JOURNAL OF
THE LEPIDOPTERISTS' SOCIETY

Volume 45 1991 Number 2

Journal of the Lepidopterists' Society
45(2), 1991, 89–104

A REVIEW OF *LITHARIAPTERYX* (HELIODINIDAE), WITH DESCRIPTION OF AN ELEGANT NEW SPECIES FROM COASTAL SAND DUNES IN CALIFORNIA

JERRY A. POWELL

Department of Entomological Sciences, University of California,
Berkeley, California 94720

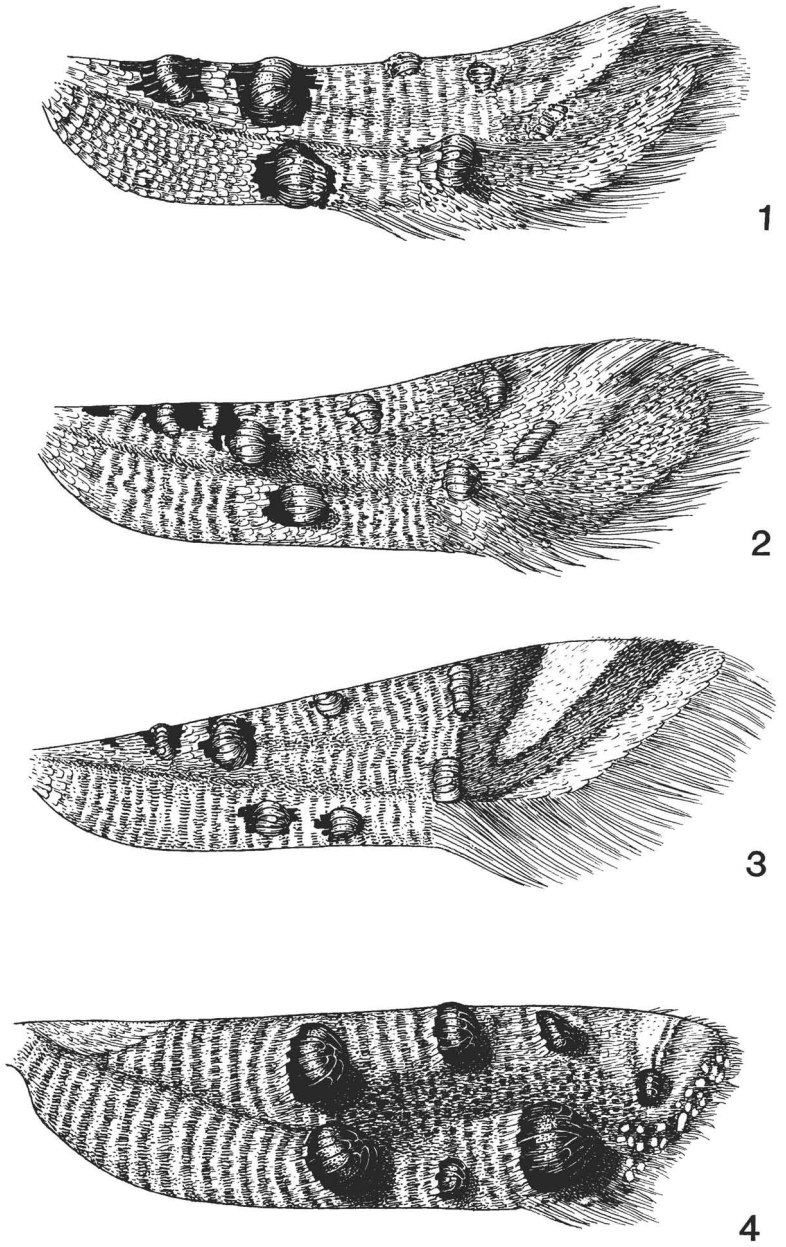
ABSTRACT. The genus *Lithariapteryx* Chambers comprises four species in the western U.S. and northwestern Mexico, although one, *L. mirabilinella* Comstock, is suspected to be a seasonal or geographical form of *L. abroniaeella* Chambers. *Lithariapteryx elegans* is a new species described from ocean beach foredunes in San Luis Obispo and Monterey counties, California. The adults are tiny, diurnal moths that have raised lead- or silver-colored spots on the forewings. The larvae are facultative leaf miners of *Abronia* and *Mirabilis* (Nyctaginaceae); each species is primarily or exclusively associated with either *Abronia* or *Mirabilis* but uses two or more species of the hostplant genus.

Additional key words: leaf miner, Nyctaginaceae, sand verbena, *Abronia, Mirabilis.*

Members of the genus *Lithariapteryx* Chambers are tiny, diurnal moths that have the forewings adorned with upraised, gem-like, rounded tufts of shining lead- or silver-colored scales (Figs. 1–5). They occur primarily in sandy situations, in close association with the larval foodplants, *Abronia* (Sand Verbena) and *Mirabilis* (Four O'clock) (Nyctaginaceae). The genus is limited to the western United States and adjacent parts of Mexico.

Lithariapteryx was proposed by V. T. Chambers (1876) for *L. abroniaeella,* which he discovered at Edgerton, El Paso Co., Colorado. The concept of *Lithariapteryx* as a distinct genus has not been questioned, and there are no synonyms.

J. A. Comstock (1940) described two additional species without comparing them to *L. abroniaeella.* These are *L. jubarella* from the low Colorado Desert of southeastern California and from near Llano in the western Mojave Desert. At the Mojave locality he found adults of *L. jubarella* on *Mirabilis,* along with larvae, which, however, produced



FIGS. 1–4. Forewing of *Lithariapteryx*: **1**, *L. abroniaeella* Chambers, Pt. Reyes, Marin Co., California; **2**, *L. mirabilinella* Comstock, Tuttle Cr., Inyo Co., California; **3**, *L. jubarella* Comstock, The Gap, Coconino Co., Arizona; **4**, *L. elegans* Powell, Oso Flaco Lk., S.L.O. Co., California.

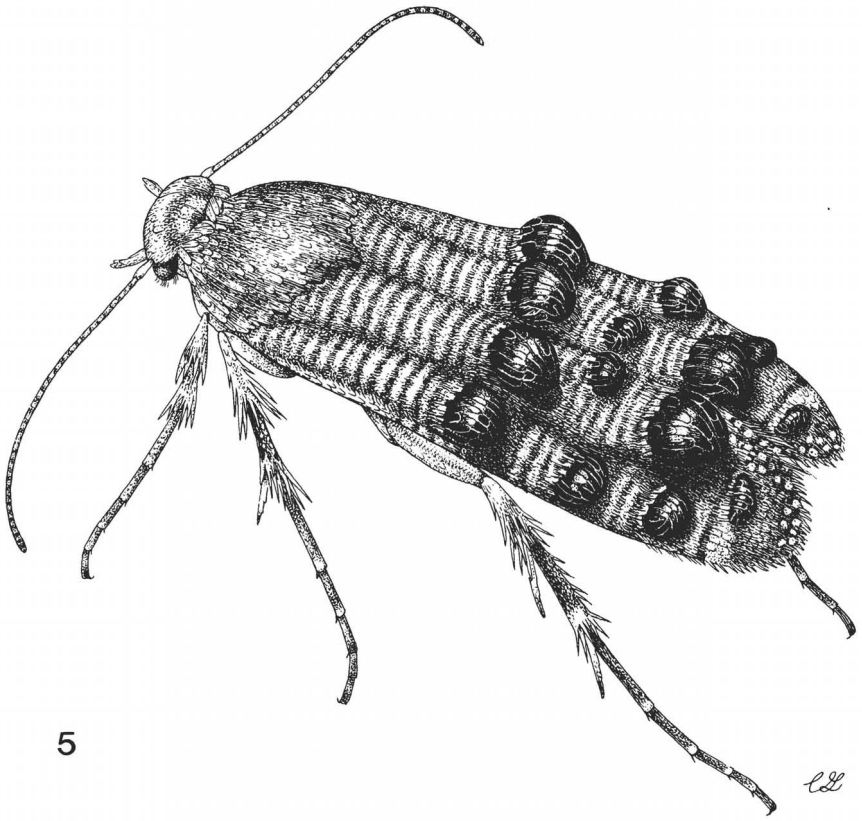


FIG. 5. Habitus of adult *Lithariapteryx elegans* Powell, Oso Flaco Lk., S.L.O. Co., California.

moths that are phenotypically different. These he named *L. mirabilinella*. Comstock suggested the possibility that the latter is a seasonal form of *jubarella*, but in reality *L. mirabilinella* morphologically is more similar to *L. abroniaeella*, from which it differs mainly in the reduced extent of orange on forewings. About 30 years ago we found a fourth species, on the coastal sand dunes of central California, that is abundantly distinct from the others; it is described here as *L. elegans*.

C. W. Baker, Boise State University, Boise, Idaho, has studied populations of moths phenotypically similar to *L. abroniaeella* and *L. mirabilinella* in Idaho, Oregon, and northern California. There are differences in size of individuals and in extent of orange on the forewings between first and second generation moths, which casts further doubt on the validity of *mirabilinella* as a taxon. Summer individuals are smaller than those of the spring generation in coastal dunes-inhabiting

populations of *L. abroniaeella* and *L. elegans* in California, judging from field-collected adults. However, I do not see evidence of seasonal color change in these populations. This suggests that marked seasonal polyphenism is not the rule in *Lithariapteryx*, which would further contradict Comstock's suspicion that *L. jubarella* is a spring morph that gives rise to a later generation of the *mirabilinella* phenotype having different male genitalia.

I suspect that there are only three species because we have not documented sympatry of *L. abroniaeella* and *mirabilinella*, which would demonstrate that these two are not geographically or environmentally induced forms. It seems best to continue to regard all four as species pending further studies of the relationships.

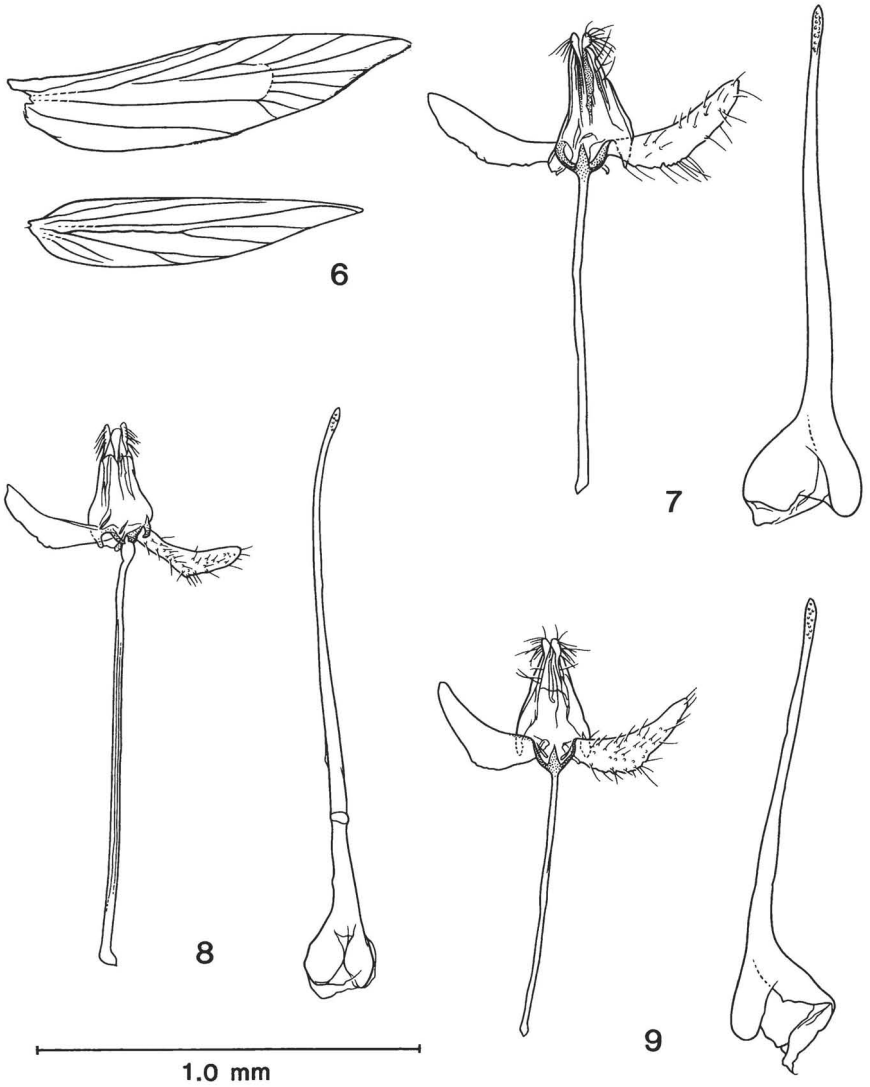
LITHARIAPTERYX CHAMBERS, 1876

Lithariapteryx Chambers, 1876, Canad. Entomol. 8:217.
Lithariopteryx Comstock, 1940, Bull. So. Calif. Acad. Sci. 38:175 (misspelling).

Type species. *Lithariapteryx abroniaeella* Chambers, 1876 (monotypy).

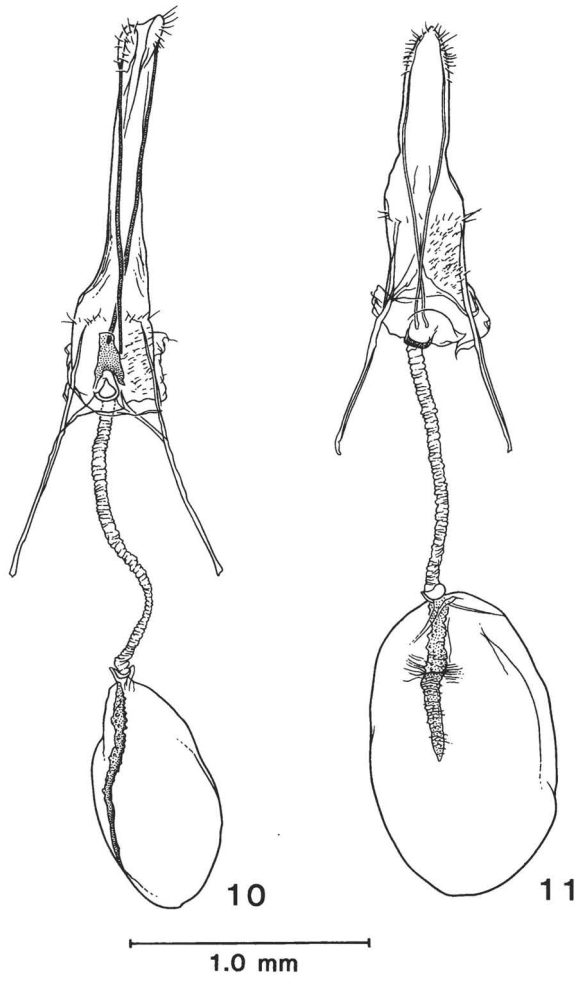
Diagnosis. Small, diurnal moths (FW length 2.8–6.5 mm). **Head:** smooth, clothed with tightly appressed, metallic colored scales; eye oval, small, index (length : height of front, measured from a horizontal line between antennal sockets to ventral margin of clypeus) = 0.75–0.83 in male, 0.67-0.70 in female; labial palpus smooth scaled, porrect, pointed, projecting to or ahead of plane of front; maxillary palpus reduced, not visible; tongue unscaled; antenna smooth-scaled, without projecting setulae in either sex, length about 0.67 FW length; ocellus prominent, situated below antennal socket, behind eye. **Forewing:** strongly attenuate distally; 10 veins all separate (Fig. 6), R stem partially to completely persistent through cell. A strong hair pencil from base of subcosta ventrally in both sexes. Scaling gray, uniformly strigulate transversely by rows of white tips; interrupted by prominent, bulging spots of elongate, metallic colored scales. **Hindwing:** lanceolate; 6 veins (+trace of 1st and 2nd A); Rs + M_1 separate, Cu_{1+2} forked near margin; fringe elongate, broader than membrane. Frenulum a single, strong bristle in both sexes. **Male genitalia:** (Figs. 7–9) with uncus undeveloped, socii relatively large, appressed to tegumen; saccus extremely elongate, slender (1.7–3.4 × tegumen length); aedeagus about 1.1 × longer than tegumen + saccus, with phallobase strongly swollen, abruptly narrowed, tapering to a lanceolate tip. **Female genitalia:** (Figs. 10, 11) apophyses moderately elongate, very slender; ostium surrounded by a thin, sclerotized ring; ductus bursae slender, elongate (more so after mating); corpus bursae oval, densely scobinate or foveolate over entire surface, sclerotization concentrated in a longitudinal band ventrally.

With the exception of color and the separate, rather than forked, R_4 + R_5 veins of the forewing, most of these characters apply equally well to species of *Heliodines* Stainton. Chambers (1876) compared his new genus to European *Glyphipteryx* Zeller, *Perittia* Stainton, and *Tinagma* Zeller, which at the time were placed together in Glyphipterygidae (Stainton 1859). Now they are considered to be Glyphipterigidae, Elachistidae, and Douglasiidae, respectively, members of three superfamilies. It is curious that Chambers did not mention his own genus *Aetole*, which he had described the previous year to accommodate *A.* (=*Heliodines*) *bella*, a new species from Texas (Chambers 1875). Presumably he believed his two genera were unrelated owing



FIGS. 6–9. **6,** Wing venation of *Lithariapteryx jubarella* Comstock, The Gap, Coconino Co., Arizona. FIGS. 7–9: Male genitalia of *Lithariapteryx,* ventral aspect, valvae spread, aedeagus removed: **7,** *L. abroniaeella* Chambers, The Gap, Coconino Co., Arizona; **8,** *L. jubarella* Comstock, Surprise Cyn., Inyo Co., California; **9,** *L. elegans* Powell, Oso Flaco Lk., S.L.O. Co., California. (Scale bar refers to Figs. 7–9, which are drawn at the same scale, including aedeagus.)

to differences in wing venation. Based on illustrations and examination of one male of the type species of *Heliodines, H. roesella* (L.), and study of several Nearctic species referable to this genus, I find few



FIGS. 10–11. Female genitalia of *Lithariapteryx*, ventral aspect: **10,** *L. abroniaeella* Chambers, The Dalles, Wasco Co., Oregon; **11,** *L. elegans* Powell, Oso Flaco Lk., S.L.O. Co., California.

consistent morphological differences between *Lithariapteryx* and *Heliodines*.

In *H. roesella, H. bella,* and *H. nyctaginella* Gibson (Spuler 1913, Forbes 1923) and *H. extraneella* (Walsingham) (JAP preps.), $R_4 + R_5$ are stalked about ½ their length, and $Rs + M_1$ are short-stalked in the hindwing. However, all veins are separate in *H. sexpunctella* (Walsingham), as is true of all four *Lithariapteryx* species. The forewing ground color in species of *Heliodines* is bright orange-red, with shining lead-gray markings, but these are not strongly raised like the metallic

scale tufts of *Lithariapteryx* are. There is considerably greater variation in male genitalia in species assigned to *Heliodines* than is true in *Lithariapteryx*. In *H. roesella* the format is similar to *Lithariapteryx*, but with the socii sclerotized and widely separated (interpreted as "uncus paired" by Pierce & Metcalfe 1935), and there are thorn-like cornuti in the vesica; the saccus is slender and long (1.3–1.4 × tegumen length) but not as extremely so as in *Lithariapteryx*. In specimens identified as *H. bella* from Riverside, CA, the socii are greatly elongated and sclerotized, and the gnathos is membranous. *Heliodines extraneella* has the VIII tergite modified elaborately, extended middorsally into an uncus-like projection, laterally into attenuate projections, analogous to the development in some scythrids; the genitalia also differ markedly, with the tegumen reduced, the socii separated, gnathos lacking or membranous, and the valvae broadened. The answer as to whether the present separation of *Lithariapteryx* and *Heliodines* and assignment of some of the latter's species are valid will have to await a comprehensive reassessment of the Heliodinidae.

Biology of *Lithariapteryx*

Chambers (1876) discovered the larvae of *Lithariapteryx abroniaeella*, and the species was reared in California by H. H. Keifer and F. N. Pierce in the 1920's and 1930's (CAS, LACM specimens). Comstock (1940) obtained the original series of *L. mirabilinella* from field-collected larvae; R. Wielgus has reared *L. jubarella* in Arizona, and I have reared the four *Lithariapteryx* from about 25 larval collections, each species represented by samples from 2–8 localities. Recently, C. W. Baker has reared *L. abroniaeella* and *mirabilinella* in Idaho, Oregon, and northern California. Moreover, collections of adults from numerous additional populations have helped confirm the foodplant associations.

The larvae mine the subsucculent leaves of *Abronia* and *Mirabilis* (Nyctaginaceae). *Lithariapteryx abroniaeella* feeds on various species of *Abronia*, including *A. fragrans* in Colorado, *A. umbellata, maritima*, and *latifolia* on coastal sand dunes in California, *A. maritima* in Baja California, and *A. mellifera* on the Columbia River dunes near The Dalles, Oregon. I also found larvae on *Mirabilis froebelii* in northern Arizona, and Baker reared them from *M. macfarlanei* in Idaho. The newly described species, *L. elegans*, has been associated with *A. latifolia* and occasionally with *A. umbellata* growing in close proximity to *latifolia*. At its localities in the Santa Maria and Monterey Bay dune systems, *L. abroniaeella* is not closely sympatric, is rare, and we have found it only on *A. umbellata*, although *A. latifolia* is its primary host in San Francisco and northward.

By contrast, most records for *L. jubarella* and *L. mirabilinella* are from *Mirabilis*: the former from *M. laevis* in the Mojave Desert (Comstock 1940), at Riverside, and Santa Cruz Island, California. In addition, we found adults abundantly on *M. bigelovii* at several sites in Inyo Co., California, and Wielgus reared *jubarella* from that host in Arizona. We found larvae of *L. mirabilinella* on *M. bigelovii* at three localities in Inyo Co. and Baker discovered the same association in eastern Oregon. Baker also reared *mirabilinella* from *M. greenei* in Siskiyou Co., California, and from *Abronia fragrans* in southwestern Idaho.

The adults are diurnal and are encountered on sunny days perching and mating on the larval food plant. On windblown coastal dunes they often are found on the sand nearby. In appearance, they have been likened to small jumping spiders (Salticidae), which are common in dune habitats; when the moths are viewed from behind, the bulging metallic colored spots resemble the eyes of a salticid. I have not seen *Lithariapteryx* taking nectar from *Abronia* or *Mirabilis*, but *Heliodines* are found in the flowers of *Mirabilis*, so the larval hosts may serve as a nectar source. The moths often visit flowers of unrelated plants in the vicinity (see data in the species accounts): *L. abroniaeella* on *Senecio* and *Haplopappus* (Asteraceae) and *Croton* (Euphorbiaceae); *L. jubarella* on *Senecio* and *Hyptis* (Lamiaceae); *L. mirabilinella* on *Eriogonum* (Polygonaceae), *Senecio*, *Eriophyllum* (Asteraceae), and *Erysimum* (Brassicaceae); and numerous adults of *L. elegans* were observed nectaring on *Mesembryanthemum* (Aizoaceae), an African plant growing interspersed with *Abronia* on beach dunes at Monterey Bay.

There is considerable variation in mine form depending upon leaf thickness and other habitat factors. Typically larvae form a blotch-like mine basally in the leaf, from which digitate feeding tunnels project; often after mining out about half the leaf contents, the larva moves to another leaf. In thick-leafed plants such as *Abronia maritima* and *A. latifolia*, mines often are confined to the lower portion of the leaves and are not easily visible from above, and all of the late instar feeding may occur within one, or two overlapping leaves. In thin-leafed hosts (e.g. *A. umbellata*, *Mirabilis laevis*), several adjacent leaves are incorporated into a webbed shelter. Frass is ejected from a hole basally in the mine, where it lodges in silk webbing. In sand verbenas this usually is attached from the underside of the leaf, and the mine is evidenced by a glob of webbing caked with sand and frass. On *Mirabilis*, the webbing connects terminal leaves, and the larvae are found within the mine or in the webbing.

At maturity the larva leaves the last mine and affixes itself to a leaf or other surface (in the lab) for pupation, which occurs in a frail, nearly transparent cocoon. Possibly dormancy occurs in this stage, particularly

in desert areas, but in my rearings, development occurred without a lengthy diapause, moths emerging in 13–14 days (*L. jubarella*), 20–24 days (*L. mirabilinella*), to as long as 25–30 days (*L. abroniaeella*) following pupation.

Coastal populations of *Lithariapteryx* evidently are multivoltine: at San Francisco Keifer reared *L. abroniaeella* in April, June, and August through October in 1926, and I found larvae in April, May, and July 50 years later; we have taken adults or larvae of *L. elegans* at the type locality in every month from March to November. Baker has observed two generations of *L. mirabilinella* in Idaho, but populations in some arid habitats may be normally univoltine, dictated by seasonal availability of food plants.

The larva of *Lithariapteryx abroniaeella* (given as *abromiella*) has been characterized and illustrated by Heppner (1987), and photographs of the pupa of *L. mirabilinella* were published by Comstock (1940).

KEY TO THE SPECIES OF *LITHARIAPTERYX*

1. FW costal area margined with orange at base, lacking silver spots in basal ⅓ ..... *elegans* Powell, n. sp.
– FW costal area marked with silver & black on basal ⅓ 2
2. FW with 8–9 silver spots, including a well developed spot on dorsal margin between the black-rimmed one at mid-dorsum and tornal spot; HW fringe gray in anal area in both sexes. Saccus very long, 3.0–3.4 × tegumen length; ductus bursae elongate, >1.5 × posterior apophyses length ..... *jubarella* Comstock
– FW with 6–7 silver spots, with at most a trace of silver before tornus beyond the black-rimmed spot at mid-dorsum; HW fringe in male and usually in female white, at least in anal area. Saccus shorter, 1.7–2.3 × tegumen length; ductus bursae shorter than posterior apophyses 3
3. FW ground color gray, usually with only a trace of orange in subterminal area .. *mirabilinella* Comstock
– FW with more extensive orange, forming a V-shaped spot surrounding subapical white triangle ..... *abroniaeella* Chambers

Lithariapteryx abroniaeella Chambers (Figs. 1, 7, 10, 12)

Lithariapteryx abroniaeella Chambers, 1876, Canad. Entomol. 8:217.
Lithariapteryx abromiella (misspelling) Heppner, 1987, Immature Insects: 411.

Diagnosis. FW length 2.8–5.0 mm. Head, tegulae, thorax dorsally shining lead-gray; labial palpus whitish; venter whitish blotched with gray. FW strigulate gray to tornus, followed by an orange V-shaped mark from costa, often incomplete; 3 conspicuous, raised, silvery spots margined with black on basal half: 2 along costa, 1 in dorsal area slightly displaced outwardly; 4 smaller silvery spots of lower relief, in distal half: 2 arising from white marks on costa at end of cell and above tornus, a larger one preceding and lining inner half of the orange V, one at apex of white marking inside V; additional white narrowly margining the V subterminally and at tornal margin. Fringe otherwise gray. HW fringe usually white blending to gray at apex, to entirely brownish gray in some females. Male genitalia as in Fig. 7 (drawn from JAP prep. 3697, The Gap, AZ; 4n); saccus 1.7–2.3 × longer than tegumen. Female genitalia as in Fig. 10 (drawn from JAP

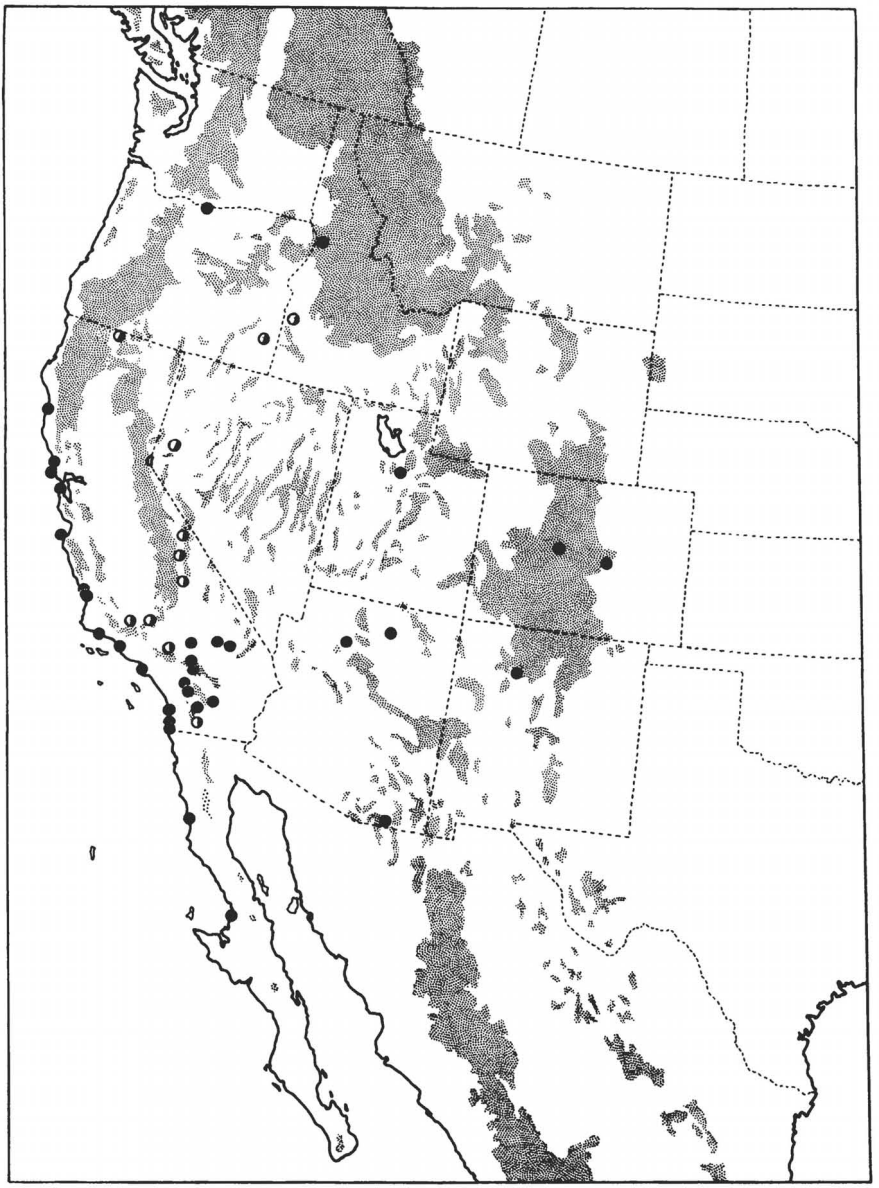


FIG. 12. Geographical distribution of *Lithariapteryx*: *L. abroniaeella* Chambers (closed circles); *L. mirabilinella* Comstock (half open circles).

prep. 6137, The Dalles, OR; 3n); ductus bursae ca. 0.75 (unmated) to 0.9 as long as posterior apophyses.

Lectotype male. By present designation: "Chambers Colo", "Lithariapteryx abroniaeella Cham Colo", "LECTOTYPE Lithariapteryx abroniaeella Chamb., by JAP '74",

"Genitalia 3840 JAP '74", in MCZ. There are 9 syntypes with the same label data (2m, 5f, 1 no abd. MCZ; 1m USNM). Chambers (1876) cited the type locality as Edgerton, Colorado; Edgerton was a railroad stop on the Denver & Rio Grande line, about 15 airline km north of Colorado Springs, situated at about 1840 m elevation.

Geographical distribution. (Fig. 12) Populations assigned to this species are widespread in sandy, arid, riverine or seacoast dune habitats, from Colorado, Utah and Idaho, New Mexico, Arizona, deserts of California, and along the Pacific Coast from the Columbia River and beach dunes of northern California to Baja California Norte.

This species is closely sympatric with *L. jubarella* in northern Arizona and the Mojave Desert in California, but populations are spatially separated in regions of overlap with *L. mirabilinella* (Mojave Desert and Great Basin) and *L. elegans* (coastal California). We did not find *L. abroniaeella* occupying *Abronia latifolia* with *L. elegans* at any site. While the latter species often was abundant, *L. abroniaeella* was rare in those dune systems (1 specimen at Asilomar, Monterey Co. in 1959; a series in March to July on *A. umbellata* at Dune Lakes, which is inland, 3.5 km north of the type locality of *L. elegans*). However, in absence of *L. elegans*, *L. abroniaeella* was abundant on beach dunes at Morro Bay in 1961 and 1990 on *A. maritima*, and at several sites from San Francisco northward, on *A. latifolia*.

Data for plant associations. MEXICO: BAJA CALIF NORTE: Playa Sta. Maria, Bahia San Quintin, III-19-72, III-26-73, *ad*: assoc. *Abronia maritima* (JAP). ARIZONA: COCHISE CO.: Carr Cyn. Rd., 1680 m, Huachuca Mts., VII-20-72 *nect*: *Senecio douglasii* (JAP). COCONINO CO.: 16 km S The Gap, V-30-65, *lar*: r.f. *Mirabilis froebelii*, emgd. VI-VII-65 (JAP 65E5). CALIFORNIA: LOS ANGELES CO.: El Segundo, VIII-20-38, "larva on *Abronia maritima*" (W.D. Pierce), VII-17-75, *ad*: assoc. *A. umbellata* (JAP). MARIN CO.: Pt. Reyes, V-16-58, *ad*. assoc. *Abronia latifolia* (JAP), V-10-68, *lar*: r.f. *A. latifolia*, emgd. V-30-68 (JAP 68E21); No. Beach, Pt. Reyes Natl. Seashore, V-13-72, *ad*: assoc. *A. latifolia* (JAP), V-11-74, *lar*: r.f. *A. latifolia*, emgd. V-31 to VI-4-74 (JAP 74E27), V-1-76, VI-4-77, VI-3-78, *ad*: assoc. *A. latifolia* (JAP), VI-3-78, *lar*: r.f. *A. latifolia*, emgd. VII-2-78 (JAP 78F4), II-20-82, *lar*: r.f. *Abronia*, emgd. III-8/13-82 (D. L. Wagner, JAP 82B8). MENDOCINO CO.: Mackerricher Beach, V-7-76, V-1/2-77, *ad*: assoc. *A. latifolia* (JAP); Inglenook Fen, VII-24-75, *ad*: assoc. *A. latifolia* (JAP). RIVERSIDE CO.: Mecca, VIII-20-56, *ad*: on *Croton californicum* (M. Wasbauer). SAN BERNARDINO CO.: Afton Rd., 36 km SW Baker, IV-25-77, *ad*: assoc. *Abronia villosa* (Chemsak & JAP); Zzyzx Spr., 15 km S. Baker, IV-27-77, *ad*: assoc. and *lar*: r.f. *A. villosa*, emgd. V-26-77 (Buegler & JAP, 77D100). SAN DIEGO CO.: Border Field St. Beach, III-3-77, *ad*: assoc. *A. maritima* (JAP); Borrego, IV-2-53, *ad*: on *Larrea* (Zygophyllaceae) (P. D. Hurd); Solana Beach, VI-19-63, *ad*: assoc. *Abronia* (JAP). SAN FRANCISCO CO.: SAN FRANCISCO, many dates IV, VI, VIII, IX, X-1926, *lar*: r.f. *Abronia latifolia* (H. H. Keifer); Baker Beach, S.F., IV-13-77, *lar*: r.f. *A. latifolia*, emgd. V-9-77 (JAP 77D85), V-31-77, VIII-29-77, *ad*: assoc. *A. latifolia* (JAP); Laguna Puerca, S.F., V-6-61, *lar*: r.f. *A. latifolia*, emgd. V-22-61 (JAP 61E3); Sutro Hts., S.F., VII-25-76, *lar*: r.f. *A. latifolia*, emgd. VIII-21-76 (JAP 76G7), SAN LUIS OBISPO CO.: Dune Lakes, 5 km S. Oceano, VI-7-73, *ad*: assoc. *A. umbellata*, V-2-74, *lar*: r.f. *A. umbellata*, emgd. V-24-74 (JAP 74E2); Morro Bay, VIII-28-61, VIII-20-90, *ad*: assoc. *A. maritima*, *nect*: *Haplopappus squarrosus* (JAP). SANTA BARBARA CO.: U.C. Goleta, VII-17-65, *ad*: assoc. *A. maritima* (JAP); Coal Oil Pt., X-7-77, *ad*: assoc. *A. maritima* (JAP). SONOMA CO.: Dillon Beach, V-18-63, *ad*: assoc. *A. latifolia* (JAP). VENTURA CO.: Mouth Ventura River, IV-24-66, *ad*: assoc. *A. maritima* (JAP). IDAHO: IDAHO CO.: 14.5 mi N Riggins, U.S. 95, *lar*: ex *Mirabilis macfarlanei*, V-VI-1984 (C. W. Baker). ORE.: WASCO CO.: 13 km E The Dalles, VI-26-75, *ad*: assoc. and *lar*: r.f. *Abronia mellifera*, emgd. VII-24/29-75 (JAP 75F37).

Lithariapteryx mirabilinella J. A. Comstock
(Figs. 2, 12)

Lithariapteryx mirabilinella Comstock, 1940, Bull. So. Calif. Acad. Sci. 38:177.

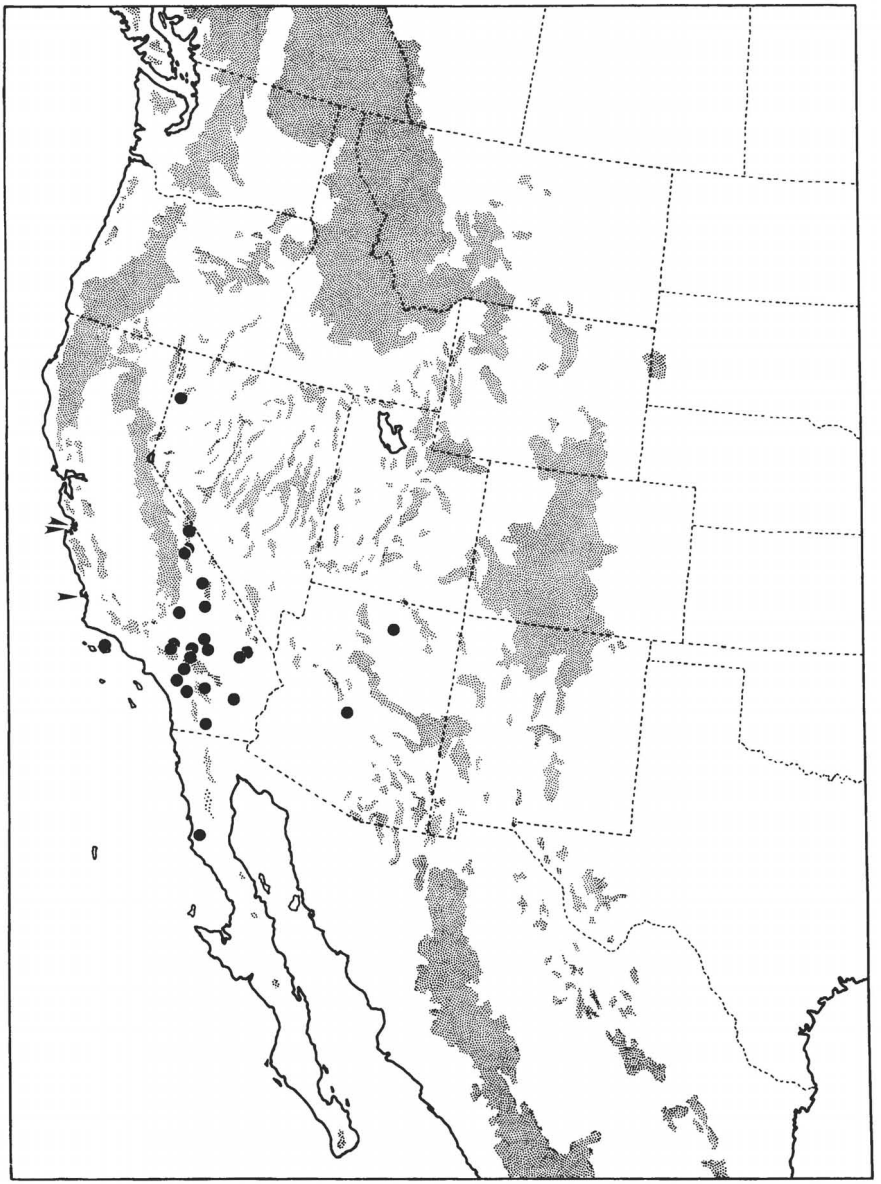


FIG. 13. Geographical distribution of *Lithariapteryx*: *L. jubarella* Comstock (closed circles); *L. elegans* Powell (beach foredunes at arrows).

Diagnosis. FW length 4.3–6.2 mm (3.6–4.0 mm, Ada Co., Idaho). As described for *L. abroniaeella* except FW paler, appearing pale gray to the unaided eye, with white scaling more extensive, the orange markings reduced to a trace or faint remnants of the V-shaped mark of *L. abroniaeella*. On one or both FW of some specimens there is a trace of an

additional silvery spot midway between the large dorsal and tornal spots. HW fringe mostly white in both sexes. Genitalia indistinguishable from *L. abroniaeella* (n = 2m, 2f).

Holotype female. California: Lovejoy Buttes near Llano [10 airline km N Llano], Los Angeles Co., emgd. May 1939, larva on *Mirabilis laevis* (J. A. Comstock). The holotype as labelled is a female, the allotype a male, the reverse of that stated by Comstock (1940).

Geographical distribution. (Fig. 12): Foothills marginal to the Colorado and Mojave Deserts of California north in the Great Basin to southern Idaho and eastern Oregon. This appears to be a high desert race of *L. abroniaeella*, but if so the geographical relationships are complex and fragmentarily known, especially in the north.

Mojave populations are characterized by having larger adults than Arizona and California *L. abroniaeella*.

Data for plant associations. CALIFORNIA: INYO CO.: Carroll Cr., 14 km SW Lone Pine, V-10-69, *lar*: r.f. *Mirabilis bigelovii*, emgd. VI-4/9-69 (Opler & JAP 69E48); Mazourka Cyn., 13 km NE Independence, V-15-69, *lar*: r.f. *M. bigelovii*, emgd. VI-9-69 (Chemsak & JAP 69E85); Tuttle Cr., 3 km SW Lone Pine, V-9-69, *lar*: r.f. *M. bigelovii*, emgd. VI-4/9-69 (Opler & JAP 69E43). KERN CO.: N. Slope Mt. Pinos, 1680 m, 19 km NW Frazier Park, IX-12-64, *ad*: assoc. *Eriogonum latifolium* (JAP); Tehachapi Mt. Park, 1680–1830 m, VI-16-81, *ad*: assoc. *Erysimum capitatum* (JAP), VI-17-81, *ad*: *nect*: *Eriophyllum* and *Senecio* (De Benedictis & JAP). LOS ANGELES CO.: 3 km NW Valyrmo, V-1-68, pupa on *M. bigelovii*, emgd. V-2-68 (JAP 68E4). SISKIYOU CO.: 11 km E Hornbrook (Klamath Riv., 4.8 km E of Ager Rd. bridge), V-28-87, *lar*: r.f. *M. greenei*, emgd. VI-6/12-87 (C. W. Baker). IDAHO: ADA CO.: Bogus Basin, (T4N, R2E, SE ¼ SEC 14), *lar*: ex *Abronia fragrans* VI-VII-1986, III-29-87, emgd. IV-87 (C. W. Baker).

NEVADA: WASHOE CO.: 4.5 km W Wadsworth, VI-23-62, *ad*: assoc. *Tetradymia comosa* (G.I. Stage). OREGON: MALHEUR CO.: Owyhee River at Tunnel Cr., IV-12-87, *lar*: ex *M. bigelovii* (C. W. Baker).

Lithariapteryx jubarella J. A. Comstock
(Figs. 3, 6, 8, 13)

Lithariapteryx jubarella Comstock, 1940, Bull. So. Calif. Acad. Sci. 38:175.

Diagnosis. FW length 4.5–6.5 mm. Usually larger than sympatric or near sympatric *L. abroniaeella* and more brightly colored, with more extensive orange markings, often a transverse band preceding the subterminal V, white markings more extensive, including a spot at costa filling the inside of the orange V. Raised silvery spots distributed similarly but with a more well defined one at base of costa and an additional, clearly defined spot midway between the dorsal and tornal spots of *L. abroniaeella*, where there sometimes is a trace in *mirabilinella*. HW fringe entirely brownish gray in both sexes. Male genitalia as in Fig. 8 (drawn from JAP prep. 6128, Surprise Cyn., CA; 4n); saccus extremely long, 3.0–3.4 × tegumen length. Female genitalia similar to *L. abroniaeella*, ductus bursae more elongate, ca. 1.7 × length of posterior apophyses.

Holotype male. California: Mason Valley [16 airline km SE Julian], San Diego Co., 23 April 1939 (L. M. Martin) (LACM). Both the holotype and "allotype" as labelled are males. Comstock (1940) stated that the holotype is male, allotype female.

Geographical distribution. (Fig. 13) Arid areas in Baja California Norte, Mexico; Arizona, Nevada, and southern California, including Santa Cruz Island; in sandy habitats or in rocky places in association with *Mirabilis laevis*.

Larvae of this species have been observed only in February and March, and apparently they feed earlier than sympatric *Lithariapteryx* species. Comstock (1940) reported that he took a series of *L. jubarella* adults on *Mirabilis* at the Lovejoy Buttes in the Mojave Desert in April 1939, along with larvae of *L. mirabilinella*; I found the same situation at two sites in the foothills of the Owens Valley in May 1969. Similarly, in northern Arizona, adults of both *L. jubarella* and *L. abroniaeella* but only larvae of the latter were present on *M. froebelii* at the end of May.

Data for plant associations. MEXICO: BAJA CALIF. NORTE: 16 km SE El Rosario, III-31-76, *ad*: assoc. *Mirabilis* (J. T. Doyen). U.S.A.: ARIZONA: COCONINO CO.: 16 km S The Gap, V-30-65, *ad*: assoc. *Mirabilis froebelii* (JAP). MARICOPA CO.: 1.5 mi NE Desert Vista Pt., II-15-76, r.f. *Mirabilis bigelovii*, emgd. III-2/11-76 (R. Wielgus). CALIFORNIA: INYO CO.: Mazourka Cyn., 13 km NE Independence, V-11/15-69, *ad*: assoc. *Mirabilis bigelovii* (Chemsak, Doyen, Opler, Powell, Rude); Tuttle Cr., 3 km SW Lone Pine, V-10-69, *ad*: assoc. *M. bigelovii* (JAP). LOS ANGELES CO.: 3 km NW Valyrmo, V-1-68, *ad*: on *M. bigelovii* (JAP). RIVERSIDE CO.: Citrus Exp. Sta., Riverside, III-12-63, *lar*: r.f. *Mirabilis laevis*, emgd. IV-1/5-63 (JAP 63C6); Devil's Garden, *lar*: r.f. *M. laevis* emgd. II-25-39; 8 km S. Sage, IV-15/16-65, assoc. *M. laevis* (C. A. Toschi & JAP); Railroad Cyn., 6 km E Elsinore, IV-14/17-65, *ad*: assoc. *M. laevis* (D. F. Veirs & JAP). SAN DIEGO CO.: Cabezas, III-28-61, *ad*: assoc. *Hyptis emory* (Labiatae) (JAP). SAN BERNARDINO CO.: Ord Mtn. IV-19-60, *ad*: assoc. *Senecio douglasii* (JAP). New York Mts., *lar*: r.f. *Mirabilis*, emgd. V-20-39. SANTA BARBARA CO.: Prisoners' Harbor Creek, Santa Cruz Id., III-16-69, *lar*: r.f. *M. laevis*, emgd. IV-3-69 (JAP 69C53). NEVADA: WASHOE CO.: 20 km NW Gerlach, VI-11-70, *ad*: assoc. *M. bigelovii* (P. A. Opler).

Lithariapteryx elegans Powell, new species
(Figs. 4, 5, 9, 11, 13)

A distinctive species with snow white venter and peculiarly stubby forewings adorned with large, upraised scale tufts of shining steel-purplish. The costa is orange on basal half without metallic spots.

Male. FW length 3.25–5.0 mm (30n). **Head:** gray to whitish dorsally, becoming white at crown and ventrally including palpi. **Thorax:** gray dorsally, tinged with rust-orange anteriorly and on tegulae; white ventrally, legs banded with gray. **Forewing:** ground color dark gray, white transverse strigulae conspicuous as in *L. abroniaeella* to reduced. Costa narrowly rust-orange along basal half, sometimes a white patch at base; orange broader in terminal area between the markings but not extended into a V-shaped mark; 3 large, strongly upraised, rounded scale tufts of shining metallic steel color, reflecting purplish: 2 in middle of wing (one in cell and one slightly more distad in dorsal area), 3rd in tornal area; 3 or 4 small tufts of shining lead-colored scales about as prominent as in *L. abroniaeella*: just below costa before and beyond a transverse line drawn through the inner edge of the large tornal spot, 3rd in subapical area, connected to costa by a white band, 4th sometimes present or represented by a trace, in pretornal area midway between the large, purplish dorsal spots. Terminal area narrowly white before fringe, which is very short, gray sprinkled with white. **Hindwing:** gray, fringe scales white proximally becoming gray distally, around entire margin. **Abdomen:** steel gray with silvery white bands distally on A3-8, broader laterally and ventrally. Genital scaling dark gray. **Genitalia:** as in Fig. 9 (drawn from paratype, Oso Flaco Lk., CA, JAP prep. no. 3705; 5n); very similar to *L. abroniaeella*; saccus and aedeagus of *elegans* slightly more slender in relation to length.

Female. FW length 3.6–5.1 mm (40n). Generally as described for male, with raised spots of FW more well developed, colors usually more vivid. **Abdomen:** lacking the gray genital scaling of male, A7 terminated by a white band, A8 eversible, unscaled. **Genitalia:** as in Fig. 11 (drawn from paratype, Oso Flaco Lk., JAP prep. no. 6243; 6n); similar to *L. abroniaeella*, ductus bursae more elongate, ca. 1.5 × length of posterior apophyses.

Holotype male and allotype female. CALIFORNIA: Oso Flaco Lake, 5 mi [8 airline km] S. Oceano, San Luis Obispo Co., 7 June 1973, on *Abronia latifolia* (J. Powell); deposited in Essig Museum of Entomology (UCB).

Paratypes (135). CALIFORNIA: MONTEREY CO.: Ft. Ord, coastal dunes, 1 f V-18-77, *lar*: r.f. *Abronia umbellata*, emgd. VI-21-77 (JAP 77E118); Marina Beach, 2 m, 1 f, VII-15-76, r.f. *A. latifolia*, emgd. VIII-9/14-76 (JAP 76G2), 1 m VI-23-87 (R. L. Langston); Marina St. Beach, 8 km NE Seaside, 27 m, 21 f, VIII-26-81 (D. L. Wagner); Seaside, 1 m, IV-30-59 (J. A. Chemsak), 5 m, VII-4-59 (JAP), 1 f, IV-15-62 (Chemsak) 1 f, VIII-26-

TABLE 1. Size of individuals in *Lithariapteryx elegans*, comparing populations of Monterey and San Luis Obispo Co., CA, and spring vs. autumn adults in S.L.O. Co. (forewing length in mm).

	Males range/mean/SD	(n)	Females range/mean/SD	(n)
Monterey	3.4–4.3/3.90/±0.28	(13)	3.6–4.3/3.96/±0.23	(25)
S.L.O.	3.5–5.0/4.29/±0.42	(19)	3.6–5.1/4.28/±0.37	(16)
March–June	3.5–5.0/4.31/±0.45	(16)	3.9–5.1/4.35/±0.33	(12)
October	4.0–4.2/4.14/±0.09	(3)	3.6–4.5/4.06/±0.43	(4)

71 "Sand Verbena" (R. L. Langston); Salinas River mouth dunes, 7 m, 13 f, VII-15-76, assoc. *A. latifolia* and 5 f, r.f. *A. latifolia* emgd. VIII-12/14-76 (JAP 76G1), 1 f, VII-15-76, r.f. pupa in sand sift sample (P. A. Rude), 2 m, 10 f, V-18-77, assoc. *A. latifolia, nect. Mesembryanthemum* and *Eriophyllum*, 1 m, *lar*: r.f. *A. latifolia*, emgd. VI-1-77 (JAP 77E111), 1 f, *lar*: r.f. *A. umbellata*, emgd. VI-15-77 (JAP 77E114), 2 m, XI-9-77 (JAP & Rude); Zmudowski St. Beach, mouth Pajaro Riv., 5 m, 1 f, VII-2-76 (J. T. Doyen & Rude). SAN LUIS OBISPO CO.: Oso Flaco Lk, 8 air km S Oceano, 7 m, 4 f, VI-7-73, on *A. latifolia* (JAP), 5 m, 5 f, III-21-74, r.f. *A. latifolia*, emgd. IV-10/21-74 (JAP 74C12), 6 m, 5 f, IV-2-77, r.f. *A. latifolia*, emgd. IV-21/29-77 (JAP 77D4), 3 m, 4 f, X-7-77 (JAP).

Individuals tend to be smaller in the Monterey Bay population than those at the Santa Maria dunes (even though the proportion that was reared was larger in the latter population sample and possibly included artificially stunted individuals); also the few moths taken in October averaged smaller than those collected as late instar larvae in March and April, or as adults in June, in S.L.O. Co. (Table 1).

Lithariapteryx elegans is almost exclusively an insect associate of beach foredune communities. It depends upon *Abronia latifolia*, an active sand dune invader, but uses *A. umbellata* on stabilized sand where it grows near *A. latifolia*. The type locality consisted of chaparral-covered stabilized dunes in the 1960's, and *A. latifolia* in the vicinity presumably was limited to foredunes to the west that I did not visit. With increasing off-road vehicle (ORV) activity, extensive sand roads and active sand invaded the Oso Flaco Lake area by 1971; the active sand gradually increased its takeover of dune vegetation during 1971–77 (see photos, Powell 1981), when *A. latifolia* became prevalent and the collections of *L. elegans* were made. In 1980 the California State Park System gained control of the area, which had been operated as a county park, and beginning in 1982 excluded further ORV activity at the Oso Flaco Lake site. By 1987, when only fragments of natural vegetation survived in the active sand dunes where *L. elegans* lived in the 1970's, a revegetation project was initiated by planting two species of native grasses. The exclusion of vehicular traffic and the planting/irrigation project evidently provided sufficient stabilization that, despite four successive dry years, colonization by a variety of native plants has been successful, including *Abronia latifolia* and *A. umbellata*. Hence, we can expect survival of *L. elegans* at the type locality.

ACKNOWLEDGMENTS

The habitus drawings of *L. elegans* and forewings were made by Celeste Greene; genitalia figures were drawn by Tina Jordan. Y.-F. Hsu assisted with data compilation. Special thanks is given to Charles W. Baker, Boise State University, Boise, Idaho, who collected and reared most of the material representing northern populations of *Lithariapteryx*. His work was funded by the U.S. Fish and Wildlife Service, Endangered Species Program. Dr. Baker also reviewed a draft of the manuscript and provided helpful comments. In addition to the collectors cited in the text, I thank the following, whose cooperation enabled study of type specimens and other material in their care: C. W. Baker, Boise St. U., Boise, Idaho (BSU); J. M. Burns and D. Furth, Museum of Comparative Zoology, Harvard U., Cambridge, Massachusetts (MCZ); J. P. Donahue, Museum of Natural History of Los Angeles County, Los Angeles, California (LACM); D. K. Faulkner, San Diego Museum of Natural History, San Diego, California (SDNHM); R. W. Hodges, U.S. National Museum of Natural History, Washington, D.C. (USNM); R. L. Langston, Kensington, California (RL); N. D. Penny, California Academy of Sciences, San Francisco (CAS). Paratypes of the new species will be distributed to all these collections. This study was based on ca. 1100 specimens, of which 74% are in UCB, 12% in LACM, 5% in USNM, 4% CAS and BSU. Field work and laboratory surveillance of rearing lots during 1965–70 was funded by N.S.F. Grants GB-4014 and GB-6813X.

LITERATURE CITED

CHAMBERS, V. T. 1875. Tineina from Texas. Canad. Entomol. 7:73–75.

——— 1876. Tineina. Canad. Entomol. 8:217–220.

COMSTOCK, J. A. 1940. Four new California moths with notes on early stages. Bull. So. Calif. Acad. Sci. 38:172–182.

FORBES, W. T. M. 1923. The Lepidoptera of New York and neighboring states. Cornell U. Agric. Exp. Sta., Memoir 68, 729 pp.

HEPPNER, J. B. 1987. Heliodinidae (Yponomeutoidea), pp. 410–411. *In* Stehr, F. W. (ed.), Immature insects. Kendall-Hunt, Dubuque, Iowa. 754 pp.

PIERCE, F. N. & J. W. METCALFE. 1935. The genitalia of the Tineid familes of the Lepidoptera of the British Isles. Pierce, Oundle, Northants, U.K. 116 pp. + 68 pl.

POWELL, J. A. 1981 ("1978"). Endangered habitats for insects: California coastal sand dunes. Atala 6:41–55.

SPULER, A. 1913. Die sogenannten Kleinschmetterlinge Europas. Stuttgart: E. Schmeizer bart'sche Verlags. CXXVII + pp. 121–523, pl. 72–91.

STAINTON, H. T. 1859. A manual of British butterflies and moths. Vol. II. London, J. Van Voorst. xi + 480 pp.

Received for publication 18 October 1990; revised and accepted 4 April 1991.