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. proletella* 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
The genus *Aleyrodes* in California

*Insecta Mundi* 1062 · 3

The genus *Aleyrodes* in California

Insecta Mundi 1062 · 3

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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

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**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.

<table>
<thead>
<tr>
<th></th>
<th><em>A. amnicola</em> Bemis</th>
<th><em>A. proletella</em> (L.)</th>
<th><em>A. pruinosis</em> Bemis</th>
<th><em>A. spiraeoides</em> Q.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Puparium</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>1,265 ± 136</td>
<td>1,030 ± 115</td>
<td>1,243 ± 65</td>
<td>1,116 ± 127</td>
</tr>
<tr>
<td></td>
<td>1,050–1,500</td>
<td>850–1,200</td>
<td>1,125–1,330</td>
<td>900–1,320</td>
</tr>
<tr>
<td>Maximum W</td>
<td>932 ± 127</td>
<td>813 ± 98</td>
<td>896 ± 58</td>
<td>832 ± 111</td>
</tr>
<tr>
<td></td>
<td>752–1,135</td>
<td>650–917</td>
<td>805–980</td>
<td>580–950</td>
</tr>
<tr>
<td>L/ W</td>
<td>1.36 ± 0.06</td>
<td>1.27 ± 0.05</td>
<td>1.39 ± 0.04</td>
<td>1.34 ± 0.13</td>
</tr>
<tr>
<td></td>
<td>1.26–1.46</td>
<td>1.18–1.33</td>
<td>1.34–1.45</td>
<td>1.14–1.55</td>
</tr>
<tr>
<td>VO L</td>
<td>83 ± 5</td>
<td>69 ± 5</td>
<td>85 ± 4</td>
<td>77 ± 7</td>
</tr>
<tr>
<td></td>
<td>70–92</td>
<td>58–75</td>
<td>80–92</td>
<td>65–87</td>
</tr>
<tr>
<td>VO W</td>
<td>78 ± 5</td>
<td>70 ± 5</td>
<td>83 ± 4</td>
<td>73 ± 7</td>
</tr>
<tr>
<td></td>
<td>65–85</td>
<td>58–75</td>
<td>75–87</td>
<td>58–82</td>
</tr>
<tr>
<td>VO L/ W</td>
<td>1.07 ± 0.05</td>
<td>1.00 ± 0.02</td>
<td>1.02 ± 0.05</td>
<td>1.04 ± 0.05</td>
</tr>
<tr>
<td></td>
<td>1.00–1.17</td>
<td>0.94–1.03</td>
<td>0.97–1.12</td>
<td>0.97–1.17</td>
</tr>
<tr>
<td><strong>Adult male</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>1,519 ± 125</td>
<td>1,473 ± 93</td>
<td>1,457 ± 145</td>
<td>1,510 ± 157</td>
</tr>
<tr>
<td></td>
<td>1,330–1,649</td>
<td>1,360–1,630</td>
<td>1,280–1,630</td>
<td>1,240–1,750</td>
</tr>
<tr>
<td>Mesotibial brush</td>
<td>3</td>
<td>2–4 (usually 3)</td>
<td>2–4 (usually 3)</td>
<td>2–4 (usually 3)</td>
</tr>
<tr>
<td>Metatibial brush</td>
<td>2–4 (usually 3)</td>
<td>2–3 (usually 3)</td>
<td>3</td>
<td>3–4 (usually 3)</td>
</tr>
<tr>
<td>Metatibial comb</td>
<td>18–24</td>
<td>23–27</td>
<td>22–30</td>
<td>19–26</td>
</tr>
<tr>
<td>Paramere L</td>
<td>140 ± 7</td>
<td>140 ± 6</td>
<td>150 ± 3</td>
<td>138 ± 9</td>
</tr>
<tr>
<td></td>
<td>128–148</td>
<td>131–146</td>
<td>146–155</td>
<td>121–150</td>
</tr>
<tr>
<td>Aedeagus L</td>
<td>103 ± 10</td>
<td>119 ± 9</td>
<td>106 ± 8</td>
<td>102 ± 7</td>
</tr>
<tr>
<td></td>
<td>87–119</td>
<td>112–141</td>
<td>102–126</td>
<td>97–116</td>
</tr>
<tr>
<td>Paramere/Aedeagus</td>
<td>1.36 ± 0.08</td>
<td>1.18 ± 0.07</td>
<td>1.42 ± 0.11</td>
<td>1.36 ± 0.07</td>
</tr>
<tr>
<td></td>
<td>1.2–1.47</td>
<td>1.03–1.25</td>
<td>1.19–1.52</td>
<td>1.25–1.43</td>
</tr>
<tr>
<td><strong>Adult female</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>1,713 ± 117</td>
<td>1,504 ± 69</td>
<td>1,588 ± 124</td>
<td>1,522 ± 74</td>
</tr>
<tr>
<td></td>
<td>1,557–1,595</td>
<td>1,455–1,552</td>
<td>1,426–1,765</td>
<td>1,420–1,620</td>
</tr>
<tr>
<td>Mesotibial brush</td>
<td>3</td>
<td>3</td>
<td>2–4 (usually 3)</td>
<td>3–4 (usually 3)</td>
</tr>
<tr>
<td>Metatibial brush</td>
<td>2–3 (usually 3)</td>
<td>3</td>
<td>3</td>
<td>3–4 (usually 3)</td>
</tr>
<tr>
<td>Ovipositor L</td>
<td>198 ± 9</td>
<td>177 ± 10</td>
<td>206 ± 22</td>
<td>181 ± 9</td>
</tr>
<tr>
<td></td>
<td>194–218</td>
<td>170–184</td>
<td>165–223</td>
<td>170–194</td>
</tr>
</tbody>
</table>
Table 2. Host plants of *Aleyrodes* species recorded in California (from Quaintance (1900), Bemis (1904), Penny (1922), and material examined in this study).

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

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.x.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: Fig. 5, 6, 17, 18, 30, 34, 35, 43* *Aleyrodes proletella* but the source of this record could not be found, and it is considered to be erroneous (G. Evans of the San Francisco Bay area. Evans (2007) mentioned this species from the Virgin Islands without further data, *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 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).
*Aleyrodes 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,
Aleyrodes pruinosus Bemis, 1904

The genus Aleyrodes in California

Heteromeles arbutifolia
Brassica oleracea

We have been unable to distinguish the puparia from those of Heteromeles arbutifolia. However, adult males of A. proleptella 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; aedeagus abruptly curved at a 90-degree angle at mid-length (Fig. 43).

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.


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.x.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.x.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.x.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.vii.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.x.1937, F.L. Blanc coll.; 9 puparia, same data but 19.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
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Ribes glutinosum], Leland Stanford Junior University campus, along San Francisquito Creek, *Heteromeles arbutifolia* - The more extensive dark color can usually be used to distinguish the puparium of this species from that -.

*Fuchsia* - *Heteromeles arbutifolia* -

U.S.A., California, 14 puparia [identified as *Specimens examined. Fig. 10–12, 21–28, 32, 37–41, 45

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 *Convolutus* [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 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 *Osmaria* [now *Oemleria*] *cerasiformis*, 14.vi.1941, W.W. Sampson coll., at BME). New synonymy. Specimens examined. Slide mounted material: 460 puparia, 68 ♂♂, 55 ♀♀ [at CSUA unless indicated otherwise]: U.S.A., California, 14 puparia [identified as *A. osmaroniae* by W.W. Sampson] #27; Imperial County: 5 puparia,
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**Fragaria** -

**Fraxinus velutina** Bemis (1904) described

**Ligustrum**

**Solanum pseudocap**

Puparium of *Citrus × sinensis* agrees with the position of the marginal, dorsal, and caudal setae characteristic of *G. Evans* the syntypes of this species, and concluded that the species belonged in the genus and slightly mismatching the date or locality given for the types in the description, that she suspected represented Cockerell. Russell (1948: 78) examined four slides at USNM labeled by Bemis as (1914) transferred the species to

collected on leaves of

New synonymies.

in California

**Insecta Mundi** 1062 · 15


**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. pruinosa* 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 data 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
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are a match for the long setae observed on some puparia of which is here interpreted to be the result of the mixed series used for the description, and the long 'spines', which the host surfaces, and we suspect that a similar explanation applies in this case. Since other than the wax pattern, setae in of their development on pubescent leaves. Mound (1963) showed that the number, size, and placement of dorsal setae of the puparia is variable and does not represent interspecific differences, being most likely the result of the long setae 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 *Osmoronia* [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
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,
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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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**Literature Cited**

**Bemis FE. 1904.** The aleyrodids or mealy-winged flies of California with citation to other American species. Proceedings of the U.S. National Museum 27: 471–537.

**Bondar G. 1923.** Aleyrodoideos do Brasil. Official State Publisher; Bahia, Brazil. 183 p.


**Hernández-Suárez E, Martin JH, Gill RJ, Bedford ID, Malumphy CP, Reyes JA, Carnero A. 2012.** The Aleyrodidae (Hemiptera: Sternorrhyncha) of the Canary Islands with special Citation to *Aleyrodes*, *Siphoninus*, and challenges of puparial morphology in *Bemisia*. Zootaxa 3212: 1–76.


**Latreille PA. 1801.** Histoire naturelle des crustaces et des insects. 3. F. Duvart; Paris, France. 468 p.

**Latreille PA. 1807.** Genera crustaceorum et insectorum secundum ordinem naturalem in familias disposita: iconibus exemplisque plurimis explicata. 3. A. Koenig; Paris, France. 258 p.


**Mound LA, Halsey SH. 1978.** Whitefly of the world. A systematic catalog of the Aleyrodidae (Homoptera) with host plant and natural enemy data. British Museum (Natural History), John Wiley and Sons; Chichester, United Kingdom. 340 p.


**Penrose D. 2001.** Cabbage whitefly: Santa Cruz County. California Department of Food and Agriculture Detection Advisory PD 65–01. California Department of Food and Agriculture; Sacramento, California, United States of America. 2 p.

**Quaintance AL. 1900.** Contribution towards a monograph of the American Aleurodidae. Technical Series, Bureau of Entomology, United States Department of Agriculture 8: 9–64.


**Schrank F von P. 1801.** Fauna Boica: durchgedachte Geschichte der in Baiern einheimischen und zahmen Thiere. 2(1). Johann Wilhelm Krüll; Ingolstadt, Germany. viii + 374 p.


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