pm 5 58–75	85 \pm 4 80–92	77 \pm 7 65–87
VO W	78 \pm 5 65–85	70 \pm 5 58–75	83 \pm 4 75–87	73 \pm 7 58–82
VO L/ W	1.07 \pm 0.05 1.00–1.17	1.00 \pm 0.02 0.94–1.03	1.02 \pm 0.05 0.97–1.12	1.04 \pm 0.05 0.97–1.17
Adult male				
L	1,519 \pm 125 1,330–1,649	1,473 \pm 93 1,360–1,630	1,457 \pm 145 1,280–1,630	1,510 \pm 157 1,240–1,750
Mesotibial brush	3	2–4 (usually 3)	2–4 (usually 3)	2–4 (usually 3)
Metatibial brush	2–4 (usually 3)	2–3 (usually 3)	3	3–4 (usually 3)
Metatibial comb	18–24	23–27	22–30	19–26
Paramere L	140 \pm 7 128–148	140 \pm 6 131–146	150 \pm 3 146–155	138 \pm 9 121–150
Aedeagus L	103 \pm 10 87–119	119 \pm 9 112–141	106 \pm 8 102–126	102 \pm 7 97–116
Paramere/Aedeagus	1.36 \pm 0.08 1.2–1.47	1.18 \pm 0.07 1.03–1.25	1.42 \pm 0.11 1.19–1.52	1.36 \pm 0.07 1.25–1.43
Adult female				
L	1,713 \pm 117 1,557–1959	1,504 \pm 69 1,455–1,552	1,588 \pm 124 1,426–1,765	1,522 \pm 74 1,420–1,620
Mesotibial brush	3	3	2–4 (usually 3)	3–4 (usually 3)
Metatibial brush	2–3 (usually 3)	3	3	3–4 (usually 3)
Metatibial comb	19–25	25–27	23–28	19–25
Ovipositor L	198 \pm 9 194–218	177 \pm 10 170–184	206 \pm 22 165–223	181 \pm 9 170–194

the egg ring (e.g., Fig. 7, 9); this wax ring apparently rubs off from the wing tips as the females drag them along the leaf surface during oviposition. Adults also coat the leaf surfaces with powdery white wax, and if nymphs or puparia are present, they are also covered with powdery wax. Both the powdery wax and the wax egg rings probably serve a protective function. No other wax secretions are evident except for white marginal wax present on nymphs and occasionally on some puparia.

Puparium color, which was the main character upon which several of these species were described as different, was found to be variable rendering it unreliable by itself. However, a combination of a few morphological

Table 2. Host plants of *Aleyrodes* species recorded in California (from Quaintance (1900), Bemis (1904), Penny (1922), and material examined in this study).

Species	Host plants
<i>A. amnicola</i> Bemis	Grossulariaceae: <i>Ribes</i> L. Rosaceae: <i>Pyrus communis</i> L. Rhamnaceae: <i>Ceanothus thyrsiflorus</i> Eschsch., <i>Ceanothus</i> L. Salicaceae: <i>Salix babylonica</i> L., <i>Salix laevigata</i> Bebb, <i>Salix</i> L.
<i>A. proletella</i> (Linnaeus)	Asteraceae: <i>Cichorium intybus</i> L. Brassicaceae: <i>Brassica oleracea</i> L.
<i>A. pruinosis</i> Bemis	Rosaceae: <i>Heteromeles arbutifolia</i> (Lindl.) M. Roemer; <i>Malus</i> L.
<i>A. spiraeoides</i> Quaintance	Aizoaceae: <i>Carpobrotus edulis</i> (L.) N.E. Br Apocynaceae: <i>Asclepias</i> L. Asteraceae: <i>Aster</i> L.; <i>Bidens</i> L.; <i>Dahlia</i> Cav.; <i>Deinandra lobii</i> (Greene) Greene; <i>Gerbera</i> L.; <i>Nothocalais</i> (A. Gray) Greene; <i>Sonchus oleraceus</i> L. 1753 not Wall. 1831, <i>Sonchus</i> L.; <i>Stevia</i> Cav. Berberidaceae: <i>Berberis aquifolium</i> Pursh; <i>Mahonia</i> Nutt. Bignoniaceae: <i>Tecomaria capensis</i> (Thunb.) Spach Boraginaceae: <i>Eriodictyon californicum</i> (Hook. & Arn.) Torr. Brassicaceae: <i>Brassica oleracea</i> L. Caprifoliaceae: <i>Lonicera involucrata</i> (Richardson) Banks ex Spreng., <i>Lonicera</i> L.; <i>Symphoricarpos albus</i> (L.) S.F. Blake Convolvulaceae: <i>Calystegia occidentalis</i> (A. Gray) Brummitt, <i>C. sepium</i> (L.) R. Br. Ericaceae: <i>Gaultheria shallon</i> Pursh; <i>Rhododendron</i> L. Euphorbiaceae: <i>Euphorbia maculata</i> L.; <i>Euphorbia</i> sp. L. Fabaceae: <i>Cercis</i> L. Grossulariaceae: <i>Ribes sanguineum</i> Pursh Hypericaceae: <i>Hypericum androsaemum</i> L., <i>Hypericum</i> L. Iridaceae: <i>Gladiolus</i> L.; <i>Iris</i> Tourn. ex. L. Malvaceae: <i>Ceiba speciosa</i> (A. St.-Hil.) Ravenna; <i>Gossypium hirsutum</i> L.; <i>Malva parviflora</i> L. Myrtaceae: <i>Melaleuca hypericifolia</i> Sm. Oleaceae: <i>Fraxinus velutina</i> Torr., <i>Fraxinus</i> L.; <i>Ligustrum</i> L. Onagraceae: <i>Fuchsia</i> L. Plantaginaceae: <i>Penstemon</i> Schmidel; <i>Plantago major</i> L.; <i>Veronica</i> L. Primulaceae: <i>Primula</i> sp. L. Rosaceae: <i>Fragaria</i> L.; <i>Malus</i> L.; <i>Rosa laevigata</i> Michx, <i>Rosa</i> L.; <i>Oemleria cerasiformis</i> (Torr. & Gray ex Hook. & Arn.) J.W. Landon; <i>Physocarpus capitatus</i> (Pursh) Kuntze Rubiaceae: <i>Burchellia</i> R. Br. Rutaceae: <i>Citrus × sinensis</i> (L.) Osbeck, <i>Citrus</i> L. Sapindaceae: <i>Aesculus californica</i> (Spach) Nutt. Scrophulariaceae: <i>Myoporum laetum</i> G. Forst, <i>Myoporum</i> Banks & Sol. ex G. Forst. Solanaceae: <i>Capsicum</i> L.; <i>Nicotiana glauca</i> Graham; <i>Solanum douglasii</i> Dunal, <i>S. pseudo-capsicum</i> L., <i>S. tuberosum</i> L. Ulmaceae: <i>Ulmus</i> L. Verbenaceae: <i>Verbena</i> L. Violaceae: <i>Viola</i> L.

characters and color was found to allow for specific identifications. These characters include features from puparium: presence (Fig. 29) or absence (Fig. 30–32) of dark pebble-like ornamentation and relative abundance of simple pores (Fig. 29–32), and from adult males: morphology of male aedeagus and of parameres (Fig. 42–45).

Key to California species

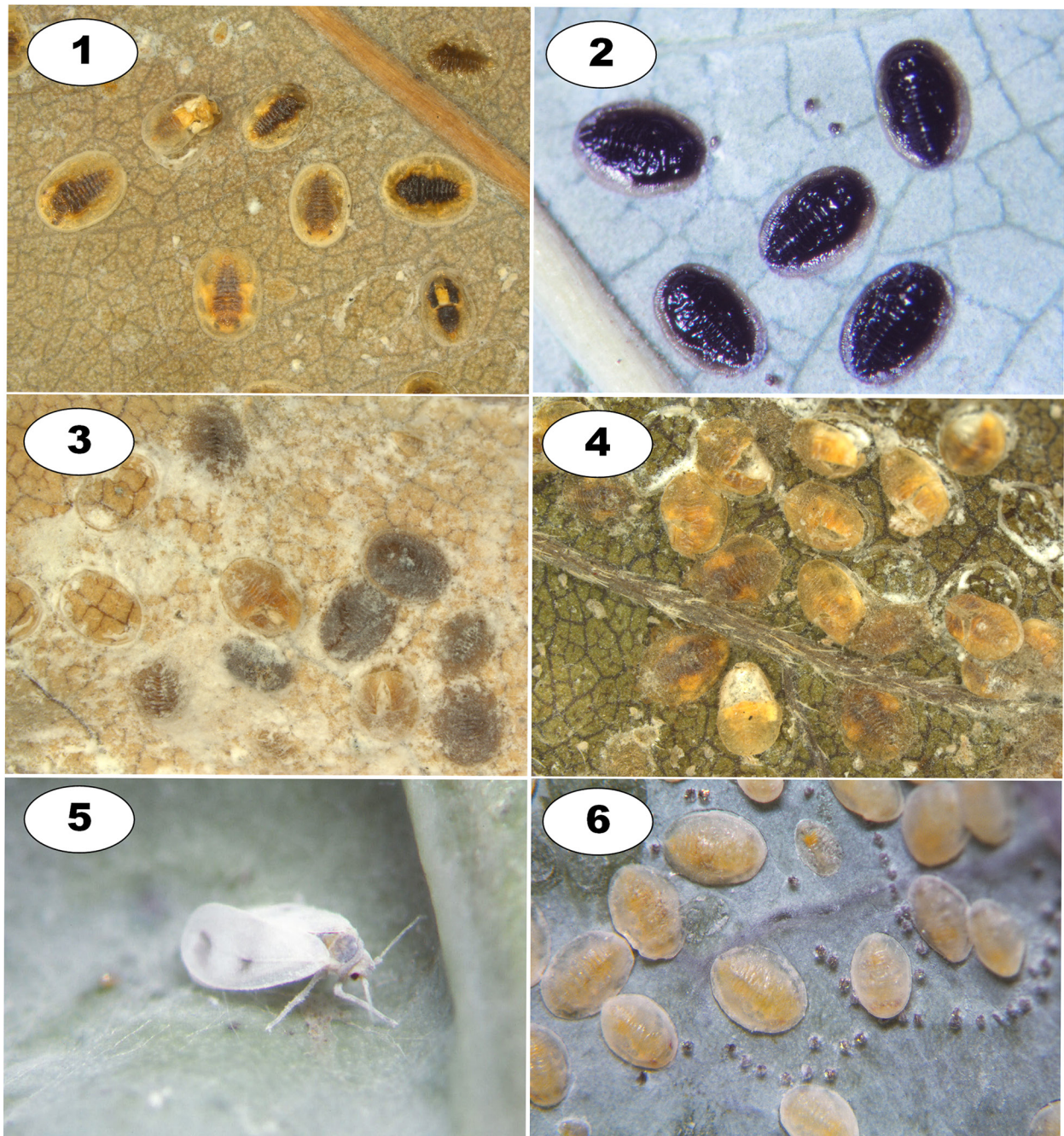
1. Medio-dorsal area of cephalothorax and anterior abdomen usually with pebble-like ornamentation and numerous simple pores (eight to 16 per segment on each side, at least on mesothorax; Fig. 29); puparium usually translucent yellow to green with a dark brown medial stripe (Fig. 1), but sometimes mostly yellow or mostly brown (Fig. 2–4); male paramere narrowed preapically and with a wider subapical flange, as wide as about 0.45 of its length (Fig. 42); common on *Salix*, *Ribes*, and *Ceanothus*, with one record on *Pyrus* ***A. amnicola* Bemis**
- Medio-dorsal area of cephalothorax and anterior abdomen never with pebble-like ornamentation and usually with only up to eight simple pores per segment on each side (Fig. 30–32); puparium uniformly grayish brown usually with margin narrowly pale, or entirely yellow to yellow with diffuse brown areas (Fig. 6–12); male paramere narrowed apically and with a narrower subapical flange, as wide as 0.25–0.35 of its length (Fig. 43–45); on various hosts **2**
- 2(1). Puparium uniformly grayish brown usually with margin narrowly pale (Fig. 7–9); on *Heteromeles arbutifolia*, with one record on *Malus* ***A. pruinosus* Bemis**
- Puparium usually translucent yellow (Fig. 6, 10–12), but sometimes with diffuse tan areas or mostly tan (e. g., Fig. 10, 11) **3**
- 3(2). Aedeagus curved abruptly at a 90-degree angle at mid-length (Fig. 43); carina along medial margin of paramere interrupted subapically (Fig. 43); polyphagous, but found only on crucifers and composites in California ***A. proletella* (Linnaeus)**
- Aedeagus curved gradually at less than a 45-degree angle (Fig. 45); carina along medial margin of paramere contiguous to tip (Fig. 45); polyphagous ***A. spiraeoides* Quaintance**

***Aleyrodes amnicola* Bemis, 1904**

Fig. 1–4, 13–16, 29, 33, 42

Aleyrodes amnicola Bemis 1904: 514 (description of nymphs and puparium, plate 27, fig. 4, 4a; syntypes from U.S.A., California, Stevens Creek, Santa Clara Valley, on *Salix laevigata*, 4.xi.1901, at USNM) — Penny 1922: 23 (erroneous mention of *Washingtonia nuda* as food plant).

Specimens examined. *Slide mounted:* 217 puparia, 22 ♂♂, 40 ♀♀ [at CSCA]: U.S.A., California: San Diego County: 2 puparia [with long caudal and posterior setae], 2 ♂♂, San Diego, on *Ceanothus* sp., 25.vi.1963, T.K. Palmer coll.; 6 puparia, Vista, 14.xi.1966, Waldrig and Krug coll.; 5 puparia, same data but on *Ribes* sp., 5.iv.1973, Anderson and Paddock coll.; 5 puparia, same data but on native gooseberry (*Ribes* sp.), 5.v.1983, H. Metcalf coll.; 13 puparia, 4 ♂♂, 5 ♀♀, Escondido, on willow (*Salix* sp.), 22.vii.1975, Gionfrido and Koide coll.; Orange County: 4 puparia, Trabuco Oaks, on *Pyrus communis*, D.H. Byers and J.L. Johnson coll.; 11 puparia, Stanton, on pussy willow (*Salix* sp.), 26.vi.1979, Bennett and Stolte coll.; Los Angeles County: 13 puparia, Camp Baldy, on *Ceanothus* sp., ix.1931, D.D. Penny and G. Pohl coll.; 1 puparia, Hollywood, on gooseberry (*Ribes* sp.), 20.viii.1937, G. Burns coll.; 3 puparia, Pasadena, on *Ceanothus* sp., viii.1938, C. Gammon coll.; 3 puparia, 3 ♂♂, Westlake Village, on *Salix matsudana* [now *S. babylonica*], 3.xii.1979, M. Pearson coll.; 5 puparia, 1 ♀, same data but on *Ribes* sp., 20.vi.1969, E.L. Paddock coll.; Ventura County: 2 puparia, 949 Main Street, on *Ceanothus* sp., 1.iv.1933, D. Fraser coll.; 6 puparia, Rancho Santa Paula and Saticoy, on willow (*Salix* sp.), 7.viii.1941, Gillogly coll.; 3 puparia, Cullignas Creek, on willow (*Salix* sp.), 3.ix.1942, Travis coll.; 5 puparia, Ojai, 9 viii 1967, Dilley and Buettner coll.; Santa Barbara County: 5 puparia, Orcutt, 19.xi.1973, Cupp and Rieneke coll.; 5 puparia, 3 ♂♂, 5 ♀♀, Santa Barbara, 27.x.1980, Pedroza and Elfstrom coll.; 16 puparia, 6 ♂♂, 11 ♀♀, Santa Barbara, on *Ceanothus* sp., 17.ix.1998, J. Kendall coll.; 3 puparia, Santa Barbara Botanical Gardens, on *Ceanothus* sp., 11.viii.1998, J. Kendall and J. Davidson coll.; San Luis Obispo County: 21 puparia, 1 ♂, 6 ♀♀, Arroyo Grande, on *Ceanothus thyrsoiflorus*, 27.x.1993, C. Krause coll.; 2 puparia, Arroyo Grande, in nursery, *Salix* sp., 22.x.2008, C.T. and C.K.; Monterey County: 2 puparia, 1 ♂, 3 ♀♀, Carmel, 20.ix.1977, on *Salix* sp., Oliver and Willey coll.; 5 puparia, Carmel Valley, on *Ceanothus* sp., 2.x.1992, B. Oliver coll.; Fresno County: 3 puparia, Washington, on willow (*Salix* sp.), 12.v.1939, Gallion coll.; 4 puparia, 1 ♂, 6 ♀♀, Firebaugh, on willow (*Salix* sp.), 22.vii.1980, N. Smith coll.; Santa Clara County:



Figures 1–6. *Aleyrodes* in situ, U.S.A., California. **1–4**) *A. amnicola*. **1**) San Mateo Co., San Mateo, on *Salix matsudana* (dry sample), 13.x.1971, P. Crane and H. Struttenecker coll. **2**) Sacramento Co., Sailor Bar, on *Salix* sp., 10.vii.1987, R. Dowell coll. **3**) Placer Co., Apple Hill, on *Ceanothus* sp. (dry sample), 26.x.1987, R. Dowell coll. **4**) San Luis Obispo Co., on *Ceanothus thrysiflorus* (dry sample), Arroyo Grande, 27.x.1993, C. Krause coll. **5–6**) *A. proletella*, Santa Cruz Co., Watsonville, on *Brassica oleracea*, 8.viii.2001, Bowman coll. Fig. 1, 3, 4 by N. von Ellenrieder and R.W. Garrison, Fig. 3, 5, 6 by R.J. Gill. Figures are not to scale.

20 puparia, Los Gatos, on *Salix* sp., 18.vi.1939, W.W. Sampson coll.; 8 puparia [with long caudal setae], 1 ♂, 3 ♀♀, Stevens Creek Reservoir, on gooseberry (*Ribes* sp.), 14.v.1978, R. Gill coll.; San Mateo County: 6 puparia, San Mateo, on *Salix matsudana* [now *S. babylonica*], 13.x.1971, P. Crane and H. Struttenegger coll.; Contra Costa County: 4 puparia, Pleasant Hill, on *Salix* sp., 26.x.1959, K.E. Danielson coll.; Sacramento County: 16 puparia, Sailor Bar, on willow (*Salix* sp.), 10.vii.1987, R. Dowell coll.; El Dorado County: 7 puparia, Gold Hill Road, 1 mi from Lotus Road, on *Ceanothus* sp., 30.v.2016, V. Popescu coll.; Placer County: 3 puparia, Apple Hill, on *Ceanothus* sp., 26.x.1987, R. Dowell coll. *Dry material*: U.S.A., California: Ventura County: 8 puparia, Calleguas Creek, on willow (*Salix* sp.), 2.ix.1947, P.B. Travis coll.; Santa Barbara County: 100 + puparia, Santa Barbara Botanical Gardens, on *Ceanothus* sp., 11.viii.1998, J. Kendall and J. Davidson coll.; San Luis Obispo County: 100 + puparia, Arroyo Grande, on *Ceanothus thyrsoiflorus*, 27.x.1993, C. Krause coll.; San Mateo County: 36 puparia, Redwood City, on *Salix* sp., x.1968, T.R. Haig coll.; Placer County: 80 puparia, Apple Hill, 26.x.1987, on *Ceanothus* sp., R. Dowell coll.

Diagnostic characters. Pupal case translucent yellow to green with a broad dorsal dark brown stripe of variable width (Fig. 1, 2) to mostly yellow or mostly brown (Fig. 3, 4). Puparium usually with pebble-like ornamentation and numerous simple pores (eight to 16 per segment on each side at least on mesothorax) on medial area of cephalothorax and abdomen (Fig. 13–16, 29). Associated adult males with paramere narrowing preapically, with a wide subapical flange, as wide as about 0.45 of its length, and carina along medial margin of paramere contiguous to tip; aedeagus curved gradually at less than a 45-degree angle (Fig. 42).

Remarks. The pebble-like ornamentation is found only in this species in California. In a few specimens (on *Salix* and *Ribes*) there are few to no pebble-like ornamentations but there are numerous simple pores as described above. Male paramere (Fig. 42) narrowing preapically and with wider subapical flange, as wide as about 0.45 of its length, differs from paramere of *A. proletella*, *A. pruinusosus*, and *A. spiraeoides* (Fig. 43–45), in which paramere narrows apically and subapical flange is narrower, as wide as 0.25–0.35 of its length. The darkening of the dorsal median area of puparium is usually distinctive for this species (Fig. 1, 14, 15), but puparia can exhibit considerable variability in their color pattern, sometimes with brown areas extensive with only the marginal areas yellow (Fig. 2, 16), sometimes with a paler brownish yellow stripe bordered by brown on both sides along medial area of abdomen (Fig. 13), to having extensive yellow areas with a restricted medial brown stripe or being entirely yellow (Fig. 3, 4). These puparia present the same pebble-like ornamentation and high number of simple pores, and available corresponding adult males share paramere shape with specimens associated with puparia displaying typical color pattern and are therefore considered conspecific.

Hosts. This species occurs in large numbers on *Salix* L. (Salicaceae), *Ceanothus* L. (Rhamnaceae), and *Ribes* L. (Grossulariaceae), with one record on *Pyrus communis* L. (Rosaceae). The mention by Penny (1922), repeated by Evans (2007), of *Washingtonia nuda* (Torr.) A. Heller as a food plant for this species was based on Bemis' (1904: 515) remark that 'adults were issuing from the pupa-cases' [found on the underside of leaves of *Salix laevigata*], 'and many had settled upon the undersides of leaves of *Washingtonia nuda*, which was growing under the hosts plants'. Since the adults were simply landing on the leaves and the species was never recorded feeding or developing on this plant, this plant should be removed from its host plant list.

Distribution. Probably throughout California, although it seems to be more common along coastal areas south of the San Francisco Bay area. Evans (2007) mentioned this species from the Virgin Islands without further data, but the source of this record could not be found, and it is considered to be erroneous (G. Evans *pers. comm.*).

Aleyrodes proletella (Linnaeus, 1758)

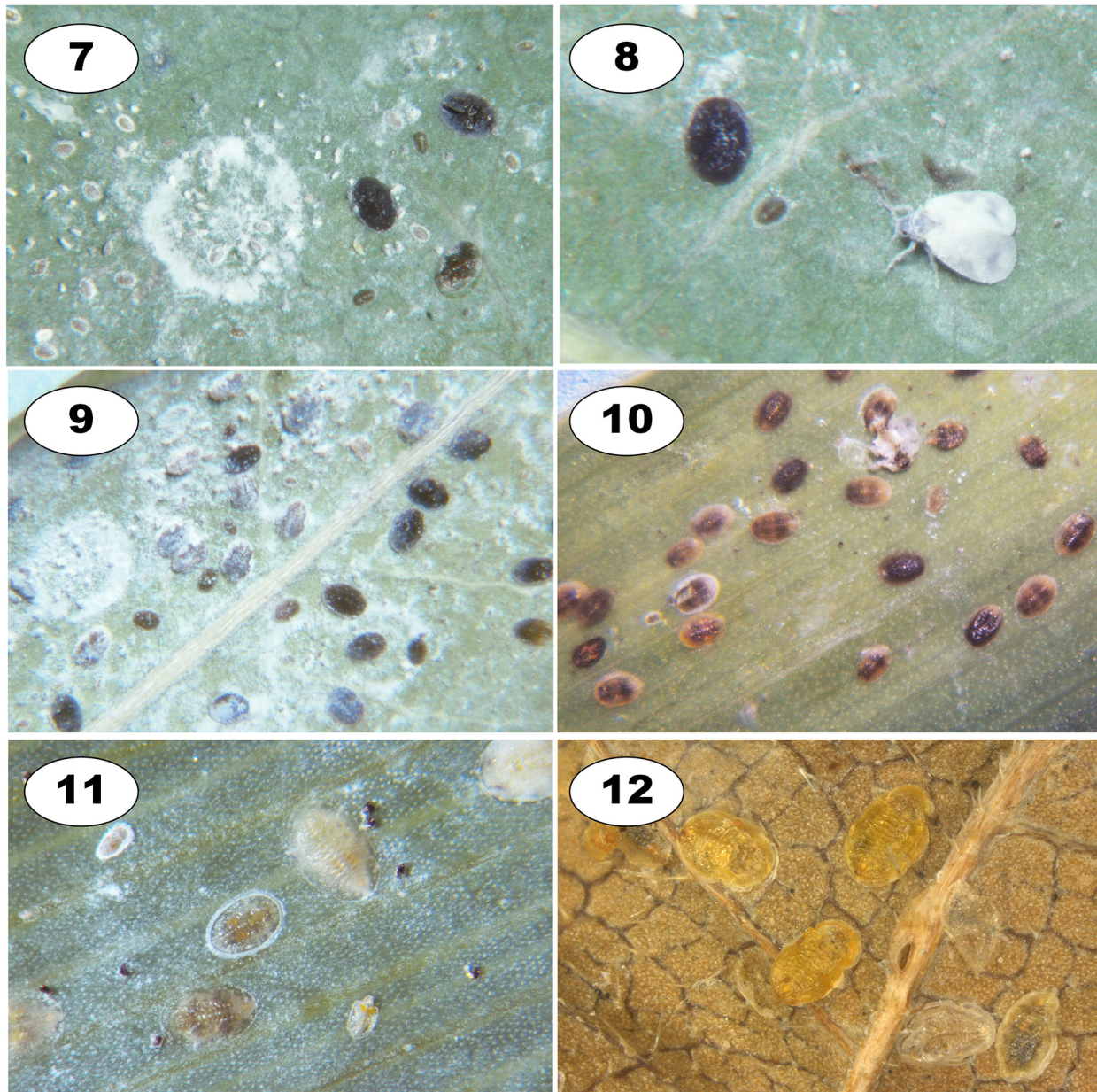
Fig. 5, 6, 17, 18, 30, 34, 35, 43

Phalaena (*Tinea*) *proletella* Linnaeus 1758: 537 (syntypes from Europe on *Brassica*, *Chelidonium*, and on *Quercus*?).

Phalaena culiciformis Geoffroy 1785: 306 (syntypes on *Chelidonium majus*).

Coccus preanthis Schrank 1801: 147.

Aleyrodes proletella: Latreille 1801: 264 (change of combination) — Walker 1858: 307 (synonymy of *Aleyrodes chelidonii* Latreille) — Bondar 1923: 125 (synonymy of *Aleyrodes youngi* Hempel) — Haupt 1935: 256 (synonymy of *Aleyrodes brassicae* Walker) — Klimaszewski and Szelegiewicz 1962: 42 (synonymy of *Coccus preanthis* Schrank) — Mound and Halsey 1978: 99 (discussion of nomenclatorial history) — Zahradnik 1991: 113 (synonymy of *Aleyrodes euphorbiae* Löw).



Figures 7–12. *Aleyrodes* in situ, U.S.A., California. 7–9) *A. pruinosus*, Riverside Co., Corona, on *Heteromeles arbutifolia*, 30.iii.1981, Reeves and Harris coll. 10–12) *A. spiraeoides*. 10–11) On *Iris* sp., no other data available. 12) Alameda Co., Mission San Jose, on *Ulmus* sp. (dry sample), ix.1916, E.O. Essig coll. [syntypes of *Aleyrodes essigi*, CAS type #6189]. Fig. 7–11 by R.J. Gill, Fig. 12 by N. von Ellenrieder and R.W. Garrison. Figures are not to scale.

Aleyrodes chelidonii Latreille, 1807: 174 (replacement name for *A. proletella* L. and synonymy of *Phalaena culiciformis*).

Aleyrodes brassicae Walker 1852: 1092 (syntypes from England on cabbage).

Aleyrodes euphorbiae Löw 1867: 746 (syntypes from Austria on *Euphorbia peplus*).

Aleyrodes preanthis: Cockerell 1902: 281 (change of combination).

Aleurodes youngi Hempel, 1901: 385 (syntypes from Brazil, Iguape and Campinas, State of São Paulo, on cabbage).

Specimens examined. Slide mounted material: 84 puparia, 10 ♂♂, 2 ♀♀ [at CSCA]: England: 2 puparia, Kent, Wye, on ground ivy (*Glechoma hederacea*), viii.1960. O. Gameel coll.; 7 puparia, 1 ♀, British Museum Laboratory Culture, on cabbage (*Brassica oleracea*), v.1966, B.R. Pitkin coll.; Dominica: 21 puparia, St. Paul Parish,

ATRC Springfield, on cabbage (*Brassica oleracea*), 11.vi.1994, M. Rose coll.; Taiwan: 2 puparia, Taipei, on *Rorippa indica*, 6.v.1992, H.C. Wen coll.; U.S.A., California, Santa Cruz County: 18 puparia, 1 ♂, 1 ♀, Watsonville, on kale (*Brassica oleracea*), 31.vii.2001, Bowman coll.; 17 puparia, 9 ♂♂, same data but 8.viii.2001; 1 ♂, same data but on radicchio (*Cichorium intybus* var. *foliosum*); 17 puparia, same data but 22.viii.2001. *Dry material*: 50 puparia, England, British Museum Laboratory Culture, on cabbage (*Brassica oleracea*), v.1966, B.R. Pitkin coll.

Diagnostic characters. Puparium usually translucent yellow (Fig. 6), although it can be slightly to moderately pigmented in colder months in temperate regions (Martin et al. 2000). Medio-dorsal area of cephalothorax and anterior abdomen never with pebble-like ornamentation and usually with only up to eight simple pores per segment on each side (Fig. 17, 18, 30). Adult male with paramere narrowing apically, with a narrow subapical flange as wide as about 0.25–0.30 of its length, and carina along medial margin of paramere interrupted subapically; aedeagus abruptly curved at a 90-degree angle at mid-length (Fig. 43).

Remarks. We have been unable to distinguish the puparia from those of *A. spiraeoides*. However, adult males of *A. proletella* differ from all other California *Aleyrodes* including *A. spiraeoides* by the aedeagus abruptly bent at a 90-degree angle at mid-length and carina along medial margin of paramere interrupted subapically (Fig. 43), versus aedeagus gradually curved at less than a 45-degree angle and carina along medial margin of paramere contiguous to tip in the other three species (Fig. 42, 44, 45).

Hosts. Polyphagous but seems to prefer crucifers (Brassicaceae). In California found only on *Brassica oleracea* L. (Brassicaceae) and *Cichorium intybus* L. (Asteraceae).

Distribution. Originally described from Europe, this species is now known from Russia, Taiwan, Australia, New Zealand, Bermuda, Brazil, numerous countries in Africa, and NE states and Oregon State in the U.S.A. (Mound and Halsey 1978; Hernández-Suárez et al. 2012; Oregon Department of Agriculture 2016). In California it was only reported from several collections on ornamental kale and radicchio in the Monterey Bay Area of Santa Cruz County in 2001. While cabbage and other related plants are commonly grown commercially in the Monterey Bay area, this species has apparently not been resampled on any of these crops or on ornamental cabbage or kale since the original collections in 2001, and its current status in the state is unknown.

Aleyrodes pruinosus Bemis, 1904

Fig. 7–9, 19, 20, 31, 36, 44

Aleyrodes pruinosus Bemis 1904: 491 (description of nymphs, puparium, and adults; plates 33, 34, fig. 40–55; syntypes on *Heteromeles arbutifolia*, from U.S.A., California, Avalon, Catalina Islands, E. Ehrhorn coll., and Leland Stanford Junior University, 1902, F.E. Bemis coll., at USNM).

Aleyrodes pruinosus euphorbiarum Cockerell 1911: 462 (description of puparium and adult female; syntypes from U.S.A., Colorado, Glenwood Springs, E. Bethel coll., on *Euphorbia robusta*, at USNM).

Specimens examined. *Slide mounted material*: 178 puparia, 225 ♂♂, 24 ♀♀ [at CSCA]: U.S.A., California, 5 puparia, 2 ♂♂, 1 ♀, on *Heteromeles* sp., x.1930; San Diego County: 1 puparium, San Diego, on crab apple (*Malus* sp.), 11.ix.1967, F. Yaruss coll.; 3 puparium, 1 ♂, 1 ♀, Chula Vista, on toyon (*Heteromeles arbutifolia*), 14.xii.1973, Knott and Webb coll.; 13 puparia [some with long caudal setae], 8 ♂♂, 8 ♀♀, El Cajon, on *Heteromeles arbutifolia*, 14.v.1975, Opel, Rys, and Dietz coll.; Orange County: 16 puparia, 2 ♂♂, 2 ♀♀, El Modena, on *Heteromeles arbutifolia*, x.1931, Penny coll.; 3 puparia, Anaheim, on California holly (*Heteromeles arbutifolia*), 15.i.1932, M.R. Olson coll.; Riverside County: 2 puparia, U.C. Riverside, on *Heteromeles arbutifolia*, 6.x.1967, R.J. Gill coll.; 1 puparium, Corona, on toyon (*Heteromeles arbutifolia*), 30.iii.1981, Reeves and Harris coll.; Los Angeles County: 8 puparia [some with long caudal and posterior setae], Catalina Island, Toyon Canyon, on toyon (*Heteromeles arbutifolia*), 29.v.1981, R. Gill coll.; San Bernardino County: 28 puparia, Ontario, on *Heteromeles* sp., 7.xii.1934, G. Pohl coll.; Ventura County: 13 puparia, 2 ♂♂, 2 ♀♀, Ventura, on toyon berry (*Heteromeles arbutifolia*), 2.viii.1933, F.R. Lewis coll.; Santa Barbara County: 8 puparia, Santa Rosa Island, Cow Canyon, 450 ft, on *Heteromeles arbutifolia*, 31.xii.2000, F. Hrusa coll.; Alameda County: 1 ♀, U.C. Berkeley campus, on *Heteromeles arbutifolia*, 29.ix.1937, F.L. Blanc coll.; 9 puparia, same data but 14.i.1939, W.W. Sampson and E.A. Drews coll.; 2 ♂♂, 2 ♀♀, same data but 19.i.1939; 15 puparia, same data but 8.ii.1939; 4 puparia, 2 ♂♂, 2 ♀♀, Berkeley, on toyon (*Heteromeles arbutifolia*), 10.x.1941, M.R. Bell coll.; 4 puparia, 2 ♂♂, 1 ♀, same data but 3.vi.1991, J. Ball coll.; San Francisco



Figures 13–16. Puparia of *A. amnicola* showing variability of color pattern, ornamentation, pore numbers, and setal length. **13)** Santa Barbara Co., Santa Barbara Botanical Gardens, on *Ceanothus* sp., 11.viii.1998, J. Kendall and J. Davidson coll. **14)** San Diego Co., Vista, on *Ribes* sp., 5.iv.1973, Anderson and Paddock coll. **15)** Santa Clara Co., Stevens Creek Reservoir, on *Ribes* sp., 14.v.1978, R. Gill coll. **16)** Sacramento Co., Sailor Bar, on *Salix* sp., 10.vii.1987, R. Dowell coll. Figures are not to scale.

County: 10 puparia, Golden Gate Park, on toyon (*Heteromeles arbutifolia*), 24.i.1939, W.W. Sampson and E.A. Drews coll.; Sacramento County: 8 puparia, Sacramento, 1408 W St., on *Heteromeles arbutifolia*, 3.v.1939, Ohrt coll.; 7 puparia, same data but 2311 14th St., Kondo leg.; Napa County: 23 puparia, 4 ♂♂, 4 ♀♀, on toyon (*Heteromeles arbutifolia*), viii.1933, E. Swift coll.; Yuba County: 2 puparia, Marysville, on *Heteromeles arbutifolia*, 15.iii.1933, Fosen coll. *Dry material*: U.S.A., California, San Diego County: 60 puparia, El Cajon, 14.v.1975, Opel, Rys, and Dietz coll.; Orange County: 3 puparia, Santa Ana Canyon, on Christmas berry (*Heteromeles arbutifolia*), 16.x.1942, House and Slaap coll.; Ventura County: 100+ puparia, El Rio, on toyon (*Heteromeles arbutifolia*), 8.x.1947, C.G. Barrett coll.; Santa Clara County: 40 puparia, Gilroy, on toyon (*Heteromeles arbutifolia*), 24.i.1947, J. Gallion and L. Plesse coll.

Diagnostic characters. Puparium uniformly grayish brown usually with narrow translucent yellow margin (Fig. 7–9); dorsum and surrounding leaf surfaces usually coated with a powdery white wax that gives the pupal cases a purplish cast. Medio-dorsal area of cephalothorax and anterior abdomen never with pebble-like ornamentation and usually with only up to eight simple pores per segment on each side (Fig. 19, 20, 31). Adult male with paramere narrowing apically, with a narrow subapical flange, as wide as 0.30 of its length and carina along medial margin of paramere contiguous to tip; aedeagus gradually curved at a 45-degree angle (Fig. 44).

Remarks. The more extensive dark color can usually be used to distinguish the puparium of this species from that of other *Aleyrodes* in California. However, *A. amnicola* and *A. spiraeoides* can also display extensive dark color. *Aleyrodes pruinosus* can be recognized from darker puparia of the former by the absence of pebble-like ornamentation and the lower number of pores, and adult males by the shape of male parameres (see under *A. amnicola*). We have been unable to find any morphological differences in the puparium and adults between this species and *A. spiraeoides*. However, puparium is relatively larger in *A. pruinosus* as are vasiform orifice length and width, although ranges overlap (Table 1). It is possible that this species name is also a synonym of *A. spiraeoides*.

Hosts. Commonly found on toyon (*Heteromeles arbutifolia* M. Roemer), with one record on *Malus* Miller (Rosaceae).

Distribution. Throughout California wherever toyon occurs. Recorded also from Colorado, Washington, Florida, Texas, and Massachusetts States in the U.S.A. and from Mexico (Evans 2007).

Aleyrodes spiraeoides Quaintance, 1900

Fig. 10–12, 21–28, 32, 37–41, 45

Aleyrodes spiraeoides Quaintance 1900: 36 (description of nymph, puparium, and adult male, plate 4, fig. 45–49, plate 8, fig. 74; syntypes from U.S.A., California, Los Angeles, on *Fuchsia*, 23.x., A. Craw coll.; Los Angeles on *Sonchus*, 21.x.1887, D.W. Coquillett coll.; Alameda on *Convolvulus* [now *Calystegia*] *occidentalis*, xi.1887, A. Koebele coll.; same but on *Malva rotundifolia* [now *Malva pusilla*], 5.xi.1885; and California, no locality given, on *Iris*, 20.x.1880, J.H. Comstock coll., at USNM).

Aleyrodes spiraeoides: Bemis 1904: 530 (description of egg, adult male and female, additional host plant records; plate 35, fig. 56–60) — Quaintance and Baker 1914: 101, illustrations of puparium and adults, photograph of puparium on leaf, plate 38, fig. 1–13; plate 46, fig. 6).

Aleyrodes diasemus Bemis 1904: 516 (description of nymph and puparium; syntypes from U.S.A., California, on *Symphoricarpos racemosus* [now *S. albus*], Leland Stanford Junior University campus, along San Francisquito Creek, 18.ix.1901; on *Ribes glutinosum* [now *R. sanguineum* var. *glutinosum*] near Menlo Park, ix.1901, Alameda, vi.1901, and King Mountain, viii.1901, at USNM but currently presumed lost) — Russell 1948: 78 (change of combination; discussion of type material). **New synonymy.**

Asterochiton diasemus: Quaintance and Baker 1914: 105 (change of combination).

Trialeurodes diasemus: Quaintance and Baker 1915: xi (change of combination).

Aleyrodes essigi Penny 1922: 23 (description of larva, puparium, and adult; illustrations of puparium and adult, fig. 1; syntypes from U.S.A., California, Mission San Jose, on *Ulmus* sp., ix.1916, E.O. Essig coll., at CAS). **New synonymy.**

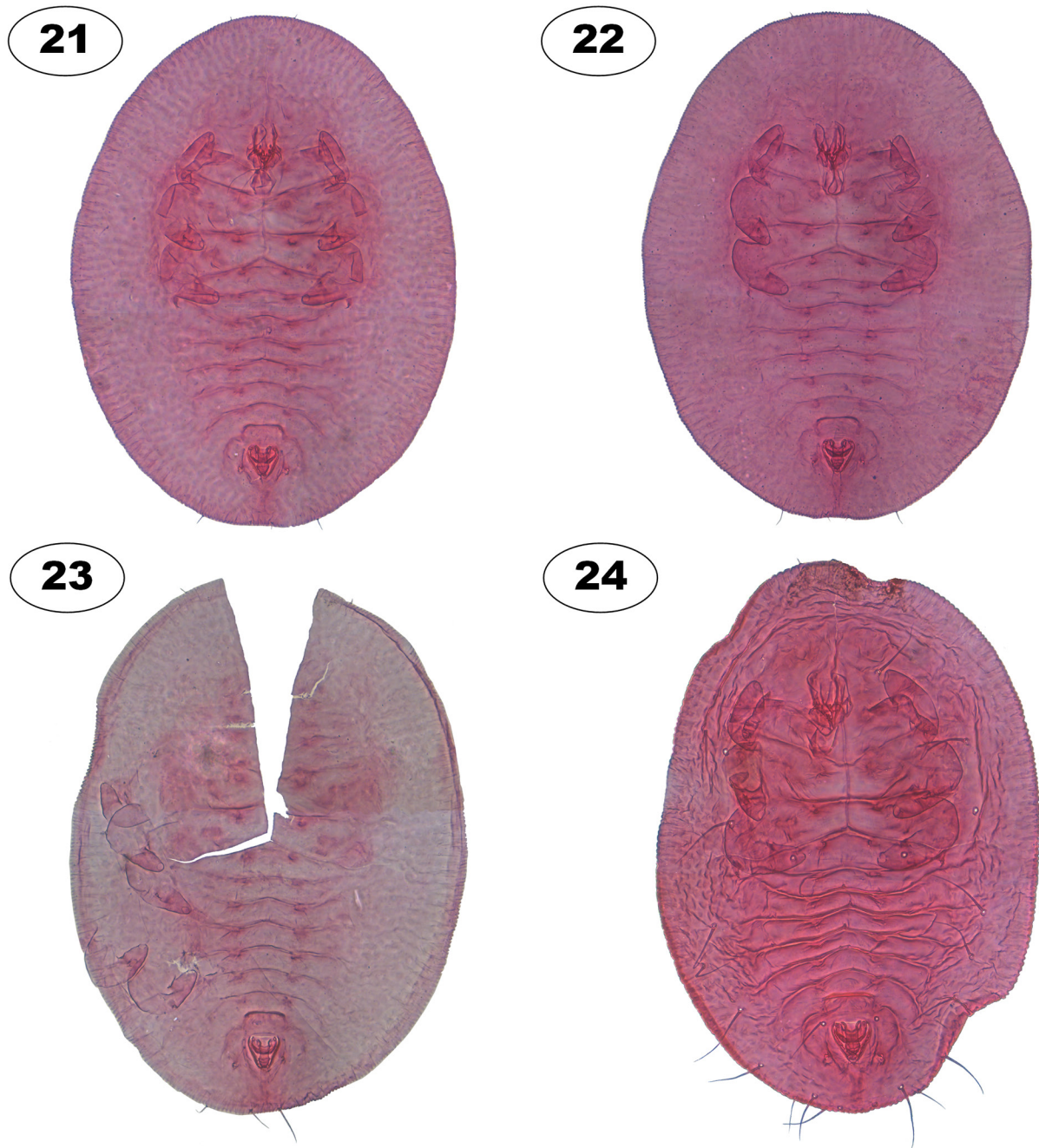
Aleyrodes osmaroniae Sampson 1945: 58 (description of puparium, fig. 1; holotype from U.S.A., California, Berkeley University campus, Strawberry Creek Canyon, on *Osmaronia* [now *Oemleria*] *cerasiformia*, 14.vi.1941, W.W. Sampson coll., at BME). **New synonymy.**

Specimens examined. *Slide mounted material*: 460 puparia, 68 ♂♂, 55 ♀♀ [at CSCA unless indicated otherwise]: U.S.A., California, 14 puparia [identified as *A. osmaroniae* by W.W. Sampson] #27; Imperial County: 5 puparia,



Figures 17–20. Puparia showing variability of pore numbers and setal length. 17–18) *A. proletella*, Santa Cruz Co., Watsonville, on *Brassica oleracea*, 8.viii.2001, Bowman coll. 19–20) *A. pruinus*. 19) San Diego Co., Chula Vista on *Heteromeles arbutifolia*, 14.xii.1973, Knott and Webb coll. 20) San Diego Co., El Cajon, on *Heteromeles arbutifolia*, 14.v.1975, Opel, Rys, and Dietz coll. Figures are not to scale.

El Centro, on *Aster exilis*, 12.vii.1973, R.A. Flock coll.; 2 puparia, Brawley, 7.xi.1975, on yerba santa (*Eriodictyon californicum*), Flock and Pineda coll.; San Diego County: 9 puparia, Fallbrook, on *Fraxinus* sp. and milkweed (*Asclepias* sp.), 19.xi.1973, N. Metcalf coll.; 15 puparia, 2 ♂♂, 2 ♀♀, Rancho Santa Fe, 26.x.1973, P. Gomes coll.; 6 puparia, San Diego, on unknown shrub, 9.xii.1987, J. Kenyon coll.; 2 puparia, San Ysidro, on *Myoporum* sp., 22.viii.1988, J. Kenyon coll.; 2 puparia, La Mesa, on *Myoporum* sp., 10.xi.1996, D. Kellum coll.; 2 puparia, El Cajon, 16.v.1934, L.W. Fox coll.; Orange County: 9 puparia, 1 ♀, Santa Ana, on Jerusalem cherry (*Solanum pseudocapsicum*), 5.i.1932, T.E. McLead coll.; 1 ♂, 1 ♀, Westminster, on *Myoporum* sp. and iceplant (*Carpobrotus edulis*), 16.i.1973, Ellis and Lilly coll.; 16 puparia [some with long setae], Laguna Beach, on *Myoporum laetum*, 5.xi.2010, J. Bethke and N. Nisson coll.; Riverside County: 2 puparia [with long setae], Riverside, on *Euphorbia supina* [now *Euphorbia maculata*], viii.1982, J. LaSalle coll.; 1 puparium [with long setae], Moreno, on potatoes (*Solanum tuberosum*), 25.ix.1979, E. Reeves coll.; San Bernadino County: 2 puparia, San Bernardino Mountains, on *Burchellia* sp., W.W. Sampson coll.; 8 puparia, Ontario, 5.xii.1937, on *Rosa* sp., G.A. Pohl coll.; Los Angeles County: 1 ♂, 1 ♀, Anaheim, on *Citrus* sp., 1.xi.1932, M.A. Olsen; 1 ♀, San Marino, on *Citrus* sp., 30.xii.1935, T. Gallion coll.; 9 puparia, Long Beach, on *Iris* sp., 20.ii.1936, A.E. Bottel coll.; 5 puparia, El Monte, 23.vii.1938, on weed in 'berry patch', E.H. Schlenz coll.; 5 puparia, same data but 31.vii.1938; Santa Catalina Island, Toyon Canyon, on sow thistle (*Sonchus* sp.), 29.v.1981, R.J. Gill coll.; 10 puparia [with long setae], Los Angeles, on *Fuchsia* sp., 18.xi.1986, Burke coll.; Ventura County: 2 puparia, Ojai Valley, on weed, 20.i.1932, E. Smith coll.; 16 puparia, 13 ♂♂, 2 ♀♀, Saticoy, on *Penstemon* sp., 18.xi.1933, Barrett coll.; 4 puparia, Hueneme, on flowering apple (*Malus* sp.), 20.ix.1933; 15 puparia, Camarillo, on *Iris* sp., 9.iii.1939, A.H. Calf coll.; Monterey County: 6 puparia, Salinas, on rose (*Rosa* sp.) and *Malva parviflora*, viii.1986, W.C. Wasik coll.; 2 ♂♂, 5 ♀♀, San Ardo, on potato (*Solanum tuberosum*), 31.viii.2001, Oliver coll.; Santa Barbara County: 4 puparia, Santa Barbara, 16.v.1972, on pansy (*Viola* sp.), C.C. Benedict coll.; 4 puparia, same data but on *Iris* sp., 26.v.1972; 3 puparia, Carpinteria, on *Gerbera* sp., 18.xi.2001, J. Davison coll.; 3 puparia, on *Ceiba speciosa*, 9.x.2003, M. Perry coll.; San Luis Obispo County: 2 puparia, 1 ♂, on *Fuchsia* sp., 14.xii.1967, J. Williams coll.; 5 puparia, San Luis Obispo, on 'skeleton weed', 11.vii.1980, B. Lilley coll.; 6 puparia, 1 ♂, Nipomo (in nursery), on *Iris* sp., 17.viii.2001, C. Taylor coll.; Tulare County: 2 puparia, Exeter, on ornamental, 4.x.1935, J.M. Awbrey coll.; Merced County: 29 puparia, Merced, on *Veronica* sp., 15.xi.1928, D.P. Wheeler coll.; 1 puparium [with long setae], Los Baños, on tomatoes (*Solanum lycopersicum*), 9.vi.1992, V. Castellano coll.; Santa Cruz County: 14 puparia, Watsonville, sow thistle (*Sonchus* sp.), 8.viii.2001, Bowman coll.; 1 ♂, same data but on kale (*Brassica oleracea*); Stanislaus County: 14 puparia [some with long setae], Knights Ferry, on *Bidens* sp., 18.x.1978, Bingham coll.; 2 puparia [with long setae], on *Verbena* sp., 4.v.1981, Zorn and Bingham coll.; Contra Costa County: 2 puparia, Antioch, on *Iris* sp., 21.i.1931; 2 puparia, 1 ♂, on peppers (*Capsicum* sp.), 20.vii.1992, J. Caprile coll.; Alameda County: 13 puparia [some with long setae], 8 ♂♂ [syntypes of *Aleyrodes essigi*, CAS type #6189], Mission San Jose, on *Ulmus* sp., ix.1916, E.O. Essig coll. [CAS]; 16 puparia, Berkeley, 5.iii.1934, E.A. Drews and W.W. Sampson coll.; 4 puparia, same data but on *cerasiformis*, 20.xi.1934, W.W. Sampson coll.; 8 puparia [paratypes of *Aleyrodes osmaroniae*], Strawberry Creek Canyon, U.C. Berkeley, on *Osmaronia* [now *Oemleria*] *cerasiformis*, W.W. Sampson coll.; 1 puparia [holotype of *Aleyrodes osmaroniae*, circled, BME type #850] + 4 puparia [paratypes of *Aleyrodes osmaroniae*], same data but [BME]; 1 ♂, Hayward, on azalea (*Rhododendron* sp.), 22.x.1938, F.J. March coll.; San Francisco County: 18 puparia, Golden Gate Park, on *Iris* sp., 24.i.1934 & 24.i.1939, W.W. Sampson and E.A. Drews coll.; 26 puparia, 1 ♂, 1 ♀, same data but on *Myoporum laetum*; 1 ♂, 2 ♀♀, San Francisco, on primrose (*Primula* sp.), 5.ix.1936, R. Kausen coll.; 4 ♂♂, 8 ♀♀, Albany, on *Iris* sp., x.1992, B. Campbell; San Joaquin County: 9 puparia [with long setae], Stockton, on tomato (*Solanum lycopersicum*), 4.vii.1984, T. Gantenbein coll.; Calaveras County: 1 puparium, 2 ♂♂, Big Trees, 13.viii.1992, D. Norfolk and K. Kenston coll.; Sacramento County: 2 ♂♂, Sacramento, on rose (*Rosa* sp.), 6.xii.1932, McFarlane coll.; 3 ♂♂, 2 ♀♀, Courtland, on *Malva* sp., 19.iv.1933, Bachman coll.; 2 ♂♂, 2 ♀♀, Sacramento, on *Mahonia* sp., 18.xi.1936, Wilkinson coll.; 1 ♂, 2 ♀♀, Folsom, on *Citrus* sp., 31.viii.1937, W.P.A. coll.; 3 ♀♀, Mills District, on privet (*Ligustrum* sp.), 7.x.1937, W. Travioli coll.; 1 ♂, 1 ♀, Mayhews, 11.x.1937, W. Travioli coll.; 3 ♂♂, 1 ♀, Folsom, on privet (*Ligustrum* sp.), 8.ix.1937, H.H. Keifer coll.; 3 ♂♂, 4 ♀, same data but 8.ix.1939; 1 puparium, 1 ♂, on *Aster* sp., 31.vii.1939, C. Schiller coll.; 3 puparia, Sacramento, on *Penstemon* sp., 16.xii.1942, J.B. Steinweden coll.; 4 puparia, same data but on *Iris* sp., vi.1977, R.J. Gill coll.; 2 ♂♂, 4 ♀♀, Sacramento, on rose (*Rosa* sp.), 24.i.1987, R.J. Gill coll.; 12 puparia, Galt, on *Stevia* sp., 6.viii.1997, Wilson and



Figures 21–24. Puparia of *A. spiraeoides* showing variability of pore numbers and setal length. **21)** San Luis Obispo Co., San Luis Obispo, on *Monstera* sp., 11.vii.1980, B. Lilley coll. **22)** Monterey Co., Salinas, on *Rosa* sp. and *Malva parviflora*, viii.1986, W.C. Wasik coll. **23)** Riverside Co., Riverside, on *Euphorbia supina*, viii.1982, J. LaSalle coll. **24)** San Joaquin Co., Stockton, on *Solanum lycopersicum*, 4.vii.1984, T. Gantenbein coll. Figures are not to scale.

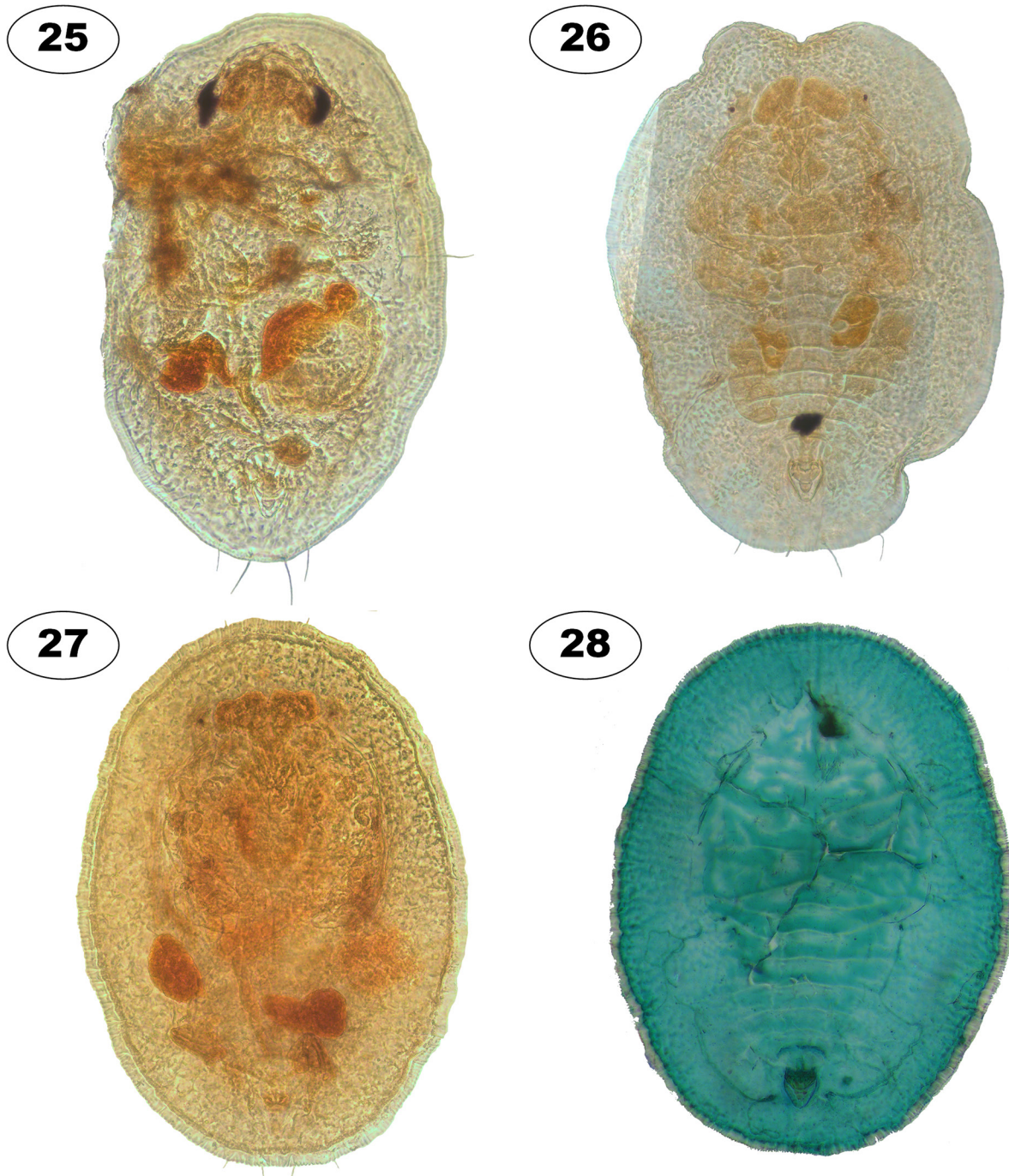
Thompson coll.; Yolo County: 5 puparia, Woodland, on *Cercis* sp., xi.1937, Wymore coll.; 1 puparium, Davis, on Arizona ash (*Fraxinus velutina*), 23.ix.1937, R.W. Downey coll.; 1 ♂, 3 ♀♀, Bryte, on Oregon grape (*Berberis aquifolium*), 26.ix.1937; 5 puparia [with long setae], on strawberry (*Fragaria* sp.), 3.x.1985, J. Wagoner coll.; Sonoma County: 1 puparium, Sonoma, on *Hypericum* sp., 13.viii.1973, I. Violotti coll.; 5 puparia, Cloverdale, on honeysuckle (*Lonicera* sp.), 10.vi.1980, R.J. Gill coll.; Napa County: 4 puparia, St. Helena, on *Hypericum* sp., 6.iii.1934, Niles coll.; Yuba County: 2 ♂♂, Wheatland, on orange (*Citrus × sinensis*), 14.vii.1937, Schaffer coll.; Mendocino County: 2 puparia, 4 ♂♂, 7 ♀♀, Fort Bragg, on *Rhododendron* sp., 17.v.1936, M.L. Jones coll.; Humboldt County: 3 ♂♂, 2 ♀♀, Feildbrook, on *Rhododendron* sp., 22.ii.2000, Haggard coll.; Butte County: 8 puparia, Chico, on *Fuchsia* sp., 26.x.1938, R. Swett coll.; 6 puparia, Wheatland, on Jerusalem cherry (*Solanum pseudocapsicum*), 12.iii.1936, Branson and Lehrer coll.; 3 puparia, Sutter County, Yuba City, on rose (*Rosa* sp.), 27.viii.1931, L.S. Jones coll.; Lassen County: 1 puparium [with long setae], Hillside Cemetery, on *Hemizonia* [now *Deinandra*] *lobbii*, T.C. Fuller coll.; Shasta County: 1 puparium [with long setae], on *Fragaria* sp., 5.ix.1961, J. Rodigou coll.; Arizona, Coconino County: 17 puparia, Flagstaff, on *Euphorbia* sp., xi.2004, D. Byrne coll.; interception from Texas, 2 ♀♀, on salal (*Gaultheria shallon*), 5.ii.1996, W. Bianchi coll. *Dry material*: U.S.A., California, Riverside Co.: 1 puparium, Banning, on *Tecomaria capensis*, 26.viii.1942, Lower coll.; San Benito County: 4 puparia, Hollister, on honeysuckle (*Lonicera* sp.), 22.iv.1948, R.P. Allen coll.; 1 puparium, same data but on privet (*Ligustrum* sp.), 23.iv.1948, Gammou and Allen coll.; Madera County: 50 puparia, Chowchilla, on *Iris* sp., 11.viii.1948, E. Danison coll.; Sacramento County: 1 puparium, Sacramento, on *Penstemon* sp., 16.xii.1942, J.B. Steinweden coll.

Diagnostic characters. Puparium translucent yellow to tan (Fig. 10–12), elliptical but outline sometimes distorted (undulate or elongate) due to development amongst leaf hairs. Medio-dorsal area of cephalothorax and anterior abdomen never with pebble-like ornamentation and usually with only up to eight simple pores per segment on each side (Fig. 21–24, 32). Adult male with paramere narrowing apically, with a narrow subapical flange, as wide as 0.30–0.35 of its length and carina along medial margin of paramere contiguous to tip; aedeagus gradually curved at a 45-degree angle (Fig. 45).

Remarks. Puparium of *A. proletella* appears to be identical but that species prefers cruciferous hosts; reliable identification can be achieved by examination of male genitalia (see under *A. proletella*). Puparia of *A. pruinosus* also seem to be undistinguishable morphologically from those of *A. spiraeoides*, usually differing by their relatively larger size and larger vasiform orifice (although ranges overlap; see Table 1) and color pattern, uniformly grayish brown usually with narrow margin yellow, although some specimens of *A. spiraeoides* present also an extensive tan coloration (e. g., Fig. 10); we have been unable to distinguish between the adults of these two species. Puparia with long setae could be mistaken for the European *A. lonicera* Walker, 1852 which can also have long setae (known so far in the USA only from Florida) but differ from it by vasiform orifice yellow and abdominal segments lacking median tubercles, versus vasiform orifice often dark and usually with shallow median tubercles on abdominal segments II–V or II–VI in *A. lonicera* (Martin et al. 2000; Stocks 2012). Their adults differ by the two diffuse dark spots on fore wing in *A. spiraeoides*, versus only one in *A. lonicerae* (Martin et al. 2000; Stocks 2012).

In his description of this species, Quaintance (1900) mentioned the absence of pores on dorsum of puparium. Although pores might not be visible in specimens that have been improperly cleaned or are unstained, they are present in all well-preserved specimens that we examined (e. g., Fig. 21–24, 32).

New synonymies. Bemis (1904) described *A. diasemus* based on an unspecified number of nymphs and puparia collected on leaves of *Symphoricarpos racemosus* (now *S. albus*) and *Ribes glutinosum* from three localities in Alameda and San Mateo Counties in California deposited at USNM (Type No. 7096). Quaintance and Baker (1914) transferred the species to *Asterochiton* Maskell and later (Quaintance and Baker 1915) to *Trialeurodes* Cockerell. Russell (1948: 78) examined four slides at USNM labeled by Bemis as *A. diasemus*, without type labels and slightly mismatching the date or locality given for the types in the description, that she suspected represented the syntypes of this species, and concluded that the species belonged in the genus *Aleyrodes* rather than *Trialeurodes*. Unfortunately, no specimens labeled as *A. diasemus* were currently located at the USNM (I. Stocks and G. Evans *pers. comm.*), and its types are therefore presumed lost. Bemis' (1904) description of the puparium mentioned the presence of 12 pairs of extremely long, stout spines. The position that he described for these 'spines' agrees with the position of the marginal, dorsal, and caudal setae characteristic of *Aleyrodes*, and we believe that

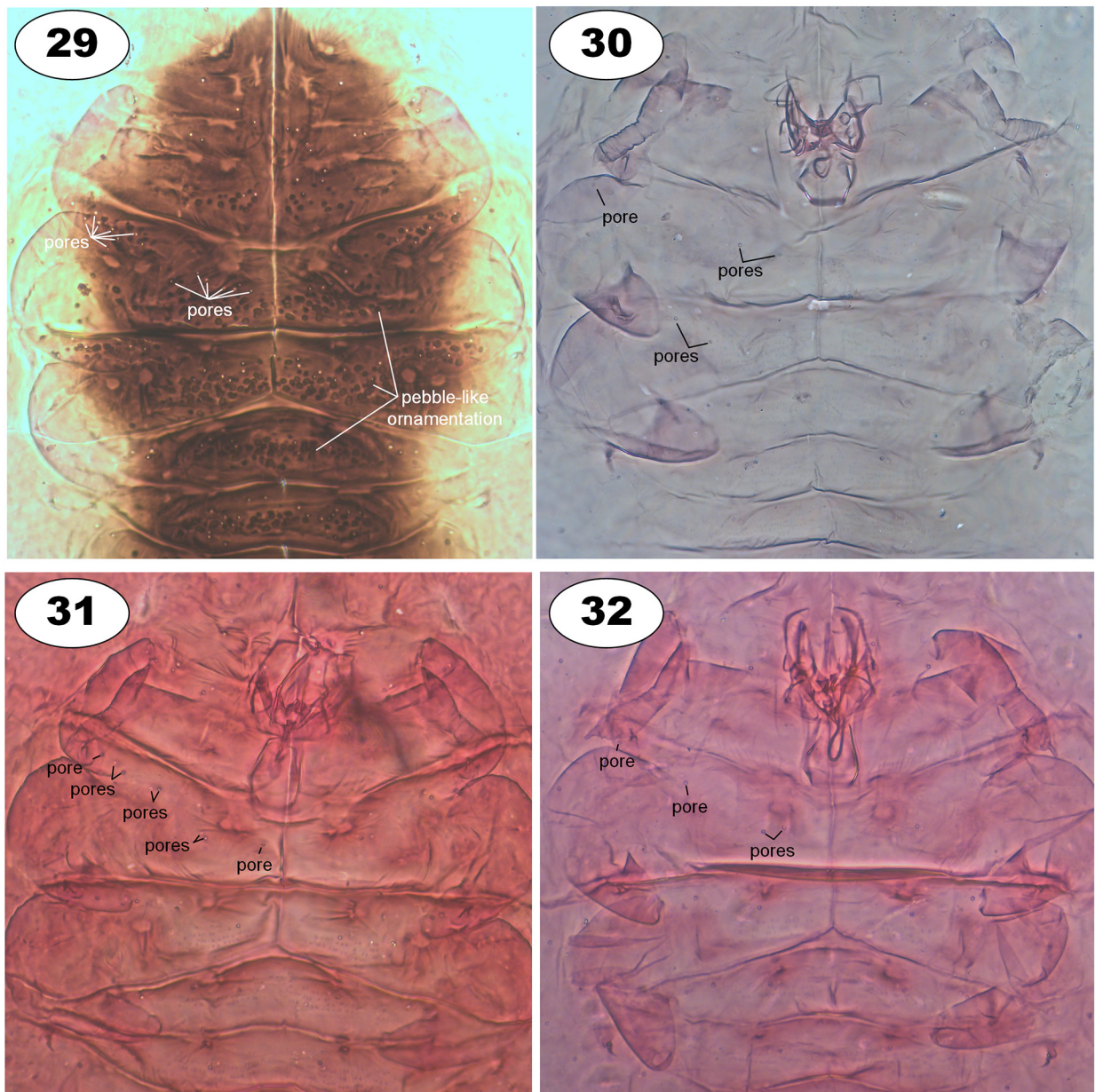


Figures 25–28. Puparia of *A. spiraeoides* showing variability of shape, pore numbers, and setal length. 25–27) **Syntypes** of *A. essigi*, Alameda Co., Mission San Jose, on *Ulmus* sp., ix.1916, E.O. Essig coll. [CAS type #6189]. 28) **Holotype** of *A. osmaroniae*, Alameda Co., Strawberry Creek Canyon, U.C. Berkeley, on *Oemleria cerasiformis*, W.W. Sampson coll. [BME type #850]. Figures are not to scale.

these 'spines' correspond to enlarged setae. Bemis (1904) also mentioned a considerable variation in the amount and kind of wax secretions: 'specimens may have both lateral and dorsal wax, or either alone, or none; when present the lateral fringe is of coalesced crystalline wax rods either free from or covered by flocculent wax; the dorsal secretion is in the form of a submarginal series of separate crystalline wax rods, rather long and curved downward.' According to Russell (1948), the specimens of *A. diasemus* studied by Bemis were collected and mounted together with *Trialeurodes vaporariorum* (Westwood) (identified by Bemis as *Aleyrodes glacialis* Bemis). Therefore, it is possible that the wax pattern described by Bemis (1904) under *A. diasemus* for some puparia corresponded to specimens of *T. vaporariorum*, explaining the unusual variability he noted. Some puparia of *A. spiraeoides* at the CSCA collection collected from *Fragaria* sp., *Myoporum*, *Solanum lycopersicum*, and *Verbena* sp. display a variable number of very long (longer than vasiform orifice) setae (e. g., Fig. 24) which agree in their positions with the 'long spines' described by Bemis (1904). The number of long setae in these populations ranges from none to up to 12 pairs, with much variability regarding which particular setae are enlarged, although the caudal pair is most commonly involved, and in some specimens only one of a pair of setae is extremely long and the other one is of the short length usual for this species. Also, we observed some specimens on *Euphorbia* sp., *Hemizonia lobbii*, *Fuchsia* sp., and *Solanum tuberosum* with long caudal setae (e. g., Fig. 23). This variability observed among specimens from the same populations on the same leaves and even within the same specimens indicates that the length of the setae of the puparia is variable and does not represent interspecific differences, being most likely the result of their development on pubescent leaves. Mound (1963) showed that the number, size, and placement of dorsal setae in *Bemisia tabaci* (Gennadius) may be correlated with the amount, distribution, and shape of leaf hairs on the host surfaces, and we suspect that a similar explanation applies in this case. Since other than the wax pattern, which is here interpreted to be the result of the mixed series used for the description, and the long 'spines', which are a match for the long setae observed on some puparia of *A. spiraeoides* developing on pubescent leaves, the description of *A. diasemus* is congruent with the characteristics of *A. spiraeoides*, *A. diasemus* is here considered a junior subjective synonym of *A. spiraeoides*.

The type series of *A. essigi* Penny, 1922, described from *Ulmus* sp. in Alameda County, was borrowed from CAS in order to diagnose this species. It comprises four slides and three vials with host leaves and dry puparia. The dry material shows numerous puparia on the underside of pubescent leaves (Fig. 12). One of the slides includes five puparia and is in very bad preservation state, with air having leaked inside and puparia barely visible. A second slide includes eight puparia, which are poorly cleared, and whose characters are also obscured by the pharate adults in several of them. The puparia display a variable number of long setae in different positions and not consistent among the specimens (e. g., Fig. 25, 26), and some have the same setae very short (e.g., Fig. 27). Not a single specimen seems to present all four pairs illustrated as being very long by Penny (1922: fig. 1) and his drawing seems to have been a composite. The contour of the puparia varies from broadly elliptical to undulate or slightly elongate (Fig. 25–27). The remaining two slides include adults, one an emerging male, and the other one seven adult males. None of the specimens were properly cleaned or stained, but the male genitalia is visible in all of them. No differences between the syntypes of *A. essigi* deposited at CAS and specimens of *A. spiraeoides* with enlarged setae were found, nor between the adult male syntypes and adult males of *A. spiraeoides*, and therefore *A. essigi* is here considered to represent a junior subjective synonym of *A. spiraeoides*, the name simply representing specimens of *A. spiraeoides* developing on pubescent leaves as in the case of *A. diasemus* discussed above. Penny (1922) described the adult 'female', likely a typo since all specimens in the type series are males, of *A. essigi* as having 'immaculate' wings. The apparent lack of the two diffuse spots on the wings usually visible in *A. spiraeoides* can be explained by the fact that these spots are not always evident in slide mounted specimens.

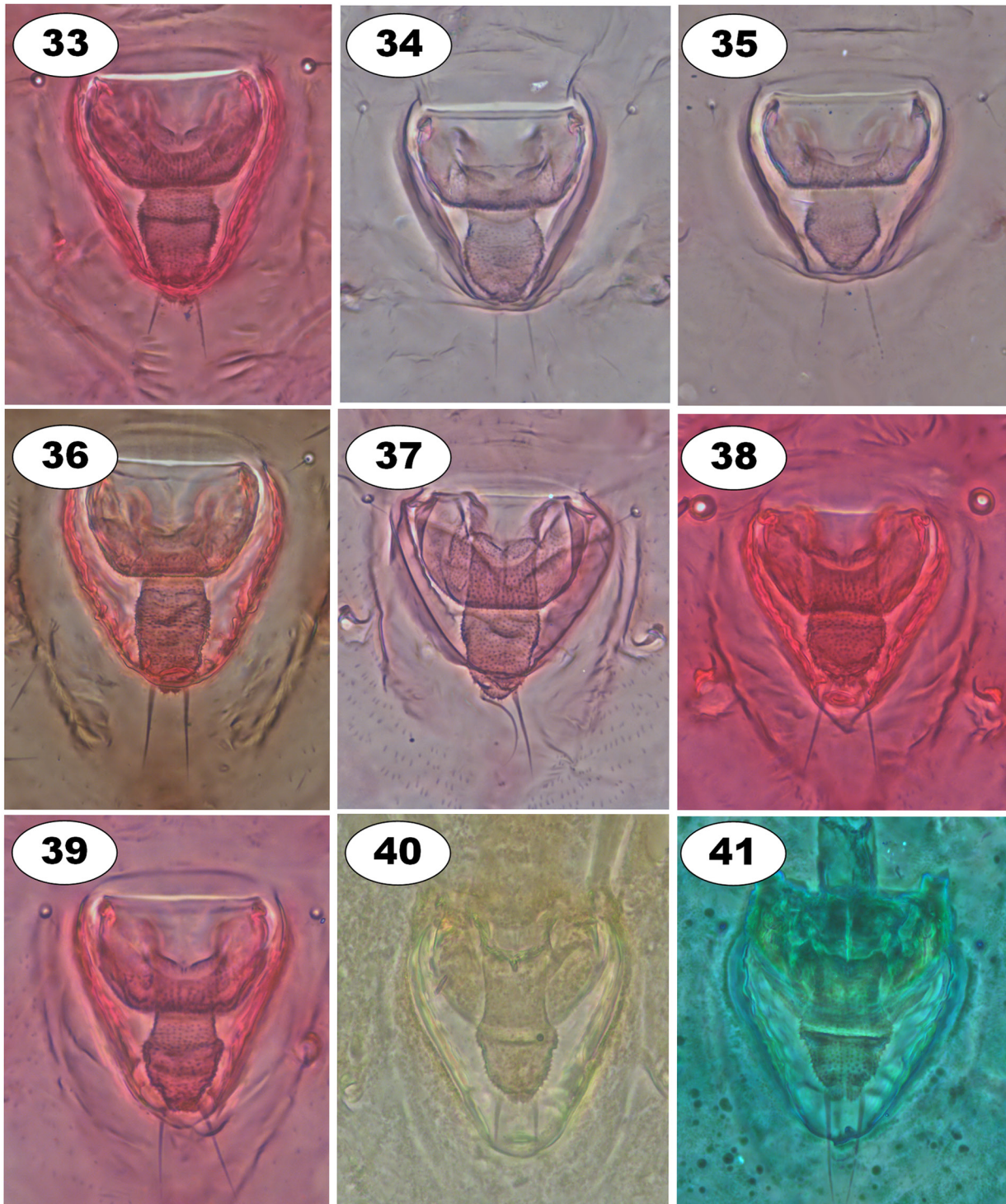
Sampson (1945) described *Aleyrodes osmaroniae* from puparia collected with specimens that he identified as *A. spiraeoides* on *Osmaronia* [now *Oemleria*] *cerasiformia* in Alameda County, and he diagnosed it from *A. spiraeoides* by the presence of a chitinized margin. The holotype and paratypes deposited at BME and paratypes deposited at CSCA were examined. In some specimens there appears to be a fine submarginal line along the puparium, and the marginal area so delimited appears darker, but no 'chitinized' areas were detected. The unusual appearance of the margin is interpreted here to represent the result of uneven staining of the cuticle, which is highly variable in the type series and within separate areas of the margin on some specimens (e. g., Fig. 28). The same submarginal line (on some sections of the puparium or along its entire contour) was observed in



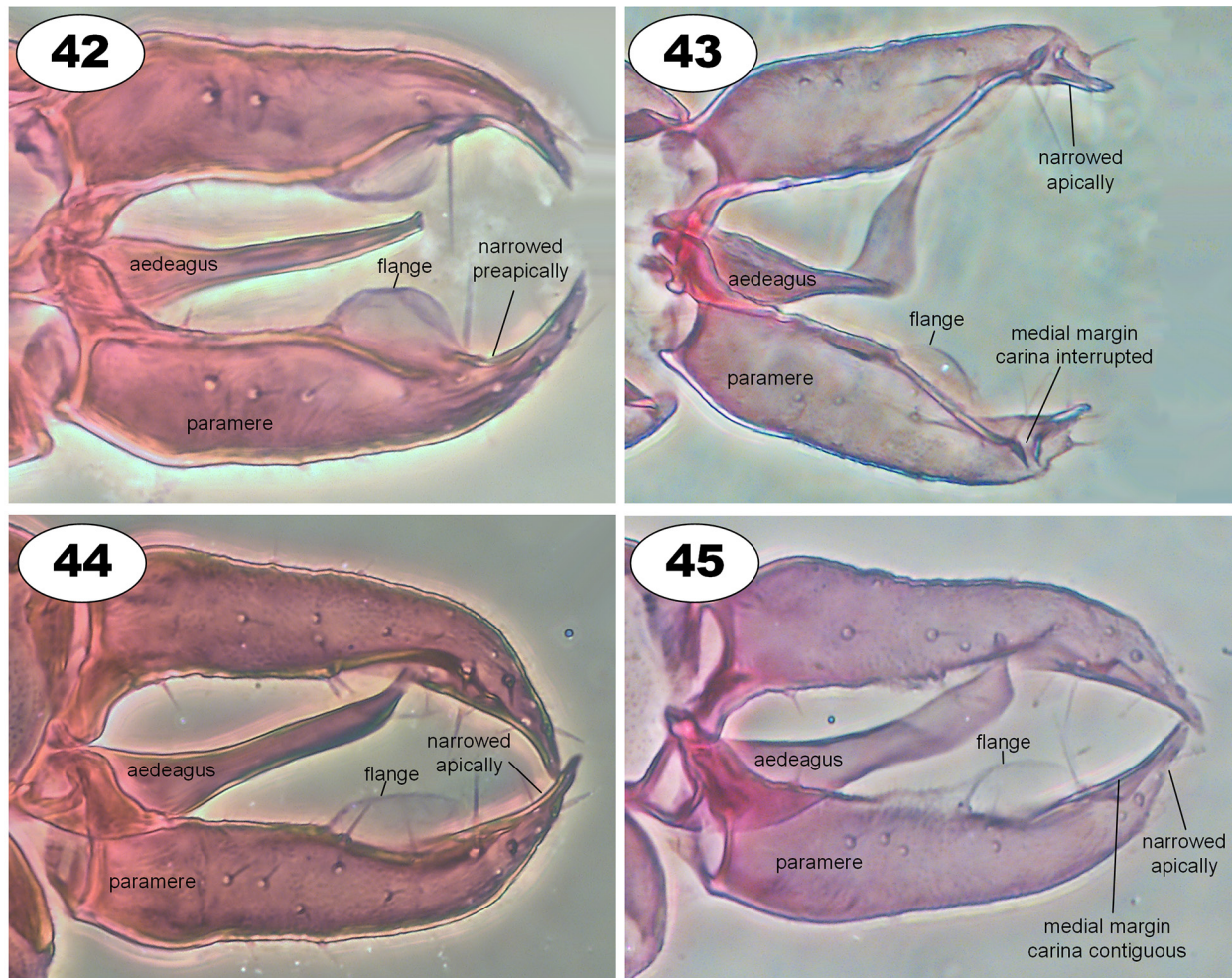
Figures 29–32. Medial section of cephalothorax and anterior abdominal segments of puparium. **29)** *A. amnicola*, San Mateo Co., San Mateo, on *Salix matsudana*, 13.x.1971, P. Crane and H. Struttenecker coll. **30)** *A. proletella*, Santa Cruz Co., Watsonville, on *Brassica oleracea*, 8.viii.2001, Bowman coll. **31)** *A. pruinus*, Santa Barbara Co., Santa Rosa Island, Cow Canyon, 450 ft, on *Heteromeles arbutifolia*, 31.xii.2000, F. Hrusa coll. **32)** *A. spiraeoides*, Sacramento Co., Sacramento, on *Iris* sp., vi.1977, R.J. Gill coll. Figures are not to scale.

other specimens of *A. spiraeoides* (e. g., Fig. 23, 25, 27) and in other *Aleyrodes* species (e. g., Fig. 14, 16, 17, 20), and it might be an artifact caused by one of the surfaces (dorsal or ventral) of the puparium being folded away from the margin during slide mounting. No differences were found among the type specimens of *A. osmaroniae* and puparia of *A. spiraeoides*, and therefore *A. osmaroniae* is here considered a junior subjective synonym of *A. spiraeoides*.

Hosts. Polyphagous, in California most common on *Iris* Tournefort ex. L. and *Gladiolus* L. (Iridaceae) but recorded from a wide range of plants (see Table 2). Penny (1922) recorded it from *Ceanothus* among other hosts,



Figures 33–41. Vasiform orifice. **33)** *A. amnicola*, Santa Barbara Co., on *Ceanothus* sp., 17.ix.1998, J. Kendall coll. **34, 35)** *A. proletella*, Santa Cruz Co., Santa Cruz Co., Watsonville, on *Brassica oleracea*, 8.viii.2001, Bowman coll. **36)** *A. pruinosus*, San Diego Co., Chula Vista on *Heteromeles arbutifolia*, 14.xii.1973, Knott and Webb coll. **37–41)** *A. spiraeoides*. **37)** Santa Barbara Co., on *Iris* sp., 26.v.1972, C.C. Benedict coll. **38)** San Joaquin Co., Stockton, on *Solanum esculentum*, 4.vii.1984, T. Gantenbein coll. **39)** Riverside Co., Riverside, on *Euphorbia supina*, viii.1982, J. LaSalle coll. **40)** Syntype of *A. essigi*, Alameda Co., Mission San Jose, on *Ulmus* sp., ix.1916, E.O. Essig coll. [CAS type #6189]. **41)** Holotype of *A. osmaroniae*, Alameda Co., Strawberry Creek Canyon, U.C. Berkeley, on *Oemleria cerasiformis*, W.W. Sampson coll. [BME type #850]. Figures are not to scale.



Figures 42–45. Male genitalia. **42)** *A. amnicola*, Los Angeles Co., Westlake Village, on *Salix matsudana*, 3.xii.1979, M. Pearson coll. **43)** *A. proletella*, Santa Cruz Co., Santa Cruz Co., Watsonville, on *Brassica oleracea*, 8.viii.2001, Bowman coll. **44)** *A. pruinosus*, San Diego Co., Chula Vista on *Heteromeles arbutifolia*, 14.xii.1973, Knott & Webb coll. **45)** *A. spiraeoides*, Monterey Co., San Ardo, on *Solanum tuberosum*, 31.viii.2001, Oliver coll. Figures are not to scale.

but since all the specimens we examined from *Ceanothus* correspond to *A. amnicola*, we consider that record as doubtful and omit it from its host plant list. Landis et al. (1958) provided additional host plants based on specimens from the Pacific Northwest (Washington, Oregon, and Idaho States).

Distribution. Throughout the state, especially in urbanized areas. Recorded also from Arizona, Colorado, Florida, Idaho, Hawaii, Louisiana, Nevada, Oregon, Utah, Texas, and Washington States in the U.S.A., and from Canada, Mexico, and Venezuela (Landis et al. 1958; Evans 2007).

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