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LEPIDOPTERA ASSOCIATED WITH WESTERN SPRUCE BUDWORM IN THE SOUTHWESTERN UNITED STATES

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ABSTRACT. Western spruce budworm, *Choristoneura occidentalis* Freeman (Tortricidae), is an important pest of Douglas-fir and white fir in the southwestern United States. A variety of other Lepidoptera, several previously unrecognized from this part of the country, commonly occupy similar feeding niches as larvae. Included are species of Geometridae, Gelechiidae, Noctuidae, Plutellidae, Pyralidae, and Tortricidae. Notes are presented on species' life history, and field identifying features in late larval and adult stages.

Western spruce budworm, *Choristoneura occidentalis* Freeman, is an important defoliator of Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, and true firs, *Abies* spp., throughout western North America. It also feeds on spruces, *Picea* spp., and western larch, *Larix occidentalis* Nutt. (Furniss & Carolin, 1977). The budworm is a common pest of Douglas-fir and white fir, *A. concolor* (Gord. & Glend.) Lindl. ex Hildebr., and is currently in outbreak status in northern Arizona (Kaibab Plateau, Coconino County), in northern New Mexico (Jemez and Sangre de Cristo Mountains, Sandoval and Taos Counties, respectively), and in Colorado (mainly in the Front Range of the Rocky Mountains—Larimer, Boulder, Jefferson, Teller, Fremont and Custer Counties).

A variety of other Lepidoptera coexist with the budworm, occupying similar feeding niches in the larval stage. These associates have been little known in this part of the country. The main objective here is to summarize this information for other workers, so that with already available keys to larvae (Carolin & Stevens, 1979, 1981), they can identify common budworm associates and have information about each species' life history and habits.

Other Lepidoptera may sometimes occur in sufficient numbers to also qualify as budworm associates. However, the ones discussed here are present more or less regularly, and are considered to be the

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common set of associates in the area. Table 1 lists these species. All probably have the ability to colonize both main budworm hosts, *Abies* and *Pseudotsuga*.

Larvae of other insect groups, including Xyelidae, Diprionidae, and Pamphiliidae (Hymenoptera), are sometimes found feeding on foliage along with budworms. These are readily separable from Lepidoptera larvae, however, and are not considered here. Also excluded is the Douglas-fir tussock moth, *Orgyia pseudotsugata* (McDunnough); although sometimes common on the same hosts, the tussock moth occupies a different feeding niche and is not usually a budworm associate.

Some of the species discussed here are well-known forest insects and have been studied elsewhere in North America. For these, pertinent information is summarized to help in field identification and an understanding of life histories as the insects relate to western spruce budworm. In several cases little is known about the species' life history and habits, and in some of these new information is presented. Incorporated also are pertinent and previously unpublished observations made by Carolin in the Pacific Northwest.

Voucher specimens are kept in the insect museum at the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Gelechiidae

Chionodes abella (Bsk.)

C. abella (Fig. 1a) is a rare species reared from white fir in the Jemez Mountains. A small (wingspan 15 mm), strikingly-patterned moth, *C. abella* is not likely to be confused with any of the other common budworm associates. The larva is mostly greenish-brown, with a tan head capsule. The thoracic legs and posterior part of the first thoracic segment are black. Details of its life history and habits are unknown.

Coleotechnites sp.

The genus *Coleotechnites* includes several well-known forest pests (e.g., the needle miners *C. milleri* (Busck) and *C. starki* (Freeman)), (Furniss & Carolin, 1978), as well as several undescribed species (R. W. Hodges, pers. comm., 1981). One or more of the latter are budworm associates, found extensively throughout the western United States. The moths (Fig. 1b) are small (wingspan 10–12 mm), and mostly black and white. We have a few specimens from the Jemez Mountains.

TABLE 1. Lepidoptera associated with western spruce budworm in the southwestern United States.

Family	Species
Gelechiidae	*Chionodes abella* (Busck)
	Coleotechnites sp.
Geometridae	*Enypia griseata* Grossbeck
	Eupithecia catalinata McDunnough
Noctuidae	*Achytonix epipaschia* (Grote)
	Syngrapha angulidens Smith
	Egira (=*Xylomyges*) *simplex* (Walker)
Plutellidae	*Ypsolophus nella* (Busck)
Pyralidae	*Dioryctria* spp.
Tortricidae	*Acleris gloverana* (Walsingham)
	Argyrotaenia dorsalana (Dyar)
	Argyrotaenia klotsi Obraztsov
	Argyrotaenia provana Kearfott
	Clepsis persicana (Fitch)
	Griselda radicana (Heinrich)
	Zeiraphera hesperiana Mutuura & Freeman

Geometridae

Enypia spp.

Although they never appear to occur in large numbers, loopers of the genus *Enypia* are widely distributed budworm associates on both *Abies* and *Pseudotsuga*. Evans (1960) indicates that *E. griseata* Grossbeck and *E. venata* (Grote) are found in the Southwest; we have occasionally reared *griseata*. Adults of both species are large (wingspan 35–39 mm) gray moths, and are difficult to tell apart by nonspecialists. *E. griseata* is shown in Fig. 1c. Eggs of both species are ivory colored when first laid. They are laid on needles, singly or occasionally in pairs. According to Evans (1960), the larvae are solitary and constitute the overwintering stage, and fully-developed larvae of the two species differ as follows:

E. griseata	*E. venata*
Head pale green-brown.	Head brown, irregularly patterned.
Body green dorsally; venter paler green. Narrow pale-green dorsal line; wide near-white sub-dorsal stripes.	Body pale golden brown dorsally; overall pattern of broken dark irregular lines; posterior parts of segments darker than anterior portions, darker reddish-brown irregular dorsal stripe.

Pupation is on the foliage, in a loosely-constructed cocoon.

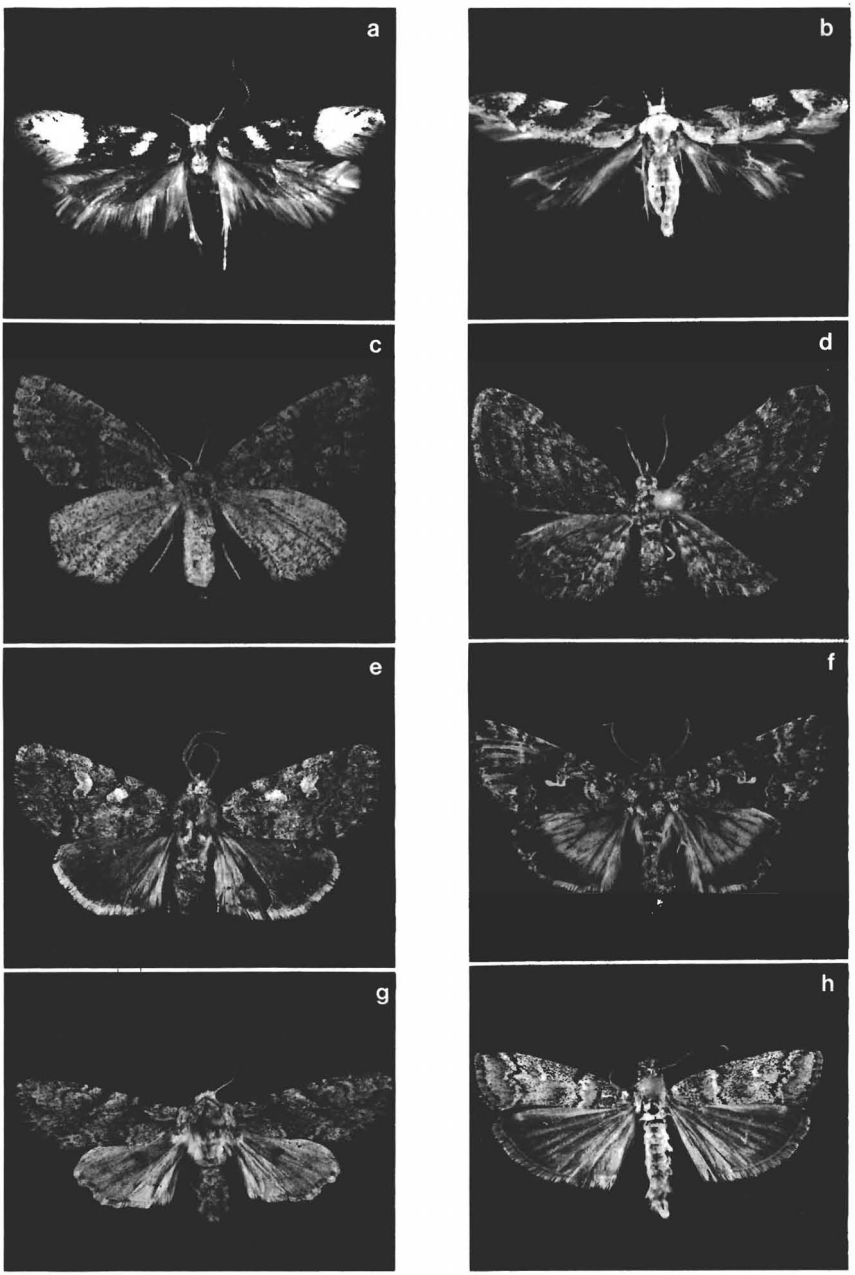
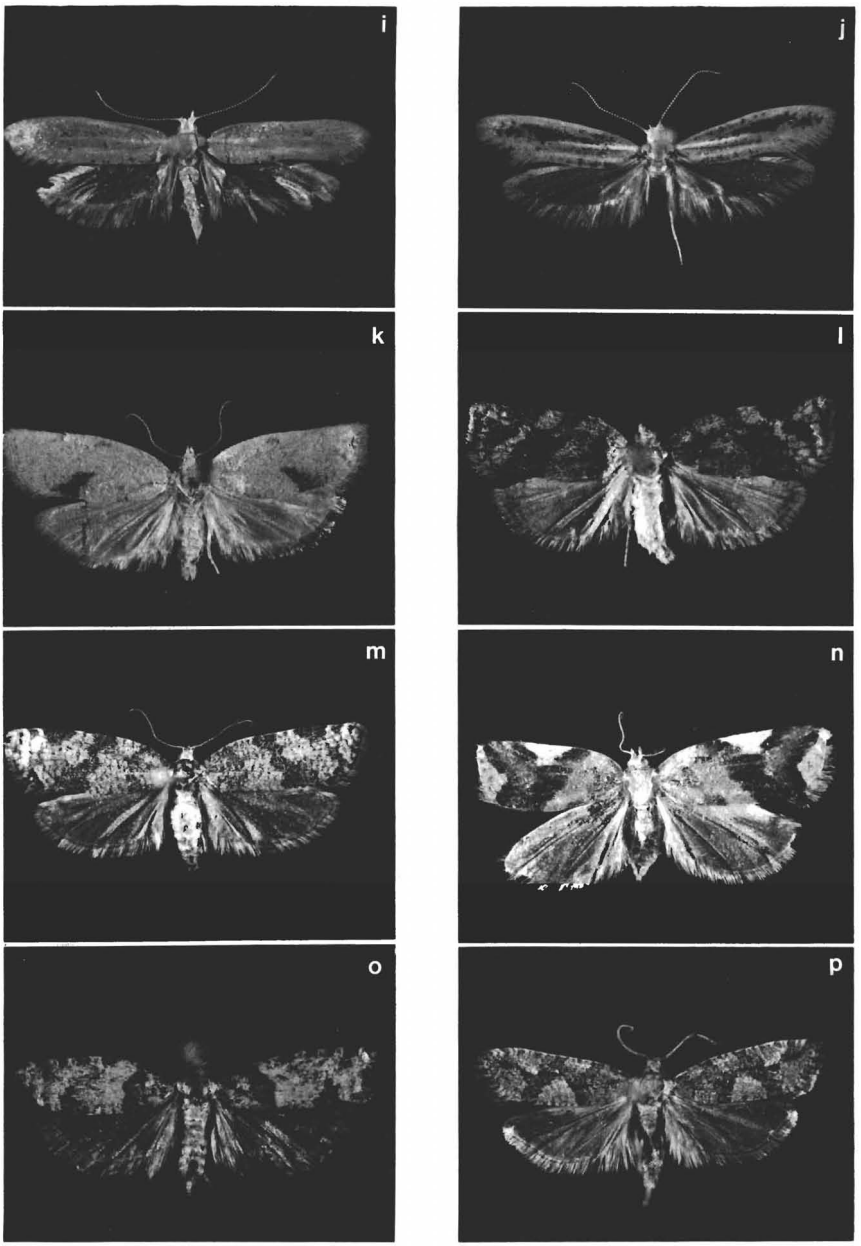


FIG. 1. Budworm associate adults: **a,** *Chionodes abella*; **b,** *Coleotechnites* sp.; **c,** *Enypia griseata*; **d,** *Eupithecia catalinata*; **e,** *Achytonix epipaschia*; **f,** *Syngrapha angulidens*; **g,** *Egira simplex*; **h,** *Dioryctria* sp.; **i, j,** *Ypsolophus nella*; **k,** *Argyro-*



taenia dorsalana; **l,** *A. klotsi*; **m,** *A. provana*; **n,** *Clepsis persicana*; **o,** *Griselda radicana*; **p,** *Zeiraphera hesperiana.*

Eupithecia catalinata McD.

E. catalinata is a little-known species of looper not previously recognized as a budworm associate. However, many members of the genus feed on coniferous foliage (McGuffin, 1958), and one, *E. annulata* (Hulst), is a recognized budworm associate on the West Coast (Carolin, 1980). The adults (Fig. 1d) are small (wingspan 20–22 mm) gray moths with indistinctly marked wings.

Noctuidae

Achytonix epipaschia (Grote)

A. epipaschia has been reared in small numbers from the Jemez Mountains. Carolin (1980) considers it a "sporadic" and "occasional" budworm associate in the Pacific Northwest. The distinctively marked gray moths (Fig. 1e) have a wingspan of 25–30 mm. They fly about the same time as does the budworm, and the two species have somewhat similar life histories; both overwinter as small larvae and pupate on the shoots where they have been feeding. Early instars of *Achytonix* also resemble those of budworm. However, in late instars, the green abdomen, conspicuous black setal bases, and three broad longitudinal lines on the dorsum make *Achytonix* readily identifiable.

Syngrapha angulidens (Smith)

S. angulidens (Fig. 1f), a large (32–34 mm wingspan), distinctively-marked noctuid, is another relatively uncommon budworm associate in the Southwest. Little is known of its life history and habits, but Eichlin & Cunningham (1978) indicate that eggs are deposited singly and larvae overwinter. Larvae of Noctuidae possess varying numbers (3–5 pairs) of abdominal prolegs. Some with three pairs move like geometrids; *S. angulidens* is one of these.

Egira simplex (Wlk.)

E. simplex is widely distributed throughout the West (Furniss & Carolin, 1977) and is an occasional budworm associate in the Southwest. Its life history is much like that of the budworm, except that *E. simplex* overwinters as a pupa in the soil. The adult (Fig. 1g) is a large (38–40 mm wingspan) gray moth. Fully developed larvae are up to 35 mm long, green with white longitudinal dorsal and subdorsal lines, and shiny black head capsules and dorsal and anal shields.

Plutellidae

Ypsolophus nella (Bsk.)

The life history and habits of *Y.* (=*Abebaea*) *nella* have not previously been described. However, records on file in the insect museum

FIG. 2. White fir needles tied into "tents" by larvae of *Ypsolophus nella*.

at the Rocky Mountain Forest and Range Experiment Station indicate that the species is common on *Abies concolor* throughout Colorado and New Mexico. It has been a consistent budworm associate on white fir in our recent collections. Carolin (1980) reported *Y.* prob. *cervella* (Walsingham) as a rarely collected associate on Douglas-fir in western Oregon in the 1950's.

Adults and larvae of *Y. nella* are highly distinctive. The adult (Figs. 1i, j) is a small (wingspan 20–21 mm) moth, with gray abdomen and hindwings, and narrow brown forewings ornamented by longitudinal lines made up of black and white scales. The amount of black on the wings varies and may be totally lacking in some individuals.

Fully developed larvae, about 15 mm long, are generally purplish to pale green, with two narrow and one broad yellowish-green longitudinal lines on each side of the dorsal midline. Black setae and

setal bases also constitute distinctive recognition characters. The larvae are particularly active and capable of unusually rapid movement when disturbed.

The character of larval feeding is also distinctive. The ends of the needles are webbed together soon after their emergence from the bud. As the needles elongate, their central parts diverge, creating an expanding "tent" (Fig. 2) within which the larva feeds. Pupation occurs in the foliage in a loosely constructed cocoon. Summer larval and pupal periods approximate that of the budworm; eggs have not been seen nor is the overwintering stage known.

Pyralidae

Dioryctria spp.

The spruce coneworm, *D. reniculelloides* Mutuura & Munroe, has long been recognized as a budworm associate, sometimes occurring in great numbers. Carolin (1980) reported as many as 158 *Dioryctria* larvae per 100 buds in a 1957 sample plot in central Oregon. Both it and insects identified as *D. pseudotsugella* Munroe are commonly reared along with budworms in the Southwest. The two *Dioryctria* species are difficult for the non-specialist to separate either as larvae or adults; for the purposes of this article *Dioryctria* associates are considered a single entity.

Moths have gray forewings with distinctive transverse bands (Fig. 1h), and are not likely to be confused with any of the other budworm associates. Although we have reared adults with wingspans as small as about 15 mm, most specimens are larger, 20–25 mm. Larvae are also distinctive; the dorsum of well-developed individuals is generally pinkish to reddish-brown, with broad, irregular white and black lines on either side of the dorsal midline. The pupa is dark brown to black and is found in the foliage. In general, the life history parallels that of the budworm; however, *Dioryctria* may pupate slightly later.

Tortricidae

Acleris gloverana (Wlshm.)

A. gloverana, the western blackheaded budworm, has not previously been known from the southwestern United States; however, it has been fairly common in Jemez Mountains rearings of budworm associates. *A. gloverana* is a serious forest pest in British Columbia and southeast Alaska (Furniss & Carolin, 1977), and its life history and habits have been thoroughly studied in that region. Also, Powell (1962) provides a detailed discussion of it.

Adults, wingspan 18–22 mm, display a bewildering variety of fore-

wing markings, making identification difficult for the inexperienced observer. Furniss & Carolin (1977) show three of the more common morphs. In general, the moth is dark colored; the forewings are variously marked with brown, white, yellow, and orange. Small larvae have black head capsules and prothoracic shields, and lemon-yellow bodies. The latter instars have chestnut-brown head capsules and grass-green bodies.

The life cycle and habits are similar to those of the western spruce budworm; however, *A. gloverana* eggs are laid singly on needles, and the egg overwinters. On the West Coast, *Acleris* adults emerge 2–3 weeks later than spruce budworms.

Argyrotaenia spp.

According to Hodges (in litt.), the genus *Argyrotaenia* includes 34 North American species. Of these, *A. dorsalana* (Dyar), *A. klotsi* Obr., and *A. provana* Kearf. are budworm associates. All are found regularly in the Southwest. These species are sufficiently similar in most respects to justify treating them together.

Except for *A. dorsalana*, details of their life histories are essentially unknown; however, they are probably all similar. Eggs of *A. dorsalana* are laid in overlapping rows on needles, much as in the case of the budworm. The eggs are slightly smaller and are finer-textured than those of budworm, and the egg mass usually has an orange-pink tint. The small larva overwinters. Larval feeding is also similar to that of budworm; pupation is in the foliage, slightly earlier than budworm.

Larvae of all species are generally green. The moths, while differently marked, are all about the same size, wingspan 20–25 mm. *A. dorsalana* is generally the most common member of the genus as a budworm associate in the Southwest. Forewings of the adult (Fig. 1k) are largely straw-yellow but exhibit a variety of brown markings. The most common form is nearly pure yellow with a small marking on the posterior margin. Some have no marks at all; others are heavily patterned.

The forewings of *A. klotsi* and *A. provana* (Figs. 1l, m) are gray-black, with distinctive white (*provana*) or yellow (*klotsi*) bands and patches. Adults of these species appear to show much less morphological variation than do those of *A. dorsalana*.

Clepsis persicana (Fitch)

C. persicana (Fig. 1n) is a striking species we reared only once from the Jemez Mountains. The forewings (wingspan 18 mm) of the adult are orange to ochreous-orange basally, having a dark gray "V"-shaped section distally and white patches on the anterior margin and apex of

the wingtip. The hindwings are gray dorsally and white ventrally. Fully developed larvae are about 12–15 mm long and generally green; the head capsule is green with a brownish tint; prothoracic and anal shields are emerald-green; the dorsum is dark olive-green with two whitish longitudinal lines and whitish setal areas. The venter is lighter green. Feeding habits are similar to that of budworm.

Powell (1964) indicates that *C. persicana* utilizes a variety of food plants other than conifers; however, he also has more recently reared it as a budworm associate in California (J. A. Powell, unpublished data). Carolin reared it once from the Blue Mountains in northeastern Oregon and several times from *Abies balsamea* L. in Maine.

Griselda radicana (Heinr.)

G. radicana, the spruce tip moth, is another common budworm associate not previously known to occur in the Southwest. We reared several specimens from the Jemez Mountains, and presumably the species occurs much more generally. *G. radicana* is a small moth, wingspan 12–16 mm, having gray forewings with distinctive rusty-colored basal sections (Fig. 1o). Young larvae are pale yellow overall. Later instars have the dorsum marked with three orange-brown to orange-red lines; fully developed larvae undergo a quiescent prepupal period, during which the abdomen becomes whitish and the lines disappear. Adult emergence is in late summer. Eggs, laid singly at the bases of needles, overwinter. Larval feeding is similar to that of budworm.

Zeiraphera hesperiana M. & F.

Z. hesperiana, commonly known as the Douglas-fir bud moth, is well known as a budworm associate. However, it has not previously been reported from the Southwest, and the only published information on its life history is a brief mention by Carolin (1980). Mutuura & Freeman (1966) described the species from British Columbia; Furniss & Carolin (1977) also record it from Oregon. We have specimens from Idaho and Montana, and from the Jemez and Sangre de Cristo ranges in New Mexico. Thus the species appears to have a wide distribution. The following notes on life history and habits are largely from Carolin's observations in Oregon. Stein and Stevens have noted similar habits in New Mexico.

The adult (Fig. 1p) is a distinctly marked, generally dark moth, wingspan 15–20 mm. At rest it is readily separable from moths of other common budworm associates by the presence of a prominent saddle-like white to brownish-white patch located centrally on the forewings. The forewings are otherwise marked with characteristic patches made

up of black, cream, brown, and orange-brown scales. Eggs overwinter. They are yellow, spiny, and laid singly on bark of limbs, 50 cm or more back from branch tips. In spring, new larvae enter buds and feed therein, concealed until the buds open. Feeding becomes visible as shoots develop. Fully developed larvae are 12–15 mm long and generally stout in form. The head capsule and prothoracic shield are golden to chestnut-brown; the abdomen is generally yellowish, with a broad, olive-brown to chocolate-brown dorsal stripe. The prothoracic shield usually has a characteristic black posterior margin. Larvae leave the feeding area to pupate in the soil or duff layer, well before the time of budworm pupation.

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