HILGARDIA

A JOURNAL OF AGRICULTURAL SCIENCE PUBLISHED BY THE CALIFORNIA AGRICULTURAL EXPERIMENT STATION

Volume 39, Number 1 · January, 1968

Host Associations and Taxonomy of Nearctic Conifer Cone Moths in the Genus *Eucosma*

(Lepidoptera: Tortricidae)

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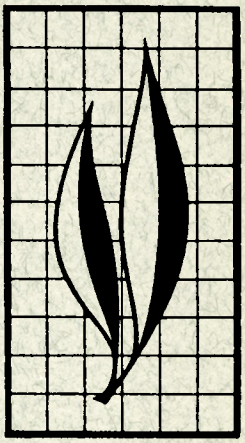

The genus *Eucosma* includes more than 150 described species in North America. Whereas larvae of most evidently are root and stem borers in plants such as woody Compositae, a small group of closely related species feeds in cones of coniferous trees. Diagnostic features, descriptions, host ranges, and geographical distributions for the ten members of this complex are given in the present paper. Four species are previously undescribed.

One species, *Eucosma tocullionana* Heinrich, in eastern North America, has been reared from various conifers—pine (*Pinus*), fir (*Abies*), spruce (*Picea*), and hemlock (*Tsuga*). Two other species, *E. monitorana* Heinrich and *E. cocana* Kearfott, of the eastern United States and Canada, are associated with pines. Of seven species that occur in western North America, three feed in pines and one in fir. Hosts are unknown for the remaining three.

Records in California indicate that specificity in host selection has resulted in isolation among populations on different conifer species. Thus, *E. bobana* Kearfott, which feeds on pinyon pines, is sympatric with *E. ponderosa* Powell in areas where Jeffrey pine occurs with the pinyons, while the latter moth is in turn broadly sympatric with the lodgepole pine-feeding *E. rescissiorana* Heinrich; yet each retains its identity in zones of overlap.

Eucosma siskiyouana (Kearfott) has formerly been confused with another tortricid, *Barbara colfaxiana* (Kearfott). Although both feed in fir cones as larvae, they are generically distinct moths.

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Host Associations and Taxonomy of Nearctic Conifer Cone Moths in the Genus *Eucosma*[1] (Lepidoptera: Tortricidae)

INTRODUCTION

THE GENUS *Eucosma* includes more than 150 described species in North America. On the basis of the few species for which biological information is available, most apparently are stem and root borers in such plants as woody composites. Members of a complex of species related to *E. bobana,* however, are borers in green branch tips and cones of coniferous trees. Among these, *E. sonomana* Kearfott and *E. gloriola* Heinrich evidently always use the tips as a larval feeding site (Heinrich, 1920; Butcher and Hodson, 1949; Drooz, 1960; Grant, 1958; Raizenne, 1952), while larvae of the remainder of the group have been found only in developing cones.

Biological information on these cone moths has been provided by Heinrich (1920, 1923) and Keen (1952, 1958), who gave fragmentary data on several species, by Lyons (1957*a*, *b*), who studied *E. monitorana* in southern Ontario, and by the report of Ollieu and Schenk (1966) on *E. rescissiorana* in Idaho. These reports indicate a similar life-cycle pattern throughout the complex, a finding supported by information obtained in the University of California Department of Entomology at Berkeley, where the species *bobana, ponderosa, rescissiorana,* and *tocullionana* have been reared during the past several years.

The moths fly in spring and early summer. *E. cocana,* in the Piedmont plain of the southeastern United States, and *E. crymalana,* of northern Arizona, have been collected from late March to late May, while records for the rest of the species show collection dates concentrated primarily in June and July. The most widely distributed species, *E. bobana,* has the longest flight period, from late April, in the desert mountains of southern California, to mid-August, at Great Basin localities in the northern part of its range. However, there is no indication that two annual generations occur at a single locality. All of the species except *E. rescissiorana* have been taken at lights, indicating that all are nocturnal.

The oviposition site has been reported for *E. ponderosa* (given as *bobana*) by Keen (1958) and for *E. rescissiorana* by Ollieu and Schenk (1966). The eggs are deposited on green, second-year cones, at the tips of the scales, by *ponderosa,* and in small masses at the juncture of two overlapping scales, by *rescissiorana.*

Newly-hatched larvae burrow into the scales, and eventually both scales and developing seed are mined out. Lyons

[1] Submitted for publication April 6, 1967.

(1957*a*) reported that larvae of *E. monitorana* are mature by mid-July, about a month or six weeks after the eggs hatch. Ollieu and Schenk (1966) found that only 13 to 18 days were required for completion of larval development in the laboratory, but their field samples showed a much longer maturation period, up to 11 weeks. Keen (1958) states that larvae of *ponderosa* feed through summer and fall, but this probably refers to the species as a whole, rather than to a single population, since both *ponderosa* and *bobana* females have been collected as late as mid-August at higher elevation sites. Several larvae frequently inhabit a single cone, and most of its contents are sometimes consumed. The frass is not ejected but is packed tightly into hollowed-out seeds and scales. Cones are sometimes stunted or begin to dry before maturity, and then drop as a result of the feeding.

At maturity, larvae either construct frass-covered cocoons on the outside of the cone or just inside it, or drop to the ground and spin cocoons in debris there. Winter is spent in the pupal stage, either on the ground or in cones that have not yet fallen.

HOST ASSOCIATIONS

In the past, little emphasis has been placed on food-plant relationships of these moths. Information in the literature indicates no overlap by two or more species in one host, but collection records given below for adults indicate that two species use pinyon pines in California. Some species exploit taxonomically diverse pines or other conifers.

Data are too fragmentary as yet to permit firm conclusions on host specificity for most species of the group. *Eucosma tocullionana* has been reared primarily from *Pinus strobus*[2] but was originally described on the basis of specimens from *Picea*. There are records implicating *Tsuga canadensis* and *Abies balsamea* as well. The remainder of the moth species appears to be more specific in host selection, but this may be in part the result of lack of records. On the basis of only two records, *E. siskiyouana* is restricted to cones of *Abies concolor,* while the rest are associated with pines, so far as known. These moths do not adhere closely in specificity to the groups of pine species given below in the list adapted from Critchfield and Little (1966), but this statement may in part reflect the present lack of taxonomic knowledge of western North American *Eucosma* species.

Two eastern species evidently inhabit representatives of the subgenus *Pinus* proper and each may be restricted to a single subsection. Thus *Eucosma monitorana,* which has a geographical range similar to that of the indiscriminate *E. tocullionana,* has been reared only from *Pinus resinosa* in the northern part of the moth's distribution. It has been associated with *P. virginiana* in Virginia, south of the area in which *P. resinosa* occurs. *E. cocana* has a distribution suggesting an association with one or more of the southern yellow pines (subsection Australes) and has been reported once from loblolly pine, *P. taeda* (MacKay, 1959). Recent collections of *cocana* in New England represent spots north of the range of *P. taeda,* but a related host, such as *P. rigida,* could serve in those areas. Members of the *E. bobana-ponderosa* complex have been reared from pines of both New World subgenera, but typical components of these two species may be restricted to the subsections Cembroides (subgenus *Strobus*) and Ponderosae (subgenus *Pinus*), respectively. The widespread *E. bobana*

[2] Nomenclature for the pines follows Critchfield and Little (1966), and for other conifers, Little (1953).

has been reared only from the pinyon pines, *P. monophylla* and *P. edulis*, but its ecological range, shown by collections of adults, is sufficiently broad to involve *P. flexilis* and possibly other pines with ranges extending into high-elevation, arid regions of the southwest. Typical *E. ponderosa* seems to be associated only with the yellow pines, *P. ponderosa* and *P. jeffreyi*. Similar moths reared from *P. attenuata* at two coastal localities in northern California are doubtfully conspecific. They represent the only known use of closed-cone pines by American cone-feeding *Eucosma*.

One species uses pines in both New World subgenera: *Eucosma rescissiorana* is known only from lodgepole pine (*P.* (*Pinus*) *contorta*) in California and Oregon, but it feeds on western white pine (*P.* (*Strobus*) *monticola*) in Idaho. Isolated records show moths from *P. monticola* in British Columbia and *P. albicaulis* in Montana that are similar, but they cannot be readily referred to *rescissiorana* on the basis of single specimens available.

Three previously undescribed species from high-elevation sites in eastern California and northern Arizona have no recorded hosts. Of these, *Eucosma monoensis* evidently shares the same hosts as *E. bobana*.

DISTRIBUTION OF HOST RECORDS FOR NEARCTIC CONE-FEEDING *Eucosma*, AMONG THE SPECIES GROUPS OF THE GENUS *Pinus*
(after Critchfield and Little, 1966)

SPECIES GROUPS	CONFIRMED RECORD	POSSIBLE ASSOCIATION*
Subgenus *Strobus*		
1. Section Strobus		
Subsect. Cembrae		
P. albicaulis		[*rescissiorana*]
Subsect. Strobi		
P. strobus	*tocullionana*	
P. monticola	*rescissiorana*	[*ponderosa*]
P. flexilis		*(bobana), (monoensis)*
2. Section Parrya		
Subsect. Cembroides		
P. edulis	*bobana*	
P. monophylla	*bobana*	*(monoensis)*
Subsect. Balfourianae		
P. aristata		*(bobana), (monoensis)*
Subgenus *Pinus*		
1. Section Ternatae (no records)		
2. Section Pinus		
Subsect. Sylvestres		
P. resinosa	*monitorana*	
Subsect. Australes		
P. taeda	*cocana*	
P. rigida		*(cocana)*
Subsect. Ponderosae		
P. ponderosa	*ponderosa*	
P. jeffreyi	*ponderosa*	
Subsect. Contortae		
P. contorta	*rescissiorana*	
P. virginiana	*monitorana*	
Subsect. Oöcarpae		
P. attenuata		[*ponderosa*]

* Possible hosts, based on collections of adults, are given in parentheses; records for moths doubtfully conspecific are shown in brackets.

HOST SPECIFICITY AND REPRODUCTIVE ISOLATION

Observations of *Eucosma* species in California suggest that considerable isolation may exist among populations on different conifer species, correlated with host specificity in several western species. Whether this selectivity has resulted in reproductive isolation, which would either prevent or inhibit interpopulational hybridization, is unknown. However, relationships among species, as shown by available specimens, indicate that reproductive isolation varies from one area to another, even within the same pair of species.

Thus, *Eucosma ponderosa,* described below from material previously treated as *E. bobana,* is sympatric with *E. rescissiorana,* in the broad sense, over much of interior California and Oregon. The latter species is known only from *Pinus contorta* in this region, while *E. ponderosa* maintains its identity in association with *P. ponderosa* and *P. jeffreyi.* To the north, however, *rescissiorana* has been reared from *P. monticola* in Idaho; and two specimens from British Columbia and Montana are not exactly comparable with either species. The individual from British Columbia, reared from *P. monticola,* shows structural relationship to *E. ponderosa,* but it differs from *ponderosa* of more southern areas by having darker-reddish forewing markings, similar to those of *rescissiorana.* The Montana individual, reared from *P. albicaulis,* is similar to the British Columbia one but is even more reddish, approaching *rescissiorana* in appearance. On the northern coast of California, two series from *P. attenuata* represent a population blend between *rescissiorana* and *ponderosa* in several respects. This area is allopatric, and is isolated by a long distance from any sampled colony of either of the two described species, so that the relationship of the knobcone pine-feeding form to the other two will not be known until more collections have been made.

Eucosma bobana is relatively constant in wing color and structural detail over a wide range in the southwestern United States, where it has been associated with pinyon pines at a number of stations. This moth is essentially allopatric with the closely related *E. ponderosa,* which shows constancy in wing color throughout the west coast cordillera. Along the east side of the Sierra Nevada, where *Pinus jeffreyi* intrudes into the Great Basin range of *P. monophylla,* the two moths have been taken at the same locality in four areas. In these cases, wing-color patterns show no indication of intergrade, although the samples are small and conclusions must be preliminary. A comparison of sizes of structures in the male genitalia, however, indicates possible hybridization between the two (see below, p. 11).

A pair with even closer superficial similarity are *E. bobana* and *E. monoensis,* the latter described below from a few specimens taken in eastern California. The two species have been taken together at all three sites from which *monoensis* is known, and they must share *Pinus monophylla* and either *P. flexilis* or *P. aristata* at those localities. Their wing color and patterns are extremely close, but males and females of both species are appreciably distinct in genital structure. Thus far these two are the only examples in the group, of two species sharing the same host at the same locality.

TAXONOMIC CHARACTERS OF THE ADULTS

Head structures are uniform throughout most of the group. Labial palpus length was compared with eye diameter to determine specific differences in other sections of the genus (Powell, 1963). With the exception of *Eucosma siski-*

youana, this comparison is constant in representative specimens of all members of the present complex. In the males, the second segment is about equal in length to the eye diameter. The third segment is considerably shorter, and is mostly concealed by the scaling of the second. It originates slightly preapically on the second, and is situated at an angle from the segment's longitudinal axis. A straight-line measurement from the base of the second segment to the apex of the third is about 1.4 times the eye diameter. In females, which have slightly smaller eyes, the second segment is about 1.15 times the eye diameter; the second plus third, about 1.6 times.

Forewing shape varies somewhat among species, but allowance must also be made for both sexual and individual variation, in using this feature. An index of wing breadth was obtained by dividing a base-to-apex measurement by the width across the end of the cell, including scale fringes. Females of most species have a slightly broader forewing than do the males. In addition, the male costal fold, a characteristic of *Eucosma,* reduces the relative width of the basal half of the wing.

The costal fold, which varies but slightly among the species, extends just to or just beyond the middle of the costa. It is narrow and tightly appressed in all species in the group. The scaling, which is enclosed within the fold, differs in color among species, correlated with the wing-marking color.

All species of the conifer-feeding group are similar in forewing color pattern. Although the dominant colors range from pale tan to red-brown and dark chocolate brown, the pattern is basically one of broad, oblique, transverse bands, broken into roundish patches, resulting in a checkered appearance. As discussed elsewhere (Powell, 1964), this is a pattern common to conifer-feeding tortricids, which represent a wide array of taxa. Thus, in the Archipini, the juniper-feeding *Choristoneura houstonana* (Grote), *Argyrotaenia cockerellana* (Kearfott), and *A. paiuteana* Powell, and the cypress-feeding *A. cupressae* Powell all resemble members of the *bobana* complex, as do forms of the *C. fumiferana* group, which use various conifers. This resemblance among members of unrelated genera evidently is the result of convergence in phenotype as part of an evolutionary process toward a cryptic appearance on conifers.

Nonetheless, in *bobana* and its relatives the colors differ among species, and specific identifications can be made on the basis of this feature alone in many cases. Some western species also show interpopulational differences, at times probably representing degrees of reproductive isolation.

In the descriptions that follow, the forewing pattern is described as dark markings on a pale ground color, even though the pale areas are greatly reduced in some species.

Male genital morphology must be used be used cautiously as a basis for species identification in this group. Although obvious differences in valva shape, for example, exist among some of the species, in others these structures are quite similar from one species to another. Moreover, details of cucullus form, sacculus shape, uncus development, and the like, vary considerably. For these reasons I am presenting three ratios comparing measurements of various parts of the male genitalia, together with simple outline drawings of the valvae, in order to indicate other features of the shape.

Measurements used in deriving the ratios are indicated in Plate III, figure 1. The ratios determined are as follows: (1) valva length (including cucullus): tegumen length (including uncus); (2) valva length (including cucullus): greatest length of cucullus; (3) valva length (excluding cucullus): greatest width of valva. The ratios are expressed

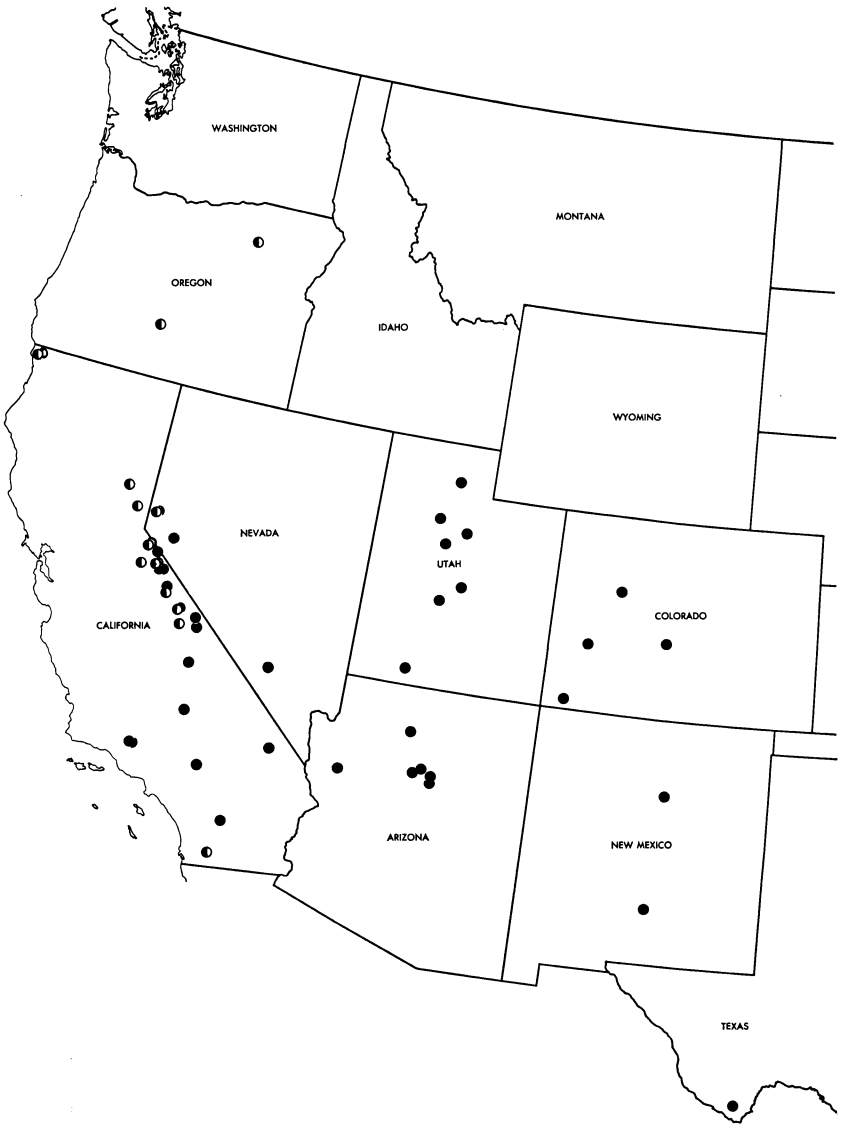


Fig. 1. Geographical distribution of *Eucosma bobana* Kearfott (solid circles) and *E. ponderosa* Powell (half-solid circles) in the western United States.

as range and average values for all slides examined.

The female genitalia have not been illustrated for most *Eucosma* because they were not used for taxonomic purposes in Heinrich's (1923) revision of the Eucosmini. As indicated elsewhere (Powell, 1963), female genital structures differ widely among some unrelated members of the genus. Within the present group, constant distinguishing features exist among species, with minor variation, and for some western species, at least, the females offer more reliable means of species differentiation than do the males. The shape of the sterigmal plate, sclerotization of the ductus bursae, and sculpture of the eighth ab-

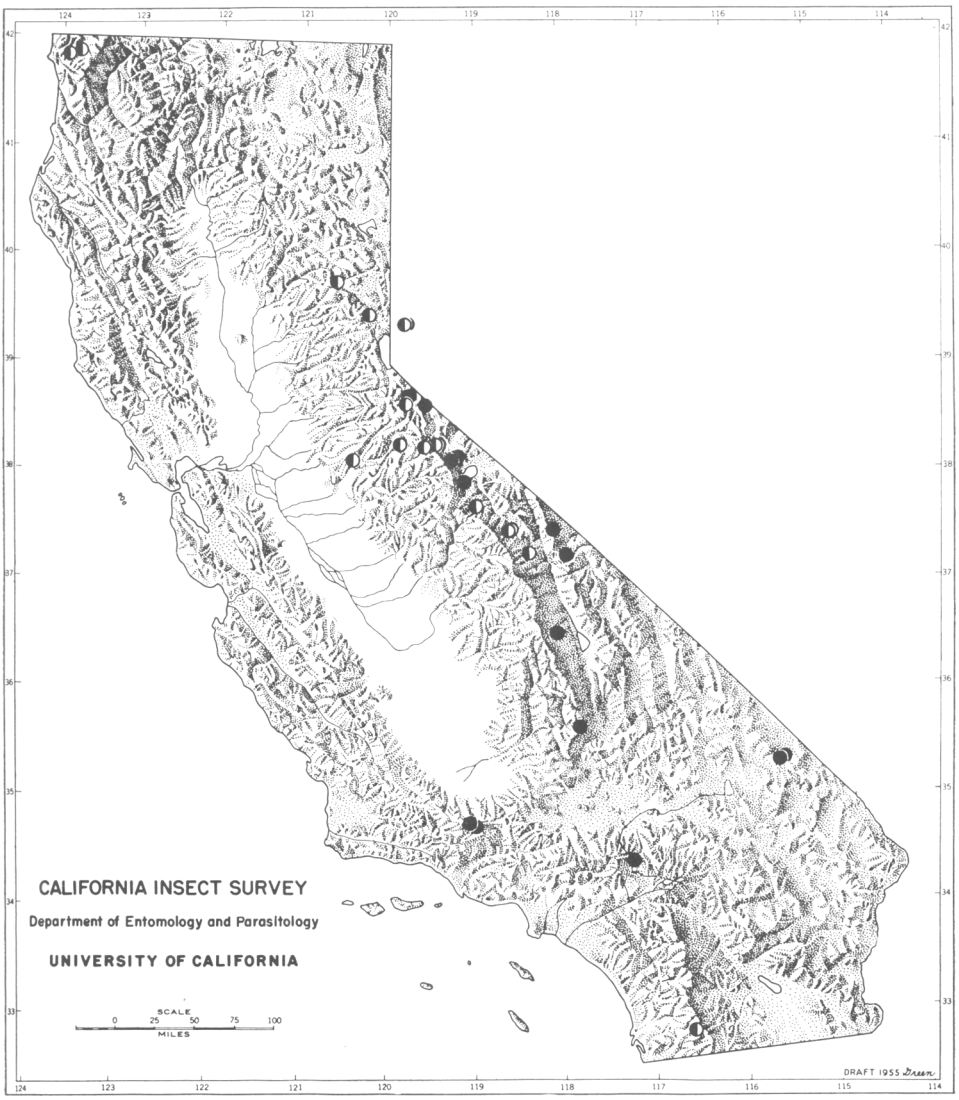


Fig. 2. Geographical distribution of *Eucosma bobana* Kearfott (solid circles) and *E. ponderosa* Powell (half-solid circles) in California.

dominal sternite, in particular, are useful in differentiating species. The shape of the sterigma varies within species, but is nevertheless of value as a taxonomic character. Other features of the female genitalia known to differ among some *Eucosma,* such as the papillae anales, sclerotization of segments IX and X, shape and length of the ductus and corpus bursae, and development of signa, are uniform throughout the *bobana* group. An exception occurs in *E. monoensis,* in which segment IX is shorter, broader, and has a sclerotized dorsal plate; the posterior apophyses are correspondingly shorter.

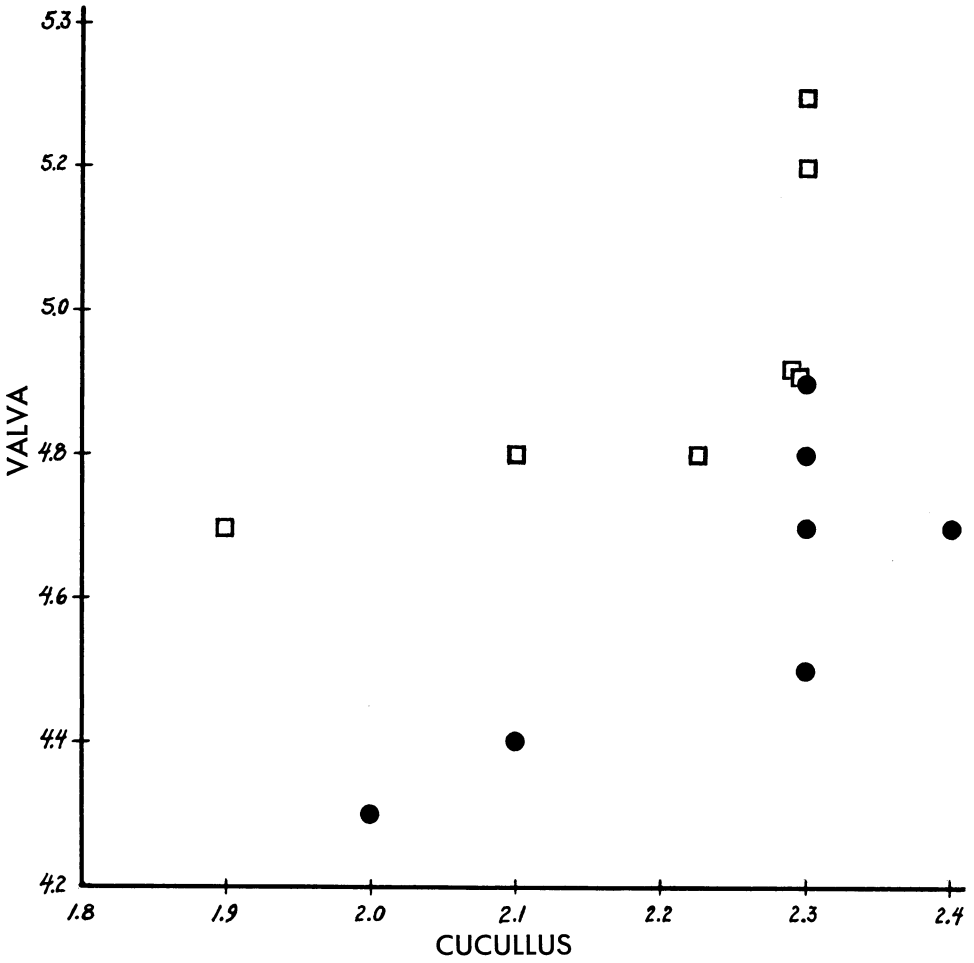


Fig. 3. Scatter diagram indicating relationship of valva length (a + a′) to greatest length of cucullus (b) (see Pl. III, fig. 1) in seven *Eucosma bobana* (closed circles) and seven *E. ponderosa* (open squares), representing geographical areas other than that of sympatry.

Eucosma bobana Kearfott

(Figs. 1, 2, 3, 4; Pl. I, fig. 1; Pl. III, figs. 1–3; Pl. V, fig. 14)

Eucosma bobana Kearfott, 1907, p. 26; Heinrich, 1920 (in part), p. 58, 1923 (in part), p. 103; Keen, 1952 (in part), p. 52, 1958 (in part), p. 136.

A moderately large moth with tan forewings, marked by well-defined, squarish blotches of dark reddish- to blackish-brown, narrowly bordered by white.

Male. Length of forewing 8.8 to 10.5 mm. *Head:* Labial palpus scaling tan, exterior lightly to heavily marked with dark brown, interior pale. Scale tufts of crown whitish-tan. *Thorax:* Dorsal scaling, including tegulae, pale orange anteriorly, becoming white posteriorly, a pair of lateral orange-brown spots preceding scutellum. Underside shining whitish, pro- and mesolegs dull brownish-orange exteriorly. *Forewing:* Length about 2.9 times width; costal fold extending to about mid-costa, slightly broadened toward middle; ter-

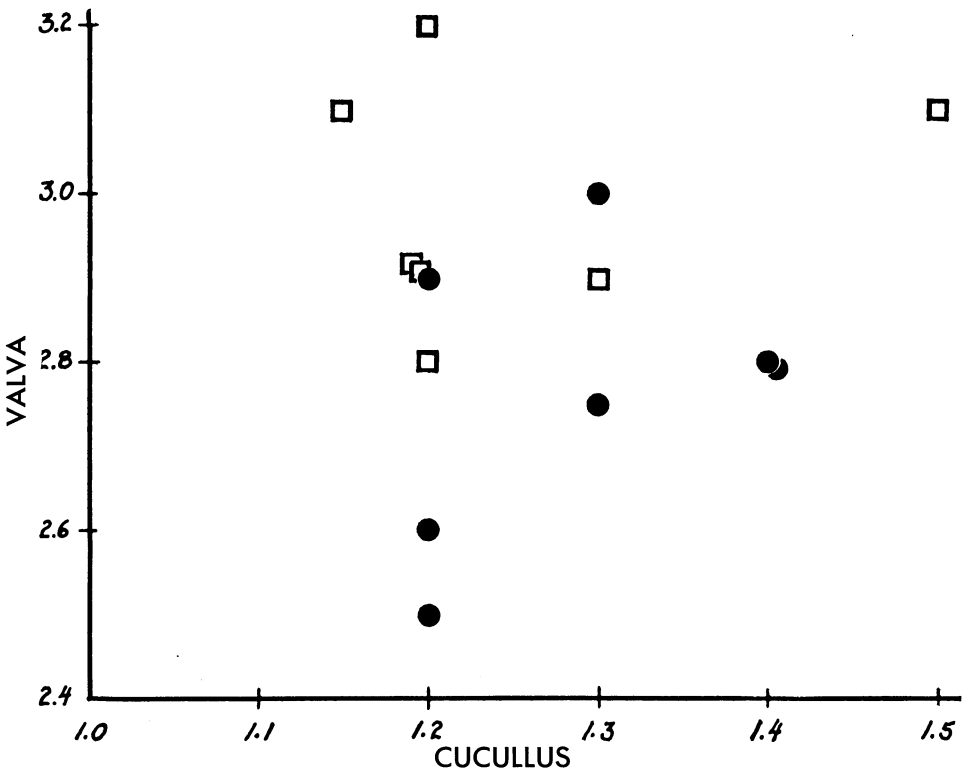


Fig. 4. Scatter diagram indicating relationship of length of valva exclusive of cucullus (a) to width of valva (c) (see Pl. III, fig. 1) in seven *Eucosma bobana* (closed circles) and seven *E. ponderosa* (open squares), representing geographical areas other than that of sympatry.

men slightly convex. Ground color pale to dark tan, rarely orange-tan; markings usually well-defined, squarish blotches, dark reddish- to blackish-brown, narrowly margined by shining white; a basal patch; a transverse band at basal one-fourth, slightly to strongly outwardly angulate in cell, usually containing scattered or distally concentrated black scaling; an outwardly curved, broad, transverse band from mid-costa to dorsum before tornus, broken into a narrow costal bar into cell (at times connected to a second costal bar just beyond), a median blotch, and a smaller dorsal blotch; usually some black scaling on the latter, often on all three; a curving band in terminal area, narrow at costa just before apex (at times connected to a small costal spot preceding), broadened below apex, narrowed into termen above tornus, the broad median portion with some, at times considerable, blackish scaling. Fringe white below apex. Underside gray, reflecting purplish; pale areas of costal margin and fringe reproduced. *Hindwing:* Dorsal scaling uniform gray; fringe whitish. Underside whitish, faintly streaked with brownish-gray. *Abdomen:* Dorsal scaling pale gray to whitish, ventral paler, genital white. Genitalia (Pl. III, figs. 1–3; drawn from plesiotypes, Ivanpah, Calif., Grand Cyn., Ariz., and Big Bend, Tex., JAP prep. nos. 112, 1871, 1890; 10 preparations examined) valva and cucullus moderately large; ratios—valva:tegumen = 1.95–2.13, av. 2.04; valva:cucullus = 1.95–2.15, av. 2.06; valva length:

width = 2.00–2.42, av. 2.16 (ratios based on seven slides from areas allopatric to *E. ponderosa;* see list, p. 11).

Female. Length of forewing 9.2 to 11.0 mm. All features essentially as described for male; coloration usually slightly darker, the forewing markings more strongly contrasting, with heavier blackish scaling. *Forewing:* Broader than in male, length about 2.6 to 2.7 times width. Genitalia (Pl. V, fig. 14; drawn from plesiotype, Westgard Pass, Calif., JAP prep. no. 1896; three preparations examined) VIII sternite heavily sclerotized except medially, with a pair of spurs on each side; sterigmal plate elongate, not sclerotized anterior of ostium; ductus bursae with basal sclerotized sleeve.

Geographical distribution. Southwestern United States, from central Texas to the western edge of the Mojave Desert in California, northward in the Great Basin at least to northern Utah and central Nevada (figs. 1, 2).

Host trees. *Pinus monophylla* and *P. edulis;* and probably *P. flexilis* or *P. aristata.*

Taxonomic discussion. This species was described on the basis of three specimens from southern Colorado and Texas, representing the three easternmost localities from which material has been available during the present study. One specimen, a male lacking abdomen, was labelled as the type by Kearfott. The other two, both of which are damaged females, were labelled cotypes. The first-mentioned locality in the original citation, Salida, Colorado, was designated as the type locality by Heinrich (1923).

Apparently only a few specimens (probably no males with abdomens) of the typical form were available to Heinrich at the time of his revision. Considerable additional material is now assembled, showing that this form is widespread in arid areas of the southwest. Phenotype variation is slight over this range. Included are two records of *bobana* reared from *Pinus monophylla,* in western Nevada and in Kern County, California. Thus it seems likely that *bobana* is a pinyon feeder, an assumption supported by the known distribution. *P. edulis* is cited by Little (1943) as a food plant in northern Arizona. Although his characterization of the moths as "gray" casts doubt on the record,[3] I have seen subsequent collections of adult *bobana* from the same area of Coconino County. The type locality, Salida, Colorado, is given as a station in the range of *P. edulis* by Rydberg (1906).

Most of the specimens Heinrich used in his characterization of *bobana* were the result of U. S. Forest Service rearings from *Pinus ponderosa* and *P. jeffreyi* in Oregon and the mountains of California. These yellow pine associates feature a darker ochreous ground color, with more extensive rust-red or orange markings. The bands of orange are more uniform, containing little or no black scaling, and tend to be straight margined, giving the wing more a banded than a checkered appearance. This moth is described below as *Eucosma ponderosa,* new species.

The genital characters of the pinyon- and yellow pine-feeding forms are quite similar. Males from areas in which the two species are allopatric tend to differ in valva shape. This distinction is expressed by the ratios given on page 11 and figures 3 and 4 (based on seven slides of each). At this sample size, the difference is not statistically significant. In the area of sympatry, not even a tendency to this difference exists (based on three slides representing each phenotype). However, there is no evidence of possible intergrade in external characters of the material I have examined from the area of overlap along the eastern edge of the Sierra Nevada.

[3] Another tortricid that feeds in the cones of pinyon pine, *Laspeyresia colorana* (Kearfott), is a generally gray moth, and may have been the species reared by Little.

RATIOS COMPARING LENGTHS OF VARIOUS PARTS OF MALE GENITALIA IN *Eucosma bobana* AND *E. ponderosa*

(See fig. 1 for explanation of letters)

LOCALITY AND SPECIES	SLIDE NO.	a + a′ : d	a + a′ : b	a : c
bobana (allopatric):				
Big Bend, Tex.	1890	2.05	2.15	2.15
Tonto Cr., Ariz.	1256	2.04	2.04	2.42
Grand Cyn.	1871	1.95	1.95	2.00
Ivanpah Mts., Calif.	112	2.13	2.13	2.31
Chuchupate R. S.	1244	...	2.10	2.17
Panamint Mts.	1253	2.00	2.09	2.00
White Mts.	1188	2.05	1.96	2.08
Averages		2.04	2.06	2.16
bobana (sympatric):				
Tom's Place	1916	2.00	2.18	2.33
Bridgeport	1904	2.13	2.17	2.00
Monitor Pass	1272	2.00	2.20	2.35
Averages		2.04	2.18	2.23
ponderosa (allopatric):				
Albee, Ore.	1878	2.09	2.29	2.42
Silver Lk.	1879	2.04	2.13	2.42
Johnsville, Calif.	.1918	1.90	2.30	2.07
Sagehen Cr.	1241	2.08	2.26	2.67
Dardanelle	102	2.14	2.47	2.58
Pine Vy.	1247	2.23	2.13	2.23
Pine Vy.	1910	2.23	2.13	2.33
Averages		2.10	2.24	2.39
ponderosa (sympatric):				
9 mi. S Reno, Nev.	1882	2.08	2.17	2.21
Sonora Bridge, Calif.	1914	2.08	2.26	2.13
Tom's Place	1884	2.13	2.04	2.13
Averages		2.09	2.16	2.16

The following collections represent the sympatric populations:

(1) INYO COUNTY, CALIF.: 9 miles west of Lone Pine, at the base of the east escarpment below Whitney Portal, a single, pale-appearing female of *E. ponderosa* was taken along with six typical *bobana* females on two July dates in 1961.

(2) MONO COUNTY, CALIF.: A sample from Rock Creek near Tom's Place, where Jeffrey and pinyon pines occur together, consists of eight specimens (1959, 1963, 1964, all August) clearly of the *bobana s. str.* phenotype, and two specimens (Aug., 1964) of the *ponderosa* phenotype.

(3) MONO COUNTY, CALIF.: A single night collection from Sonora Junction, north of Bridgeport, contains eight typical, although worn, *ponderosa* and one fresh *bobana*. The latter is considerably smaller (forewing length, 8.7 mm) than the *ponderosa* from the same locality (forewing length, 11.5 to 13.1 mm), and shows no indication of phenotypic change toward *ponderosa*.

(4) WASHOE COUNTY, NEV.: A locality 9 miles south of Reno yielded a light-trap sample in July, 1965, of two *ponderosa* and one *bobana*, all worn.

Larger, reared series from these and intervening areas, and studies on mating behavior are needed to confirm the

constancy of host relationships and isolation of the two moths. Lack of good evidence of intergrade indicates that the two should be considered as separate species.

Eucosma bobana may not be specific to the pinyon pines. Specimens taken at lights at 10,000 feet elevation, in the White Mountains of eastern California, along with *E. monoensis* (described below), apparently originated from *Pinus flexilis* or *P. aristata,* as there is no pinyon nearby. In areas such as northern Arizona, the species may use other pines where these occur within arid, high-elevation zones in *bobana's* range.

Material examined. (62 ♂, 90 ♀). ARIZONA, COCONINO Co.: Grand Cyn., So. Rim P.O., 1 ♂, V-30-65, found dead in porchlight (J. Powell); Hochderffer Hill, 12.5 mi. N W Flagstaff, 1 ♂, VII-9-61, 1 ♀, VII-16-61 (R. W. Hodges); Ft. Valley, 7.5 mi. N W Flagstaff, 1 ♂, VII-11-61 (R. W. Hodges), 2 ♂, 7 ♀, VI-20 to VII-4-64 (J. G. Franclemont); Parks, 2 ♂, 3 ♀, VI-26-57 (Martin, Ford, Rees); Walnut Cyn., 6.3 mi. E E S E Flagstaff, 3 ♂, 1 ♀, VI-20-65, 2 ♂, 2 ♀, VII-1-65 (J. G. Franclemont); Vail Lk. Rd., 9.5 mi. S E Flagstaff, 1 ♀, VII-11-61 (J. G. Franclemont). MOHAVE Co.: Hualapai Mts., 1 ♂, "May 16–23," Wheeler Cyn, Hualapai Mts., 1 ♀, "May 16–23" (no further data); "Mohave Co.," 5 ♀, "Aug. 8–15," 1 ♂, 1 ♀, "Aug. 24–31" (no further data).

CALIFORNIA, ALPINE Co.: Markleeville, 1♀, VI-17-58 (W. W. Middlekauff). MONO Co.: 4 mi. E Monitor Pass, 5 ♂, 1 ♀, VI-24-62 (C. D. MacNeill, J. Powell); Sonora Bridge Camp, nr. Sonora Jct., 1 ♀, VII-28-62 (MacNeill, Rentz, Lundgren), By-day Cr., 5 mi. W Bridgeport, 2 ♀, VII-7-62 (W. A. Foster); Bridgeport, 1 ♂, VI-15-61 (R. W. Thorp); The Hot Spr., 2.5 mi. S Bridgeport, 2 ♀, VIII-15-63, flight trap (H. B. Leech); Leevining, 1 ♀, VII-11-61 (W. E. Ferguson); Rock Cr., 1 mi. S W Tom's Place, 1 ♂, VIII-7-59, 1 ♀, VIII-11-64 (C. D. MacNeill), 6 ♀, VIII-13-63 (M. J. Tauber, C. A. Toschi); Crooked Cr. Lab., 3 airline mi. N Inyo Co. line, White Mts., 10,150 ft., 1 ♂, 6 ♀, VI-19 to VI-21-61, 3 ♂, VII-2, 21-61, at light (J. Powell), 3 ♀, VII-17, 18-61 (J. S. Buckett, J. K. Drew). INYO Co.: Westgard Pass, 7,200 ft., 9 ♂, 4 ♀, VII-26-62 (MacNeill, Rentz, Brown, Lundgren); 9 mi. W Lone Pine, 1 ♀, VII-8-61, at light (J. Powell), 5 ♀, VII-19-61, at light (P. D. Hurd, Jr., J. Powell); Bailey Peak (= Mahogany Flat, nr. Rodgers Peak, 8,200 ft.), Panamint Mts., 3 ♂, VII-4-40 (C. Henne). KERN Co.: Walker Pass, 1 ♂, 1 ♀, VII-17-56, reared from cones of *Pinus monophylla,* emgd. VI-27, VII-18-57 (H. Ruckes, Jr.). VENTURA Co.: Chuchupate Rgr. Sta., W base Mt. Frazier, 1 ♂ V-8-59, at light (J. Powell); 7 mi. N W Frazier Park, 2 ♂, 2 ♀ VII-1-65, black light (J. Powell). SAN BERNARDINO Co.: 12 mi. S E Ivanpah, New York Mts., 1 ♂ V-1-56, at light (J. Powell); Keystone Cyn., New York Mts., 5,400 to 5,800 ft., 1 ♂ IV-20-60 (J. M. and S. N. Burns); Apple Valley, 1 ♀ V-20-55 (J. E. H. Martin). RIVERSIDE Co.: Pinyon Flat (16 rd. mi. S E Palm Desert), 3 ♂ IV-17-62 (MacNeill, Rentz, Brown).

COLORADO, GARFIELD Co.: Glenwood Spr., 1 ♂, "9, 1892" (W. Barnes), 2 ♀, "July" (no further data). CHAFFEE Co.: Salida, 1 ♂ (lectotype) (no further data). MONTROSE Co.: Uncompahgre Plateau, 16 mi. S W Montrose, 7,800–8,100 ft., 1 ♀, VI-24-57 (F. and P. Rindge). MONTEZUMA Co.: Mesa Verde Natl. Park, 1 ♀, VII-23-41 (A. B. Klots). "S. W. Colo.," 1 ♀, VII-23-89 (cotype) (no further data).

NEVADA, WASHOE Co.: 9 mi. S Reno, 1♀, VII-65 (J. P. Vanucci). LYON Co.: Yerrington, 2 ♀, reared from *Pinus monophylla,* emgd. from cones IV-27-40 (Hopk. 32586) (J. Reveae). NYE Co.: Ranier Mesa above Yucca Flat, 3 ♂, 3 ♀, VIII-12, 14-64, at light (W. E. Ferguson). CLARK Co.: 2 ♀, "May

16–23," 2 ♂, 1 ♀, "June 24–30" (no further data).

NEW MEXICO, SAN MIGUEL Co.: Rowe, 1 ♂, VI-10-40 (G. Willett). OTERO Co.: High Rolls, Sacramento Mts., 1 ♀, "Aug." (Cassino Colln.).

TEXAS, BREWSTER Co.: Basin Area, Big Basin Natl. Park, 1 ♂, 3 ♀, V-28-59 (H. F. Howden, E. C. Becker); The Basin, Big Basin Natl. Park, 6 ♂, 2 ♀, V-2 to V-11-59 (M. R. MacKay). HARRIS Co.: 1 ♀, "7-5-99" (cotype) (no further data).

UTAH, WEBER Co.: Ogden, 1 ♀, V-5-59, light trap (G. F. Knowlton, L. G. Fronk). TOOELE Co.: Stockton, 1 ♀, VII-1-07, 1 ♂, VI-30-13 (T. Spalding). UTAH Co.: Provo, 1 ♀, VI-25-09 (T. Spalding). JUAB Co.: Eureka, 1 ♀, VIII-16-11 (T. Spalding); Trout Creek, 1 ♀, VII-21-22 (T. Spalding). SANPETE Co.: 17 mi. E Mayfield, 10,200 ft., 1 ♀, VII-20-60 (F., P., and B. Rindge). SEVIER Co.: Richfield, 2 ♀, V-28-30, light trap (no further data). KANE Co.: Glendale, 1 ♀, VI-23-41 (G. H. and J. L. Sperry).

Eucosma ponderosa Powell, n. sp.

(Figs. 1, 2, 3, 4; Pl. I, fig. 2; Pl. III, figs. 4, 5)

Eucosma bobana: Heinrich, 1923 (not Kearfott, 1907), (in part) p. 103; Keen, 1952 (not Kearfott, 1907), p. 52, 1958 (not Kearfott, 1907), (in part) p. 136; Ross, 1958, p. 30 (?).

A western member of the complex, associated with yellow pines, which is somewhat larger than *bobana* and has orange forewing markings usually lacking black scaling, on an ochreous-tan ground.

Male. Length of forewing 8.4 mm. (reared) to 11.4 mm. *Head:* Labial palpus exterior scaling reddish-orange, interior pale. Tufts of crown pale ochreous toward front, becoming orange posteriorly. *Thorax:* Dorsal scaling deep metallic reddish to red-orange anteriorly, becoming whitish posteriorly and on tegulae apices, a lateral pair of orange spots preceding scutellum. Underside shining white, pro- and mesolegs pale orange or brownish exteriorly. *Forewing:* Length about 2.8 to 2.9 times width. Pattern essentially as described for *bobana,* the ground color usually darker, an ochreous tan, the markings bright orange or reddish-orange, usually well defined, but containing little or no black scaling; markings margined by silvery gray which tends to be broader than the white margins on *bobana,* reducing the tan ground color, often to narrow, transverse bands. Underside pale gray to blackish-gray. *Hindwing:* Dorsal scaling uniform pale gray to blackish-gray; fringe slightly paler. Underside whitish, slightly to heavily suffused with pale to dark-grayish. *Abdomen:* Dorsal scaling pale to dark gray, ventral paler, genital whitish. Genitalia (Pl. III, figs. 4, 5; drawn from paratypes, Pine Vy., Calif., and Silver Lk., Ore., JAP prep. nos., 1247, 1878, 10 preparations examined) very similar to *bobana;* differs by a slightly narrower valva and smaller cucullus; uncus usually pointed; ratios—valva:tegumen = 1.90–2.23, av. 2.08; valva:cucullus = 2.11–2.47, av. 2.24; valva length:width = 2.07–2.67, av. 2.39 (ratios based on seven slides from areas other than sympatry with *E. bobana,* see table p. 11).

Female. Length of forewing 8.9 mm (reared), 10.2 to 13.4 mm. All features essentially as described for male. *Forewing:* Markings more uniformly a bright reddish-orange, rarely more than a few scattered black scales; ground color tan, at times with considerable orange scaling interspersed, obscuring the pattern; broader, length about 2.7–2.8 times width. Genitalia not distinguishable from *bobana* (three preparations examined).

Holotype male and allotype female. OREGON, LAKE Co.: Embody's Mill nr. Silver Lake, 5,300 ft., August 5, 1915.

Reared from cones of *Pinus ponderosa* in 1916 (P. D. Sergent); deposited in U. S. National Museum. Eighty paratypes (22 ♂, 58 ♀) listed below under material examined.

Geographical distribution (figs. 1, 2). Mountains adjacent to the western margins of the Great Basin, from the Blue Mountains in northeastern Oregon, southward through the east slope of the Cascades and Sierra Nevada, into the mountains of southern California.

Host trees. *Pinus jeffreyi* and *P. ponderosa.*

Taxonomic discussion. As previously noted, *Eucosma ponderosa* has been included with *bobana* in past treatments, primarily because so little material of *bobana* was available. The Jeffrey- and ponderosa pine-feeding populations show little variation and are quite distinct from *bobana* in forewing color. The two have been taken flying together at stations along the east side of the Sierra Nevada, without evidence of intergrade in wing color.

Material examined (23 ♂, 58 ♀). California, Plumas Co.: Johnsville, 1 ♂, 2 ♀, VII-28-65, 14 mi. SW Johnsville, 2 ♀, VIII-9-65 (J. S. Buckett). Nevada Co.: Sagehen Cr. nr. Hobart Mills, 1 ♂, 2 ♀, VII-5-62, at light (J. Powell), 1 ♂, VII-16-62 (M. E. Irwin). Alpine Co.: Pleasant Vy. [S E of] Markleeville, 9 ♀, VII-15-61 (W. E. Simonds). Calaveras Co.: 4 mi. E Murphys, 3,000 ft., 1 ♂, VII-9-63, blacklight trap (P. Quyle). Tuolumne Co.: Dardanelle, 4 ♂, 4 ♀, VI-19-56, reared from cones of *Pinus jeffreyi,* emgd. VI-17 to VI-21-57 (H. Ruckes, Jr.), 1 ♂, VII-19-64 (M. L. and S. H. Lundgren). Mono Co.: Leavitt Mdws., 7,200 ft., 4 ♀, VIII-12-63, flight trap (H. B. Leech); Sonora Bridge Campgr. nr. Sonora Jct., 2 ♂, 6 ♀, VII-28-62 (MacNeill, Rentz, Lundgren), 3 ♀, VII-15-64 (M. L. and S. H. Lundgren); Deadman Recr. area S of Leevining, 10 ♀, IX-58, reared from cones of *Pinus jeffreyi,* emgd. VI-21-59; Rock Cr., 1 mi. S W Tom's Place, 1 ♂, 1 ♀, VIII-8-64 (C. D. MacNeill). Inyo Co.: 7 mi. N Parcher's Camp, 1 ♀, VI-30-61, at light (J. Powell); 9 mi. W Lone Pine, 1 ♀, VII-8-61, at light (J. Powell). San Diego Co.: Pine Valley, 3,500 ft., 3 ♂, 6 ♀, reared from *Pinus jeffreyi,* emgd. VIII-27-15 (Hopk. 13276 a) (F. P. Keen and Patterson). County unknown: Mono Natl. Forest, 3 ♀, VIII-28-14, reared from *Pinus jeffreyi,* emgd. VI-23-15 (Hopk. 12558 b) (Patterson).

Nevada, Washoe Co.: 9 mi. S Reno, 1 ♂, 1 ♀, VII-65 (J. P. Vanucci); 6.4 mi. up Hiway 27 from Steamboat Spr., 1 ♀, VIII-24-63 (H. B. Leech).

Oregon, Umatilla Co.: Albee, 4,000 ft., 1 ♂, 1 ♀, VIII-8-13, reared from *Pinus ponderosa* (Hopk. 9074 b) (W. D. Edmonston); Lake Co.: Embody's Mill nr. Silver Lake, 5,300 ft., 4 ♂, 1 ♀, reared from *Pinus ponderosa,* VIII-5-15, (Hopk. 13251 h) (P. D. Sergent).

Paratypes deposited in collections of California Academy of Sciences, San Francisco; California State Department of Agriculture, Sacramento; California Insect Survey, University of California, Berkeley; Canadian National Collection, Ottawa; Pacific Southwest Forest and Range Experiment Station, Berkeley; U. S. National Museum, Washington, D.C.; and University of California, Davis.

One additional female has been examined, which is labeled Riverside, Calif., June 17, 1928, at light (P. H. Timberlake). This dwarfed individual (forewing length, 8.8 mm) may have resulted from an introduction of cone material to the Riverside area, as there are no native pines in the immediate vicinity.

Several collections have been examined which differ from *Eucosma ponderosa* sufficiently to preclude their referral to this species in a typical sense. Additional data will be necessary in order to define their precise relationships within the group. They are as follows:

(1) Del Norte County, Calif.: 5 ♂, 2 ♀, reared from *Pinus attenuata* (Gas-

quets, Hopk. No. 13,374A; Patrick's Creek, Hopk. No. 14,265C). These appear to be intermediate between *E. ponderosa* and *rescissiorana* in forewing color, having dark-reddish, well-defined markings which form continuous bands, or nearly so, and vary to a phenotype rather close to typical *ponderosa.* The male genitalia (three preparations examined) do not indicate a strong relationship with either of these species. The relative sizes of measured parts give ratios similar to those of *bobana* proper (Del Norte population—valva:tegumen = 2.00–2.11, av. 2.04; valva:cucullus = 1.91–2.11, av. 2.01; valva length:width = 2.17–2.20, av., 2.19). The *Pinus attenuata* feeders were referred to *E. ponderosa* (as *bobana*) by Keen (1958), but the fact that *E. ponderosa* and *rescissiorana* are broadly sympatric over a wide geographical range suggests that the Del Norte moths may represent another isolate, perhaps specifically associated with knobcone pine. Inasmuch as the Del Norte localities are allopatric from recorded sites of the other two species, and are isolated from them by a long distance, it seems best not to treat the *P. attenuata* associates as a distinct species until more information is available about *ponderosa* and *rescissiorana* in the Coast Ranges of northern California and Oregon.

(2) British Columbia, Canada: 1 ♂, reared from cones of *Pinus monticola* (Slocan, III-29-54, B.C. 53-1070-01, F. I. S.). The forewing markings are slightly darker-reddish than those of most *ponderosa,* are somewhat retricted, but contain considerable black scaling (even more than does *bobana*) which tends to form narrow, black margins to the transverse bands. The genitalia ratios are similar to those of average *ponderosa* (valva:tegumen = 2.19; valva:cucullus = 2.30; valva length: width = 2.32).

(3) Beaverhead County, Montana: 1 ♀, reared from cone of *Pinus albicaulis* (Dillon, Hopk. No. 21,944, A. L. Gibson). This specimen is large (forewing length, 12.0 mm) and has forewing markings similar to those of the preceding specimen from British Columbia—dark red-brown with considerable black scaling. The ground color has a reddish-gray tinge, approaching that of *E. rescissiorana.*

(4) Durango, Mexico: 1 ♂, at light (10 mi. W La Ciudad, 9,000 ft., V-8-61, Howden and Martin). This specimen has forewing colors the same as those in typical *ponderosa* and, other than its large size (forewing length, 12.4 mm), has only minor differences in forewing pattern to distinguish it from *ponderosa.* The genitalia are also larger than those of *ponderosa* and differ particularly by a strongly produced uncus; otherwise, their ratios are quite similar to those in the California and Oregon species (valva:tegumen = 2.00; valva:cucullus=2.35; valva length:width=2.33). *Pinus ponderosa* is one of many pine species that occur in this region (Critchfield and Little, 1966).

Eucosma rescissiorana Heinrich

(Pl. I, fig. 3)

Eucosma rescissiorana Heinrich, 1920, p. 58, 1923, p. 104; Keen, 1952, p. 52, 1958, p. 136; MacKay, 1959, p. 48; Ollieu and Schenk, 1966, p. 268.

Eucosma sp. prob. *bobana:* Ross, 1958, p. 31 (?).

A western species with predominantly dark-reddish markings, which feeds on lodgepole and western white pines.

Male. Length of forewing about 10.5 mm. Generally as described for *E. bobana,* the scale coloring darker, labial palpus, legs, etc., mostly dark reddish. *Forewing:* Length about 2.9 times width; pattern basically similar to that of *bobana,* the tan ground color reduced to rather narrow bands, well defined by whitish scaling; markings dark brick-red with scattered marginal black scaling, especially in basal half of wing;

basal patch and transverse band at basal one-fourth nearly confluent, the ground color between reduced to an ill-defined gray-and-tan band; median band broad, complete from beyond mid-costa to before tornus, only partially broken in cell; outer band complete, from costa before apex, not narrowed, ending in termen above tornus; a spot at apex. Fringe whitish, intermittently streaked with gray. Underside gray; costa and termen paler. *Hindwing:* Darker gray than in *bobana;* similar to *ponderosa. Abdomen:* Dorsal scaling gray, the segments not appreciably paler posteriorly. Genitalia (two preparations examined) similar to *bobana,* the cucullus about as large as in *ponderosa,* the valva broad as in *bobana;* ratios—valva:tegumen = 2.06–2.25; valva:cucullus = 2.18–2.31; valva length:width = 2.09–2.21.

Female. Length of forewing 8.3 mm (reared) to 11.0 mm. Other characters as described for male. Genitalia not distinguishable from *E. bobana* (two preparations examined).

Geographical distribution. Mountains of western North America from southern Alberta through Washington and Oregon to the central Sierra Nevada in California.

Host trees. *Pinus contorta* and *P. monticola;* and possibly *P. albicaulis* and *P. attenuata.*

Taxonomic discussion. This species was originally described from a unique specimen reared from lodgepole pine in southern Oregon, and I have seen only a few subsequent records, all the result of larval collections. It has been reared from *Pinus monticola* in Idaho and from *P. contorta* in California, Oregon, and Alberta.

The occurrence of *E. rescissiorana* in California was confirmed by a collection from Truckee, Nevada County, in 1963, an area well within the range of *E. ponderosa,* at a site about 10 miles from Sagehen Creek, where typical *ponderosa* has been taken at lights. Thus, the two species appear to maintain their respective host specificity and isolation over a broad range in Oregon and California. In addition to the difference in forewing color—tan and orange in *ponderosa,* gray and red in *rescissiorana*—the male genitalia of *rescissiorana* also appear to differ by a slightly broader valva.

Collections from northwestern California on *Pinus attenuata,* from British Columbia on *P. monticola,* and from Montana on *P. albicaulis,* discussed above (p. 15), represent populations that exhibit characteristics intermediate between *E. rescissiorana* and *E. ponderosa.*

Material examined (5 ♂, 9 ♀).—CANADA, ALBERTA: Cypress Hills, 2 ♂, 2 ♀, reared from *Pinus contorta* cones II-10-64 (F.I.S.—63A937-01).

CALIFORNIA, NEVADA Co.: 2 mi. N Truckee, 1 ♂, 5 ♀, VII-63, reared from cones of *Pinus murrayana,* emgd. XII-31-63, II-17, II-24-63, III-63 (R. W. Stark, J. H. Borden).

IDAHO, SHOSHONE Co.: 10 mi. N Clarkia, 1 ♀, VII-7-60, reared from *Pinus monticola* cones, emgd. VII-29-60 (D. L. Williamson).

OREGON, DESCHUTES Co.: La Pine, 1 ♂, 1 ♀, VIII-8-53, reared from *Pinus contorta,* emgd. IV-7-54 (Hopk. 32735A) (F. P. Keen). LAKE Co.: N fork Sprague Riv., 5,800 ft., 1 ♂, VII-28-15, reared from *Pinus murrayana* (Hopk. 13250 d) (holotype) (P. D. Sergent).

Eucosma franclemonti Powell, n. sp.

(Pl. I, fig. 6; Pl. IV, fig. 6; Pl. VI, fig. 19)

A large moth of the group in northern Arizona, which resembles *bobana* in coloration, but with transverse bands of the forewing more or less uninterrupted and straight-margined.

Male. Length of forewing 10.0 to 11.9 mm. *Head:* Labial palpus exterior brownish-orange, interior paler. Scaling of crown whitish, slightly tinged with pale orange posteriorly. *Thorax:* Dorsal

scaling orange, an ill-defined whitish transverse band across middle, including tegulae apices. Underside white, pro- and meso-legs tinged with pale orange exteriorly. *Forewing:* Length, about 2.8–2.9 times width; costal fold slightly broader than in related species; apex acute, termen rather strongly angled back. Ground color pale tan, tinged with ochreous, shading to white toward darker markings; markings reddish-brown, strongly infused with shining gray in dorsal area before middle and in costal half beyond middle; pattern similar to *E. bobana;* basal patch, containing a white spot below vein Cu; a transverse band from costa at basal one-fourth to dorsum before middle, ill-defined basad, margined outwardly by a straight, distinct line (not bent outward toward middle as in *bobana*); median transverse band broken in cell only by a whitish line, not broken below cell, the two blotches broadly joined above tornus, the lower one as broad as upper, reaching to tornus; outer band reduced, the preapical spot usually obscure, scarcely evident to terminal margin; whole apical area paler, the markings not strongly contrasting and not well defined by white margins as in *bobana.* Fringe whitish, blotched with golden-tan. Underside mostly dark gray, the margins tan with traces of the upperside markings reproduced. *Hindwing:* Dorsal scaling uniform dark gray, fringe whitish-gray. Underside whitish, with scattered grayish clouding. *Abdomen:* Dorsal scaling gray, the segments margined whitish posteriorly; ventral scaling paler, genital whitish. Genitalia (Plate IV, fig. 6; drawn from paratype, Franclemont prep. RH-1, one preparation examined) ratios — valva:tegumen = 2.45; valva:cucullus = 2.25; valva length:width = 2.27; uncus short, not exceeding "shoulders" of tegumen.

Female. Length of forewing 13.4 to 13.7 mm. All characters essentially as described for male. *Forewing* about as narrow as in male except for costal fold area. Genitalia (Plate VI, fig. 19; drawn from paratype, JAP prep. No. 1924, one preparation examined) very similar to *bobana,* the sterigma sclerotization with a V-shaped notch anteriorly and the VIII sternite sclerotization reduced anteriorly.

Holotype male. ARIZONA, COCONINO Co.: Hochderffer Hill, 8,500 ft., 12.5 mi. NNW Flagstaff, July 16, 1961 (J. G. Franclemont), and **allotype female,** same locality, July 9, 1961 (R. W. Hodges), deposited in Franclemont Collection, Cornell University. Five paratypes listed in material examined, below.

Geographical distribution. Known only from the type locality in the San Francisco Mountains of northern Arizona.

Host trees. Unknown.

Material examined. ARIZONA, COCONINO Co.: Hochderffer Hill, 8,500 ft., 12.5 mi. NNW Flagstaff, 2 ♂, 4 ♀, VII-9-61 (R. W. Hodges), 1 ♂, VII-16-61 (J. G. Franclemont), deposited in collections of California Insect Survey, University of California, Berkeley; Cornell University; and R. W. Hodges, Washington, D.C.

Eucosma monoensis Powell, n. sp.

(Pl. I, fig. 4; Pl. IV, fig. 10; Pl. V, fig. 15)

A large, pale tan moth in eastern California.

Male. Length of forewing 11.0 to 11.3 mm. *Head:* As in *bobana,* labial palpus rather short, scaling exteriorly pale orange-tan, interiorly white. Tufts of crown pale, becoming ochreous laterally. *Thorax:* Dorsal scaling orange-tan, tegulae whitish on posterior half, scutellar area whitish. Underside white, pro- and mesolegs pale orange-tan exteriorly. *Forewing* about 2.7 to 2.8 times width; costal fold rather narrow, ending before middle of costa, with upraised, brownish scaling; costa very slightly curved beyond; apex acute, termen rather

strongly angled back, slightly convex. Ground color ochreous-tan, markings slightly darker, orange-tan, narrowly margined whitish, the lines with scattered to rather complete rows of silvery-gray scales replacing the white. Pattern similar to *bobana,* but obscured owing to lack of contrast between ground and markings. Fringe whitish, tinged with pale brownish-ochreous. Underside pale gray, costal and terminal areas whitish, blotched with pale ochreous. *Hindwing:* Dorsal scaling pale gray; fringe whitish. Underside white. *Abdomen:* Dorsal scaling whitish basally, becoming pale brownish distally, ventral whitish. Genitalia (Pl. IV, fig. 10; drawn from holotype, JAP prep. No. 1181, two preparations examined) similar to *bobana,* the valva broader; ratios—valva:tegumen = 2.08–2.18; valva:cucullus = 2.18–2.27; valva length:width = 1.75–1.88.

Female. Length of forewing 12.0 to 13.4 mm. All characters essentially as described for male; larger and forewing usually slightly broader, length about 2.6 to 2.8 times width. Genitalia (Plate V, fig. 15; drawn from paratype, White Mts., JAP prep. No. 1899, two preparations examined) differ from *bobana* by the shorter, broader IX–X segments, by the shorter sterigma, which is narrowly sclerotized around the ostium, by a less strongly sclerotized VIII sternite which lacks the paired, lateral spurs, and by a shorter sclerotized sleeve of the ductus bursae.

Holotype male and allotype female. CALIFORNIA, MONO Co.: Crooked Creek Lab., White Mts., 10,150 ft., 3 airline miles north of Inyo Co. line, June 22 and June 18, 1961, at light (J. Powell). Deposited in California Academy of Sciences, San Francisco. Four paratypes, listed in material examined, below.

Geographical distribution. Central eastern California, from Bridgeport (6,500 ft.) southward to the White Mountains (10,000 ft.) and Westgard Pass (7,200 ft.).

Host trees. Unknown.

Taxonomic discussion. The pale markings, which scarcely contrast with the forewing ground color, best distinguish *monoensis* superficially from other members of the complex. In addition, it differs from *bobana,* which it most closely resembles, by the silvery-gray scaling marginal to the markings. This is not comparable with the black scaling of *bobana,* which occurs within the dark markings. In *monoensis,* the gray scaling is a replacement of white outside the orange-tan markings. In older specimens, this silvery-gray scaling is largely lost.

At the type locality, the species must be associated with *Pinus aristata* and/or *P. flexilis,* while at Bridgeport and Westgard Pass, *P. monophylla* is the probable host. At all three sites, *monoensis* flies with and evidently shares the same pines as *bobana.*

Material examined (2 ♂, 4 ♀). CALIFORNIA, MONO Co.: Bridgeport, 1 ♂, VI-15-61 (R. W. Thorp); Crooked Creek Lab., White Mts., 10,150 ft., 3 airline mi. N Inyo Co. line, 1 ♂, 2 ♀, VI-18 to VI-21-61, at light (J. Powell). INYO Co.: Westgard Pass, 1 ♀, VI-15-60 (H. K. Court). Deposited in collections of California Insect Survey, University of California, Berkeley; and U. S. National Museum, Washington, D.C.

Eucosma cocana Kearfott

(Fig. 5; Pl. I, fig. 5; Pl. IV, fig. 7; Pl. V, fig. 16)

Eucosma cocana Kearfott, 1907, p. 26; Heinrich, 1923, p. 104; Kimball, 1965, p. 259.

Eucosma sp. (near or = *cocana*): MacKay, 1959, p. 47.

An eastern species, primarily of the southeastern Piedmont, which has predominantly dark-reddish forewings, densely infused with leaden-gray scaling.

Male. Length of forewing 8.8 to 9.7

Fig. 5. Geographical distribution of *Eucosma cocana* Kearfott in the eastern United States.

mm. All characters essentially as described for *E. bobana,* the scaling generally darker, as in *E. rescissiorana.* Scaling of labial palpus dark reddish-gray, of crown, pale orange-red, of legs, reddish-gray. *Forewing:* About 2.7 to 2.8 times width; costal fold large, reaching to mid-costa, rather broad, blackish-gray with some white scales contrasting with reddish basal area of wing. Ground color tan, greatly reduced, as in *rescissiorana,* scarcely evident on some speci-

mens. Pattern basically as described for *rescissiorana,* obscured by leaden or whitish-gray scaling which forms transverse striae replacing much of both the deep reddish markings and the tan intervening areas. In worn specimens the gray tends to be lost, leaving a more orange and tan color. *Hindwing:* Dorsal scaling dark gray, as in *rescissiorana. Abdomen:* Dorsal scaling gray, paler posteriorly. Genitalia (Pl. IV, fig. 7; drawn from plesiotype, Conn., JAP prep. No. 1880, four preparations examined) valva relatively short, broad and with a large cucullus; ratios—valva:tegumen = 1.85–1.92, av. 1.94; valva:cucullus = 1.86–2.00, av. 1.96; valva length:width = 1.92–2.00, av. 1.96.

Female. Length of forewing 10.0 to 10.7 mm. All characters essentially as described for male. Genitalia (Pl. V, fig. 16; drawn from plesiotype, Florida, JAP prep. No. 1923, one preparation examined) sterigma a complete ring; VIII sternite only lightly sclerotized on margins, without spurs; ductus bursae without sclerotized areas.

Geographical distribution. East coastal areas from the Cape Cod region of Massachusetts through the southeastern Piedmont to northern Florida (fig. 5).

Host trees. Probably *Pinus taeda;* possibly other pines of the subsection Australes.

Taxonomic discussion. This species was described from a single male specimen from southwestern North Carolina. The species evidently was not reported again during the next 50 years, and has remained scarce in collections. I have seen only a few records and no reared specimens. Most of the records are from the southeastern Piedmont, and the distribution strongly suggests an association with one or more of the southern yellow pines. MacKay (1959) described larvae of a cone-feeding *Eucosma* from *Pinus taeda* in North Carolina as probably *E. cocana.* Evidently adults were not reared from this collection to confirm the identity, but it seems quite likely that *cocana* was the species involved. The only other member of the group known from that area is *E. tocullionana,* which MacKay differentiates in the same paper, based on larval specimens from the type locality of *tocullionana.*

Two recent collections, a female from coastal Massachusetts and a worn male from Connecticut, extend the distribution considerably northward. *Pinus rigida* is a possible host in that area.

Material examined (9 ♂, 6 ♀). Connecticut, Middlesex Co.: N end Higby Mt., 4 mi. W Middletown, 1 ♂, V-22-65 (J. M. Burns).

Florida, Gadsen Co.: Quincy, 1 ♂, 1 ♀, IV-25-62, 5 ♂, 1 ♀, III-25 to IV-25-63 (W. B. Tappan). Escambia Co.: Pensacola, 1 ♂, IV-21-61, 1 ♀, IV-20-61 (S. Hills).

Massachusetts, Plymouth Co.: Agric. Exp. Sta., E Wareham, 1 ♀, VI-19-63 (C. P. Kimball).

North Carolina, Polk Co.: Tryon, 1 ♂, "5–17" (Fiske) (holotype).

Virginia, King and Queen Co.: (no locality) 3 ♀, V-2 to V-24-42 (L. A. Hetrick).

Kimball (1965) reported the species from Cassadaga, Volusla County, Florida, a slightly southerly extension of the range indicated by the above records.

Eucosma tocullionana Heinrich

(Fig. 6; Pl. II, fig. 1; Pl. IV, fig. 8; Pl. VI, fig. 17)

Eucosma tocullionana Heinrich, 1920, p. 59, 1923, p. 105; MacKay, 1959, p. 48.

A small, eastern member of the group with dark brown to blackish forewing markings which obscure all but rectangular patches of the tan ground color.

Male. Length of forewing 6.3 to 8.0 mm. All characters essentially as described for *E. bobana,* the scaling gen-

Fig. 6. Geographical distribution of *Eucosma tocullionana* Heinrich in eastern North America.

erally darker and without orange-red tinge. *Head:* Scaling pale to dark brownish tan exteriorly. Scaling of crown pale tan. *Forewing:* Length 2.6–2.7 times width; costal fold narrow, elongate, extending to beyond mid-costa. Markings basically similar to those of *E. bobana,* the tan ground color reduced, well defined by shining, pale gray margins (similar to *rescissiorana*); markings of intermixed light brown and black scales, the latter at times domi-

nant (appearing dark chocolate-brown to the unaided eye); basal patch and transverse band at basal one-fourth separated only by some gray scaling; gray also often replacing costal half of submedian ground-color area, the dorsal half forming a large, well-defined quadrate spot preceding median band, latter from beyond mid-costa to dorsum before tornus, narrowed toward latter, not divided in cell, interrupted there only by some gray scaling; outer band reduced to a spot in apical area not reaching costa or termen; terminal area tan defined by silvery gray. Fringe contrasting, whitish gray. Underside dark gray, strongly reflecting purplish; pale spots of costa and termen reproduced. *Hindwing:* Dorsal scaling dark brown; fringe brownish gray. Underside whitish with scattered grayish clouding. *Abdomen:* Dorsal scaling gray, paler posteriorly and ventrally; genital scaling pale grayish. Genitalia (Pl. IV, fig. 8; drawn from plesiotype, No. Carolina, JAP prep. No. 1885, three preparations examined) ratios — valva:tegumen = 1.95–2.00, av. 1.97; valva:cucullus = 1.95–2.15, av. 2.03; valva length:width = 1.83–2.27, av. 2.06.

Female. Length of forewing 7.7 to 9.4 mm. All characters essentially as described for male. Genitalia (Pl. V, fig. 17; drawn from plesiotype, Wisconsin, JAP prep. No. 1892, two preparations examined) sterigmal plate flattened-oval, the portion anterior to ostium relatively broad; VIII sternite with a narrow marginal band heavily sclerotized, without spurs; ductus bursae without sclerotized area.

Geographical distribution. Eastern North America from New Brunswick and southern Ontario to northern Wisconsin, southward along the Appalachian chain to the southern border of North Carolina (fig. 6).

Host trees. *Pinus strobus, Picea, Abies balsamea,* and *Tsuga canadensis.*

Taxonomic discussion. The adults of this species have broad, dark brown markings on the forewing, which form continuous, transverse bands, leaving only narrow areas of intervening tan. The small size is similar to that of *monitorana,* the only species with which it might be confused, but *tocullionana's* forewing colors will serve to distinguish it from *monitorana,* which has restricted reddish-brown, dark markings on a whitish ground.

Heinrich (1920) described *tocullionana* from material reared from cones of *Picea* collected in Connecticut. Nearly all subsequent larval collections have involved *Pinus strobus,* while one specimen from Pennsylvania is labelled "cone borer in eastern hemlock." The same host, *Tsuga canadensis,* also seems to be the only possible association of moths taken at lights near Middletown, Connecticut. In addition, W. E. Miller (*in litt.*) has examined adults of this species reared from *Abies balsamea* in Massachusetts. Thus, *tocullionana* is apparently a general conifer feeder over a wide range in southeastern Canada and northeastern United States.

Material examined (60 ♂, 74 ♀). CANADA, NEW BRUNSWICK: N of Boiestown, North Co., 1 ♀, reared from white pine [*Pinus strobus*] cone, III-2-64 (63-0884-01). QUEBEC: Ancaster, 1 ♀, VI-30-56 (J. E. H. Martin); Wright, 1 ♀, VI-11-35 (F. A. Urquhart); Norway Bay, 1 ♂, VII-3-37, 7 ♂, V-28 to VI-6-38, 2 ♀, VI-19, 28-39 (E. G. Lester). ONTARIO: Go Home Bay, 1 ♂, VI-21-32 (G. S. Walley); Carp, 1 ♂, V-29-34 (W. J. Brown); Orillia, 1 ♂, VI-9-25 (J. McDunnough); Severn, 1 ♀, VI-14-25 (J. McDunnough).

CONNECTICUT, MIDDLESEX Co.: Middletown, 1 ♂, 2 ♀, V-29 to VI-9-63 (J. M. Burns); N end Higby Mt., 4 mi. W Middletown, 6 ♂, 2 ♀, V-22-65 [assoc. *Tsuga canadensis*] (J. M. Burns). NEW LONDON Co.: Lyme, 2 ♂, 2 ♀, V-16-16, reared from *Picea* (Hopk. 13921 a) (A. B. Champlain) (holotype). NEW HAVEN Co.: New Haven, 1 ♂, VI-7-64, reared from *Pinus strobus* cones, emgd.

VII-14-64 (Hopk. 49,955). FAIRFIELD Co.: Stamford, 1 ♀, VII-16-31, reared from white pine [*Pinus strobus*] (No. 72 B.T.R. Lab. Col.).

MASSACHUSETTS, MIDDLESEX Co.: Tyngsboro, 1 ♂, "6/10/18" (no further data).

NEW JERSEY, ESSEX Co.: Montclair, 1 ♀, VI-14-99 (W. D. Kearfott).

NEW YORK, ONONDAGA Co.: Syracuse, 1 ♂, 1 ♀, IV-5-30 "white pine" (A. H. MacAndrews). TOMPKINS Co.: 6 Mile Cr., Ithaca, 10 ♂, 18 ♀, V-23 to VI-14-57, 1 ♂, 1 ♀, V-21, 26-59 (J. G. Franclemont). WESTCHESTER Co.: Pelham, 1 ♂, 6 ♀, VI-59, 3 ♀, VI-4 to VI-12-61 (A. B. Klots).

NORTH CAROLINA, BUNCOMBE Co.: Asheville, Bent Cr., 1 ♂, "6-5-36, wh. pine cones" [*Pinus strobus*] (R. J. Knowal). MACON Co.: Highlands, 3,865 ft., 9 ♂, 16 ♀, VI-25 to VIII-4-58 (J. G. Franclemont); Van Hooke Campgr., 4 mi. N W Highlands, 3,000 ft., 2 ♂, 6 ♀, VII-2-65, reared from *Pinus strobus* cones, emgd. VIII-1 to VIII-5-65 (C. W. O'Brien).

PENNSYLVANIA, WESTMORELAND Co.: Ligonier, 1 ♂, VI-23-53, "cone borer in eastern hemlock" [*Tsuga canadensis*] (no further data).

TENNESSEE, SEVIER Co.: Great Smoky Mt. Natl Park, 1 ♂, V-18-57 (J. R. Vockeroth).

VIRGINIA, ALBEMARLE Co.: Charlottsville, 1 ♂, 1 ♀, VII-20, 27-64, reared (Hopk. 49,954) (W. J. Schroeder).

WISCONSIN, ONEIDA Co.: Lake Katherine, 10 ♂, 8 ♀, VI-3 to VI-29-61 (H. M. Bower).

Eucosma monitorana Heinrich

(Pl. II, figs. 2, 3; Pl. IV, fig. 9; Pl. VI, fig. 18)

Eucosma monitorana Heinrich, 1920, p. 58, 1923, p. 105; Lyons, 1957 *a, b,* pp. 150, 264.

Eucosma sp., Barras and Norris, 1963, p. 61, 1965, p. 1033.

An eastern species similar in size to *tocullionana,* differing by a pale, cream-colored forewing ground and dark reddish-brown markings.

Male. Length of forewing 6.8 to 7.7 mm. All characters essentially as described for *E. tocullionana,* the dark markings deep reddish-brown rather than a mixture of light brown and black. *Head:* Labial palpus second segment dark gray; third, cream-white to grayish. Scaling of crown cream-whitish becoming pale reddish-brown laterally. *Thorax:* Dorsal scaling red-brown on anterior half, dark gray on posterior. Legs dark gray, marked with white. *Forewing:* Length about 2.7 times width; coastal fold relatively broad, extending to mid-costa. Markings dark red-brown; basal patch, transverse band at basal one-fourth, and intervening areas more or less replaced by dark gray; submedian ground-color area broad, cream-white to ochreous, margined by shining silvery white, at times mostly replaced by grayish on costal half; post-median transverse band narrow, not well defined, partially broken by gray in cell; ground color following it usually well-defined, pale, margined with silvery grayish; outer transverse band expanded, whole apical and terminal area red-brown. Fringe rather dark gray. Underside gray reflecting purplish; costa white-spotted. *Hindwing:* Dorsal scaling pale to dark gray, darker distally; fringe paler. Underside pale grayish with scattered, ill-defined infuscation. *Abdomen:* Dorsal scaling gray, ventral pale gray. Genitalia (Pl. IV, fig. 9; drawn from plesiotype, Wisconsin, JAP prep. No. 1006, two preparations examined) similar to *tocullionana,* tegumen shorter; ratios—valva: tegumen = 2.15–2.24; valva:cucullus = 2.00–2.07; valva length:width = 1.91–2.13.

Female. Length of forewing about 7.0 to 9.0 mm. All characters similar to male, the scale coloring usually darker, with considerable gray infusion. Fore-

wing as narrow as in male, 2.7 times width, ground color usually darker, deep ochreous, not so strongly contrasting with the reddish. Genitalia (Pl. VI, fig. 18, drawn from plesiotype, Wisconsin, JAP prep. No. 1921, two preparations examined) VIII sternite without dense sclerotized areas, a slightly darkened region on anterior and posterior margins; sterigma short, roundish, anterior margin of ostium with only a narrow sclerotized band; ductus bursae without sclerotized area.

Geographical distribution. Eastern North America from southern Ontario to northern Wisconsin, southward to northern Virginia.

Host trees. *Pinus resinosa* and probably *P. virginiana.*

Taxonomic discussion. Adults of this eastern species are smaller than most other members of the complex. The distinctive white median area of the forewing and the deep reddish markings differentiate *E. monitorana* from *toculionana,* which is about the same size. The two sometimes are taken flying together.

E. monitorana was originally described from western Pennsylvania, where it was reared from a species of *Pinus.* It was encountered at several localities in southern Ontario by Lyons (1957*a, b*) during his studies of *P. resinosa* seed production. The only other rearing record is that of the type series, from *Pinus* species in Pennsylvania, but the reports of Barras and Norris (1963; 1965) in Wisconsin are referable to *E. monitorana* according to W. E. Miller (*in litt.*) who has studied specimens provided by Barras after publication of the Wisconsin studies. The moth's distribution suggests it may be associated with *P. resinosa* generally, but a single male in the U. S. National Museum records the species in Virginia ("Va.," no locality given), "on *P. inops*" (=*Pinus virginiana*). *P. resinosa* does not extend this far south according to Critchfield and Little (1966), and several pines may be used.

Material examined. (6♂, 9 ♀). CANADA, ONTARIO: Kindiogami Lake, 2 ♂, 2 ♀, V-9-52, reared from red pine [*Pinus resinosa*] cone (L. A. Lyons).

NEW YORK, TOMPKINS Co.: Cornell University campus, Ithaca, 1 ♀, V-19-58 (J. G. Franclemont); 6 Mile Creek, Ithaca, 1 ♂, 1 ♀, V-14-61 (J. G. Franclemont).

PENNSYLVANIA, MONTOUR Co.: Danville, 1 ♂, 1 ♀, VI-21-15, reared from *Pinus,* emgd. V-9-16 (Hopk. 13908 d) (A. B. Champlain) (holotype).

VIRGINIA:[4] "Va," 1 ♂, V-28-85, "on *P. inops*" [=*Pinus virginiana*] "Qn." [Quaintance?].

WISCONSIN, ONEIDA Co.: Lake Katherine, 2 ♂, 4 ♀, V-24 to VI-8-61 (H. M. Bower).

Several additional localities in Ontario were reported by Lyons (1957*b*) in connection with his studies on red pine.

Eucosma siskiyouana (Kearfott), n. comb.

(Fig. 7; Pl. II, figs. 4, 5; Pl. IV, figs. 11, 12; Pl. VI, fig. 20)

Evetria siskiyouana Kearfott, 1907, p. 77.

Barbara colfaxiana var. *siskiyouana:* Heinrich, 1920, p. 53, 1923, p. 28; Keen, 1952 (in part), p. 21, 1958 (in part), p. 131, *et seq.*

A western species with broad forewings which are more or less evenly checkered, dark brown and gray.

Male. Length of forewing 9.2 to 10.7 mm. *Head:* Labial palpus slightly shorter than in other members of the *bobana* group, second segment about 0.9 as long as eye diameter, II + III *in situ* about 1.1 times eye diameter; pale to

[4] *E. monitorana* is recorded at Falls Church, Virginia, by Heinrich (1920), but I have not seen specimens representing this record.

Fig. 7. Geographical distribution of *Eucosma siskiyouana* (Kearfott) in the western United States.

dark-brownish exteriorly, whitish-tan interiorly. Scale tufts of crown pale tan, brownish laterally, at times becoming blackish at posterior margin. *Thorax:* Dorsal scaling pale reddish- or rosaceous brown anteriorly, becoming whitish posteriorly, a dark spot just mesad of tegula apex on each side. Underside whitish to pale brownish, legs pale reddish-brown to dark brown, banded with reddish-brown and tan. *Forewing:* Length 2.4–2.6 times width; costal fold rather broad, to about mid-costa; termen very slightly convex. Basic pattern of *bobana* not evident; whole wing more or less evenly checkered with approximately equal-sized, grayish blotches, well defined by trans-

verse black lines, several of these mostly filled with dark brown scaling; basal patch, outer half of blotch below vein Cu in basal half; a pair of narrow blotches before end of cell, above and below vein R; a small square beyond cell before tornus on vein Cu; a small square before apex; a narrow bar at termen. The pale areas at times with considerable pinkish scaling. Fringe pale grayish with alternating darker bands. Underside dark brown, strongly reflecting purplish; costa and termen with strongly contrasting whitish marks. *Hindwing:* Dorsal scaling dark brown; fringe slightly paler. Underside basal and anal areas brownish, costal and apical areas whitish with rather well-defined brown mottling. *Abdomen:* Dorsal scaling dark brown, ventral blackish, reflecting purplish. Genitalia (Pl. IV, figs. 11, 12; drawn from plesiotypes, Siskiyou and Modoc counties, Calif., JAP preps. Nos. 247, 1266, four preparations examined) rather variable; ratios—valva:tegumen = 1.96–2.27, av. 2.13; valva:cucullus = 1.92–2.17, av. 2.07; valva length:width = 2.07–2.38, av. 2.18.

Female. Length of forewing 9.6 (reared) to 11.7 mm. All characters essentially as described for male. Forewing about as broad as in male, exclusive of costal fold area. Dorsal scaling of head, thorax and forewing usually with considerable pinkish or rosaceous scaling in pale areas (rarely in males); pattern not otherwise differing consistently from that of male. Genitalia (Pl. VI, fig. 20; drawn from plesiotype, Modoc Co., Calif., JAP prep. No. 1902, two preparations examined) similar to *E. tocullionana;* VIII sternite narrowly sclerotized around margins; sterigma short, irregularly notched posteriorly, well developed around anterior side of ostium; ductus bursae without sclerotized area.

Geographical distribution. Widespread but poorly known in boreal western United States; southern Oregon through the mountains of California; and single records for northern Arizona and central Colorado (fig. 7).

Host trees. *Abies concolor* and possibly other *Abies.* Keen (1958) lists *A. grandis* and *A. magnifica* for *siskiyouana,* but his treatment does not distinguish *siskiyouana* from *Barbara colfaxiana* (*e.g.,* Keen, 1958, fig. 39, p. 132).

Taxonomic discussion. This species, which was described from a single male specimen, does not closely resemble either any member of the *bobana* complex or *Barbara colfaxiana* (Kearfott), with which *E. siskiyouana* has been confused for the past 40 years. I have seen only two reared specimens, each from cones of *Abies concolor,* and each was obtained along with a series of *B. colfaxiana* from the same cones. Evidently these two specimens, both females, led Heinrich (1920, 1923) to the erroneous assumption that the brown form described as *siskiyouana* was a variety of *B. colfaxiana.* Although several large series of the latter species reared from *Abies* show the fir-feeding form to resemble adults of *colfaxiana* reared from other hosts, the *Abies* associate has been called *Barbara colfaxiana* var. *siskiyouana,* following Heinrich's (1920) suggestion. Probably Heinrich had no male of *siskiyouana* available during his study, since the obvious generic difference would have been immediately apparent.

The type, a male, at the American Museum of Natural History, New York, is in good condition, and it compared quite well (including the genitalia slide prepared by N. S. Obraztsov) in 1962 with a male from Siskiyou County. The species varies little, and specimens from various parts of the western United States are easily recognizable.

Thus the name *siskiyouana* should not be used in the genus *Barbara,* and if the *Abies*-feeding form of *B. colfaxiana* proves sufficiently distinct to warrant nomenclatural designation, another name should be proposed.

Material examined. (21 ♂, 13 ♀). ARIZONA, GILA Co.: Tonto Cr. Camp nr. Kohl's Ranch, 1 ♂, VI-30-56 (Martin, Comstock, Rees); Tonto Cr. Fish Hatchery, Mogollon Rim, 6,400 ft., 1 ♂, VI-21-57 (Martin, Ford, Rees).

CALIFORNIA, SISKIYOU Co.: mile 9.5 Everett Hiway, Mt. Shasta, 1 ♂, VII-24-65, at light (E. and I. Munroe); MacBride Spr., Mt. Shasta, 4,800 ft., 1 ♀, VII-24-65, at light (E. and I. Munroe), 1 ♀, VII-21-66, at light (J. Powell); Mt. Shasta City, 1 ♂, VI-22-58, at light (J. Powell); "Siskiyou Co.," 1 ♂ (no further data) (holotype). MODOC Co.: 6 mi. N W Cedarville, 12 ♂, 3 ♀, VII-4-62 (J. S. Buckett). GLENN Co.: Plaskett Mdws., 1 ♂, "3-07-48" (Lanham); 6 ♀, VII-31-65 (J. T. Doyen). PLUMAS Co.: Johnsville, 2 ♂, VII-16-62, 1 ♂, VII-28-65 (J. S. Buckett). PLACER Co.: McKinny Cr., 2,500 ft., 1 ♀, IX-3-14, reared from *Abies concolor,* emgd. IV-12-15 (Hopk. 12564 a) (J. E. Patterson). EL DORADO Co.: Blodgett Forest, 4,200 ft., 13 mi. E Georgetown, 4 ♂, VII-4 to VII-14-67, blacklight trap (J. Powell). TUOLUMNE Co.: Niagara Cr. Campgr., 3 ♀, VIII-11-63 (H. B. Leech); 4 mi. W Pinecrest, 3 ♀, VII-8 to VII-12-61 (J. G. Rozen). LOS ANGELES Co.: "Camp Baldy, San Berna. Mts." [nr Mt. Baldy, San Gabriel Mts.], 1 ♀, "July 16-23" (no further data).

COLORADO, EL PASO Co.: Rock Cr. Cañon, 1 ♀, VII-4-61, 1 ♀, VII-4-63 (M. May).

OREGON, JACKSON Co.: Colestin, 1 ♀, VII-18-14, reared from *Abies concolor,* emgd. VI-18-15 (Hopk. 12538 a) (P. D. Sergent); 3 mi. S Ashland, 3,500 ft., 1 ♀, VII-22-66, at light (J. Powell).

Eucosma crymalana Powell, n. sp.

(Pl. II, fig. 6; Pl. IV, fig. 13)

An early-flying species in northern Arizona, which has brick-red forewings with reduced, partially obscured, ochreous-tan markings.

Male. Length of forewing 11.4 to 12.7 mm. *Head:* Labial palpus scaling bright brick-red exteriorly, pale interiorly. Tufts of crown pale yellowish, pale reddish adjoining eyes and at sides of occipital margin. *Thorax:* Dorsal scaling pale red-brown anteriorly, becoming upraised, yellowish-white at tegulae apices and posteriorly on pronotum except for a transverse band of elongate, reddish scales before scutellum. Underside shining white; legs mottled with deep brick-red exteriorly. *Forewing:* Length about 3.0 times width; costal fold narrow, costal outline straight to end of cell. Ground color dark brick-red, suffused with shining rosaceous in outer one-third. Markings ochreous-tan, mostly suffused with rosaceous to pale ochreous, margined with whitish; an ill-defined patch near base, following a basal patch of ground color; a well-defined, transverse band from costa before middle to dorsum beyond middle, broadened in cell, narrowed below it, recurved or becoming obscure before dosal margin; a second, parallel transverse band from costa at end of cell toward tornus, usually ill-defined and becoming obscure before tornus, at times well-defined and pale in terminal area beyond cell, ending abruptly just above tornus; an ill-defined, rosaceous band in cell connecting the two transverse bands, margined below by a whitish line; terminal margin with a series of ill-defined, pale dots, extended onto fringe, at times through fringe. Underside gray, reflecting purplish; margins and submarginal area of outer one-third pale, well marked or tinged with brick-red. *Hindwing:* Dorsal scaling uniform dark gray; fringe at times whitish with a basal row of reddish scales around apex. Underside whitish; tinged with reddish in apical area. *Abdomen:* Dorsal scaling dark gray; ventral and genital paler. Genitalia differing markedly in valva shape from other members of the complex (Pl. IV, fig. 13; drawn from paratype, Prescott, JAP prep. No. 1184, two preparations examined); ratios—valva:

tegumen = 2.04–2.30; valva:cucullus = 2.36–2.55; valva width:length = 1.88–2.00.

Female. Unknown.

Holotype male. ARIZONA, COCONINO Co.: Grand Canyon, South Rim P. O., 7,000 ft., May 30, 1965, porch light (J. Powell); deposited in California Academy of Sciences. Four paratypes from Arizona, listed below under material examined.

Geographical distribution. Mountains of north central Arizona.

Host trees. Unknown.

Taxonomic discussion. This species is easily distinguishable from all the foregoing on the basis of superficial appearance and genitalia form. In valva shape, *crymalana* tends toward *momana* and members of the succeeding complex in Heinrich's (1923) arrangement, but the overall appearance indicates that *crymalana* is a member of the *bobana* group and suggests that it will be found associated with a conifer when details of the biology are known.

Although two of the types were already dead when found in late May, two others, in worn condition, were taken alive at the same time. This and the Prescott (5,280 ft. elevation) record suggest that the peak flight period ranges from about mid-April to mid-May, probably while snow is still on the ground at those elevations.

Material examined. ARIZONA, COCONINO Co.: Grand Canyon, South Rim P. O., 7,000 ft., 4 ♂, V-30-65, at light (J. Powell). YAVAPAI Co.: Prescott, 1 ♂, IV-22-36 (Crosby and Bishop). Deposited in collections of California Academy of Sciences, San Francisco; California Insect Survey, University of California, Berkeley; and Cornell University, Ithaca, New York.

NEARCTIC CONIFER CONE-FEEDING MEMBERS OF *Eucosma*, WITH HOST ASSOCIATIONS*

E. bobana Kearfott, 1907	*Pinus monophylla, P. edulis,* (*P. flexilis* or *P. aristata*)
E. ponderosa Powell, n. sp.	*P. ponderosa, P. jeffreyi,* [*P. attenuata, P. monticola*]
E. rescissiorana Heinrich, 1920	*P. contorta, P. monticola,* [*P. albicaulis*]
E. franclemonti Powell, n. sp	Unknown
E. monoensis Powell, n. sp.	(*P. aristata* or *P. flexilis,* and *P. monophylla*)
E. cocana Kearfott, 1907	*P. taeda,* (*P. rigida*)
E. tocullionana Heinrich, 1920	*Picea, Tsuga canadensis, Abies balsamea, Pinus strobus*
E. monitorana Heinrich, 1920	*P. resinosa, P. virginiana*
E. siskiyouana Kearfott, 1907	*Abies concolor*
E. crymalana Powell, n. sp.	Unknown

* Probable hosts, based on collections of adults, are given in parentheses; records for specimens questionably conspecific shown in square brackets.

ACKNOWLEDGMENTS

Many of the critical data contributing to the present study were drawn from larval collections made by several persons either now or formerly associated with the Department of Entomology, University of California, Berkeley: J. H. Borden, C. W. O'Brien, H. Ruckes, Jr., and R. W. Stark. Thanks are also due numerous persons, mentioned under material examined, who made collections of the moths in my interest in California during the past several years. This material is deposited in the California Insect Survey Collection, University of California, Berkeley.

Cooperation by the following enabled use of private and institutional collections in their care: A. B. Klots, American Museum of Natural History, New York; C. D. MacNeill, California Academy of Sciences, San Francisco; H. H. Keifer, California State Department of Agriculture, Sacramento; T. N. Freeman, Canadian National Collection, Ottawa; J. G. Franclemont, Cornell University, Ithaca; C. P. Kimball, Barnstable, Massachusetts; L. M. Martin, Los Angeles County Museum; P. J. Darlington, Museum of Comparative Zoology, Harvard; J. S. Buckett, University of California, Davis; J. F. G. Clarke, U. S. National Museum, Washington, D.C.; and T. W. Koerber, U. S. Forest Service, Southwest Forest and Range Experiment Station, Berkeley.

H. V. Daly and R. W. Stark, University of California, Berkeley, and W. E. Miller, North Central Forest Experiment Station, St. Paul, Minnesota, provided assistance with development of the manuscript.

Completion of the project was in part enabled through support by National Science Foundation Grant GB-4014.

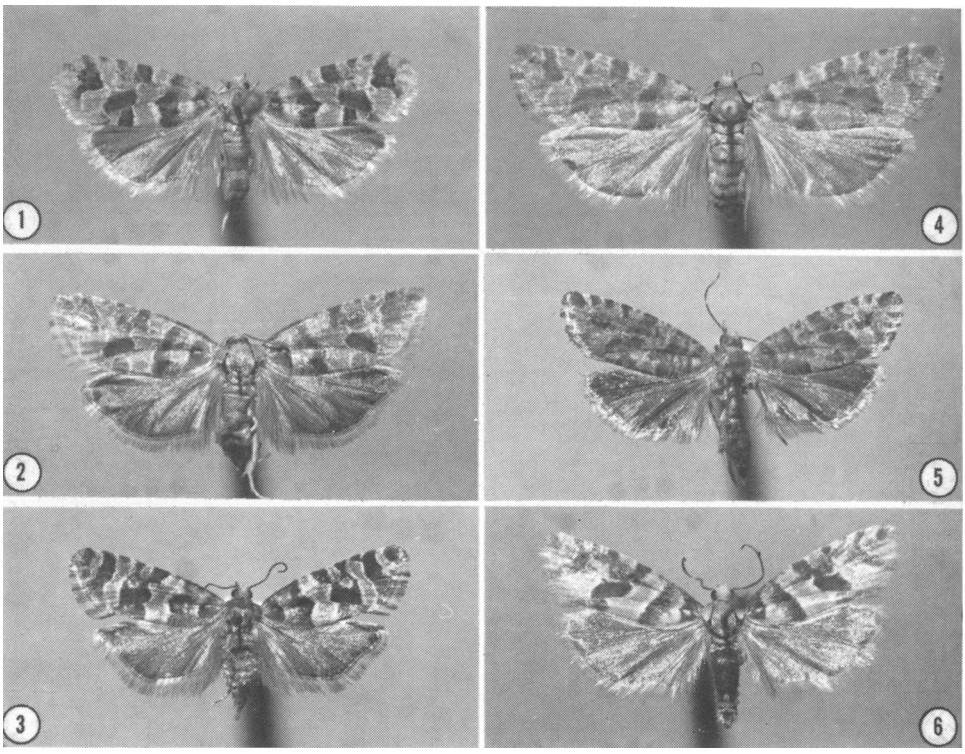


Plate I. **Fig. 1.** *Eucosma bobana* Kearfott, ♀, Walker Pass, Kern Co., Calif., July 17, 1956, reared from *Pinus monophylla* (H. Ruckes, Jr.) **Fig. 2.** *E. ponderosa* Powell, ♀, Deadman Recreation Area, Mono Co., Calif., September, 1958, reared from *Pinus jeffreyi* (H. Ruckes, Jr.). **Fig. 3.** *E. rescissiorana* Heinrich, ♀, 2 mi. N Truckee, Nevada Co., Calif., July, 1963, reared from *Pinus contorta* (R. W. Stark and J. H. Borden). **Fig. 4.** *E. monoensis* Powell, ♀, allotype, Crooked Creek, White Mts., Mono Co., Calif., June 18, 1961. (J. Powell). **Fig. 5.** *E. cocana* Kearfott, ♀, Quincy, Gadsen Co., Fla., April 25, 1962 (W. B. Tappan). **Fig. 6.** *E. franclemonti* Powell, ♂, holotype, Hochderffer Hill, Coconino Co., Ariz., July 16, 1961 (J. G. Franclemont).

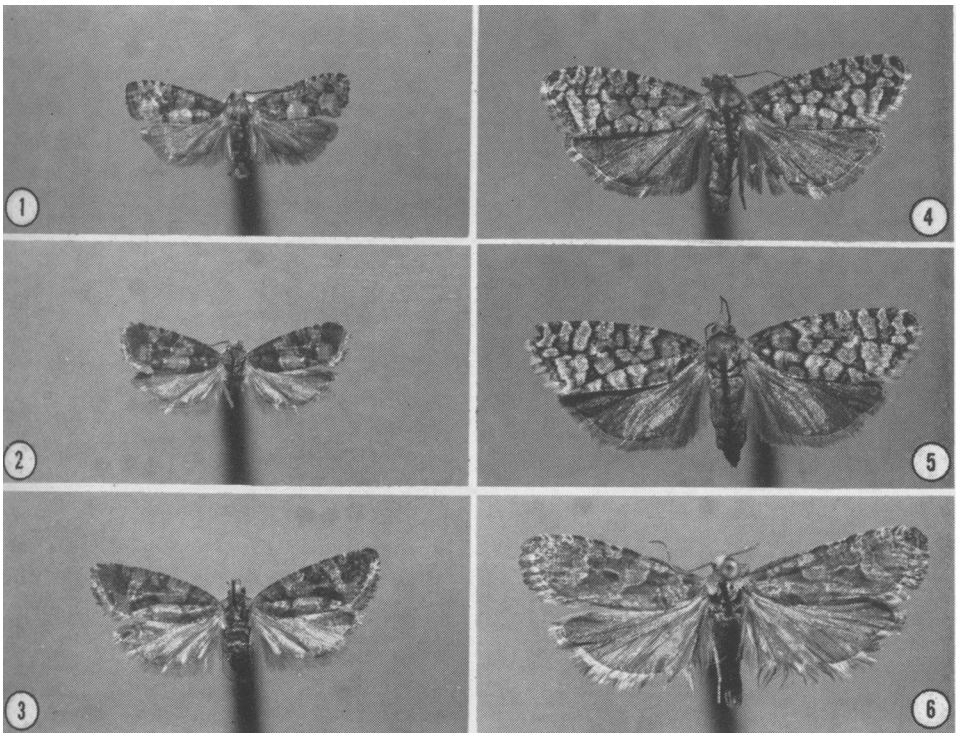


Plate II. **Fig. 1.** *Eucosma tocullionana* Heinrich, ♂, 4 mi. W Middletown, Middlesex Co., Conn., May 22, 1965 (J. M. Burns). **Fig. 2.** *E. monitorana* Heinrich, ♂, Lake Katherine, Oneida Co., Wis., May 31, 1961 (H. M. Bower). **Fig. 3.** *E. monitorana* Heinrich, ♀, same data, June 3, 1961. **Fig. 4.** *E. siskiyouana* (Kearfott), ♂, 6 mi. N W Cedarville, Modoc Co., Calif., July 3, 1962 (J. S. Buckett). **Fig. 5.** *E. siskiyouana* (Kft.), ♀, same data. **Fig. 6.** *E. crymalana* Powell, ♂, holotype, Grand Canyon, Ariz., May 30, 1965 (J. Powell).

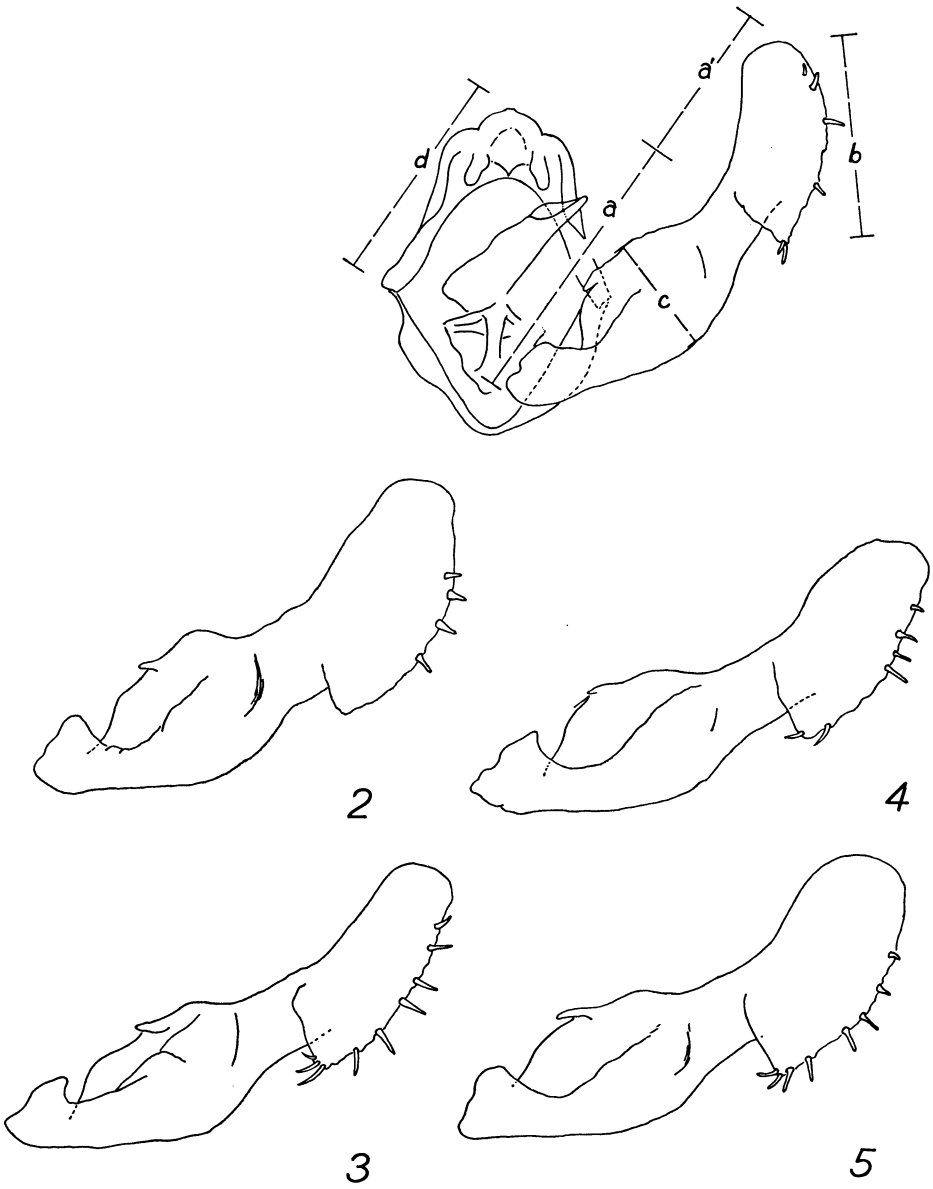


Plate III. **Fig. 1.** *Eucosma bobana* Kearfott, Coconino Co., Ariz., male genitalia, ventral aspect; letters *a* to *d* indicate distances measured in deriving ratios given in Table 2 and figures 3 and 4. *a* = valva, including cucullus; *a'* = cucullus; *b* = greatest length of cucullus; *c* = greatest width of valva; *d* = tegumen length including uncus. *Eucosma* species, valvae, inner aspect: **Fig. 2.** *E. bobana,* Texas. **Fig. 3.** *E. bobana,* Ivanpah Mts., Calif. **Fig. 4.** *E. ponderosa* Powell, Silver Lk., Ore. **Fig. 5.** *E. ponderosa,* Pine Valley, Calif.

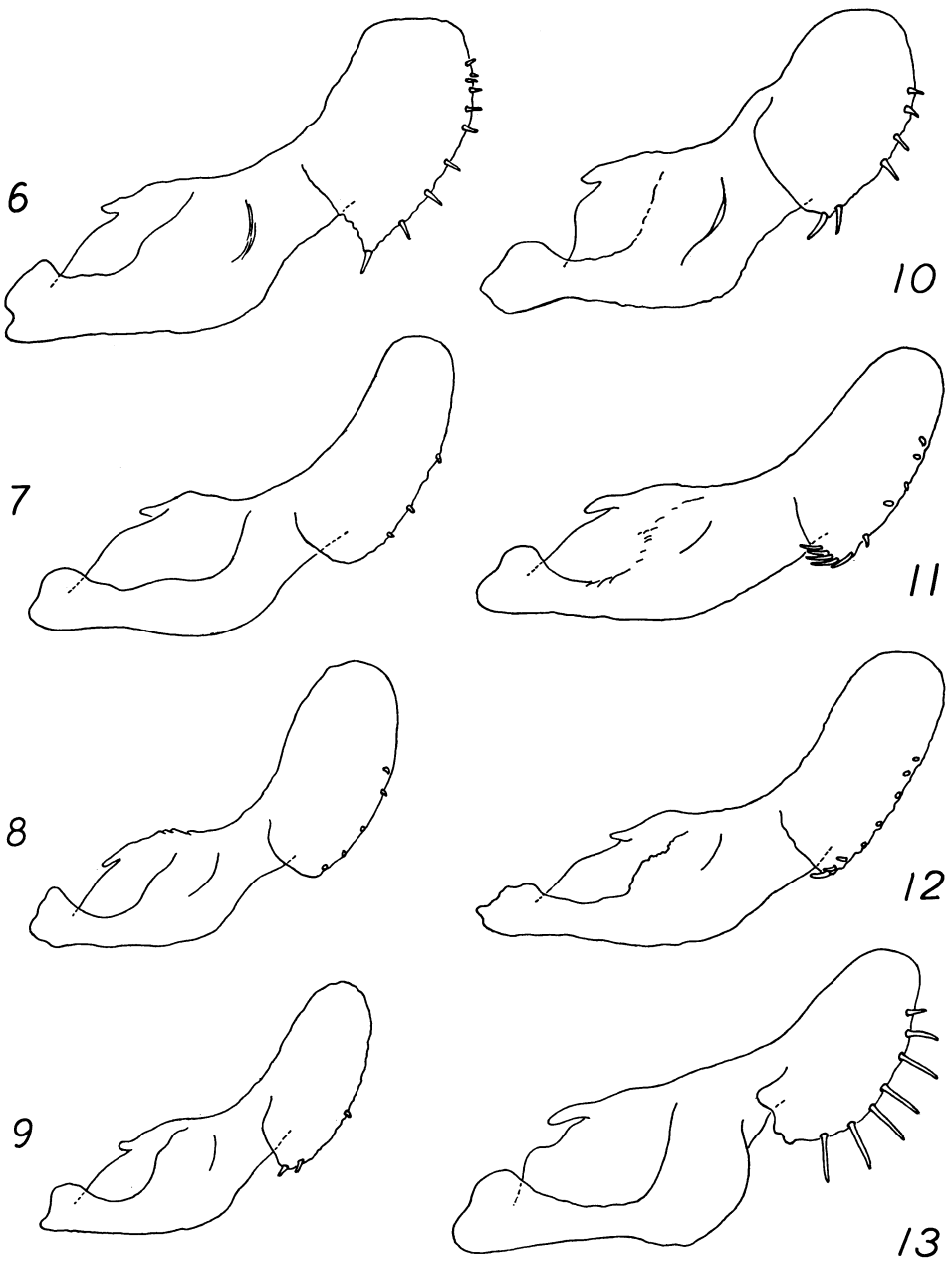
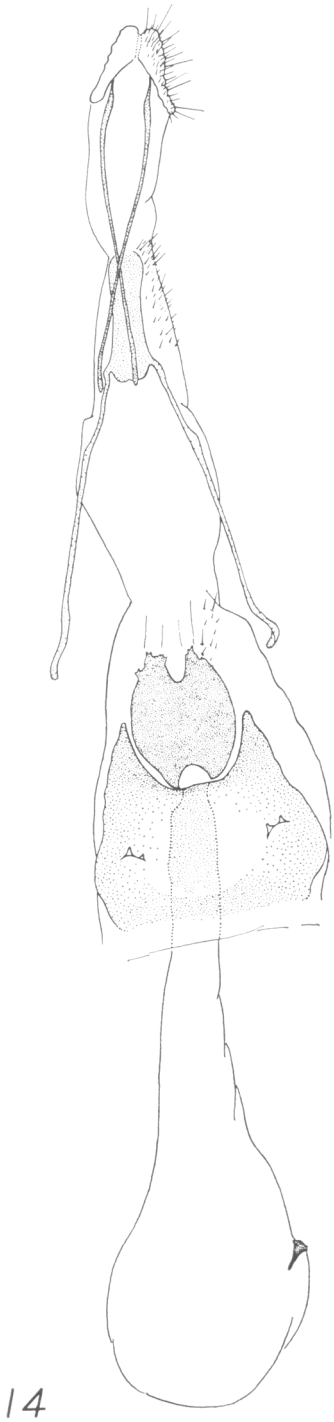
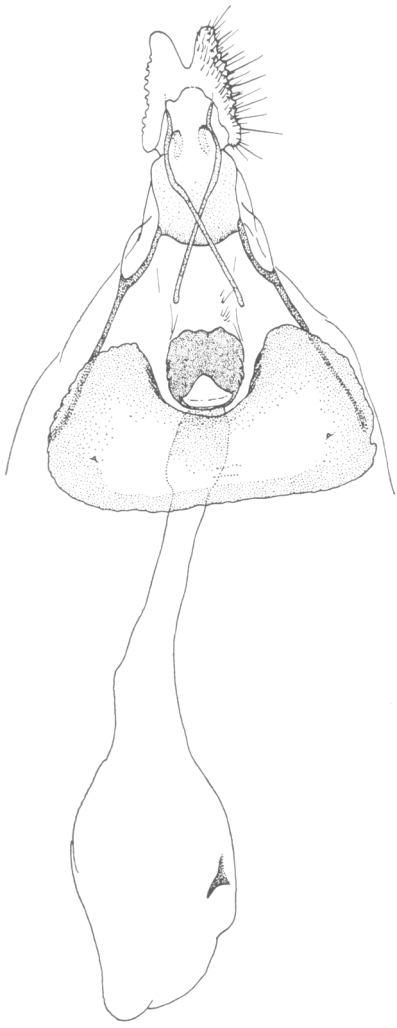


Plate IV. *Eucosma* species, male valvae, inner aspect. **Fig. 6.** *E. franclemonti* Powell. **Fig. 7.** *E. cocana* Kearfott. **Fig. 8.** *E. tocullionana* Heinrich. **Fig. 9.** *E. monitorana* Heinrich. **Fig. 10.** *E. monoensis* Powell. **Fig. 11.** *E. siskiyouana* (Kearfott), Siskiyou Co., Calif. **Fig. 12.** *E. siskiyouana,* Modoc Co., Calif. **Fig. 13.** *E. crymalana* Powell.





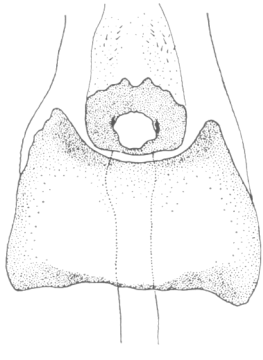


Plate V. *Eucosma* species, female genitalia, ventral aspect. **Fig. 14.** *E. bobana* Kearfott. **Fig. 15.** *E. monoensis* Powell. **Fig. 16.** *E. cocana* Kearfott, sterigmal plate and VIII abdominal sternite.

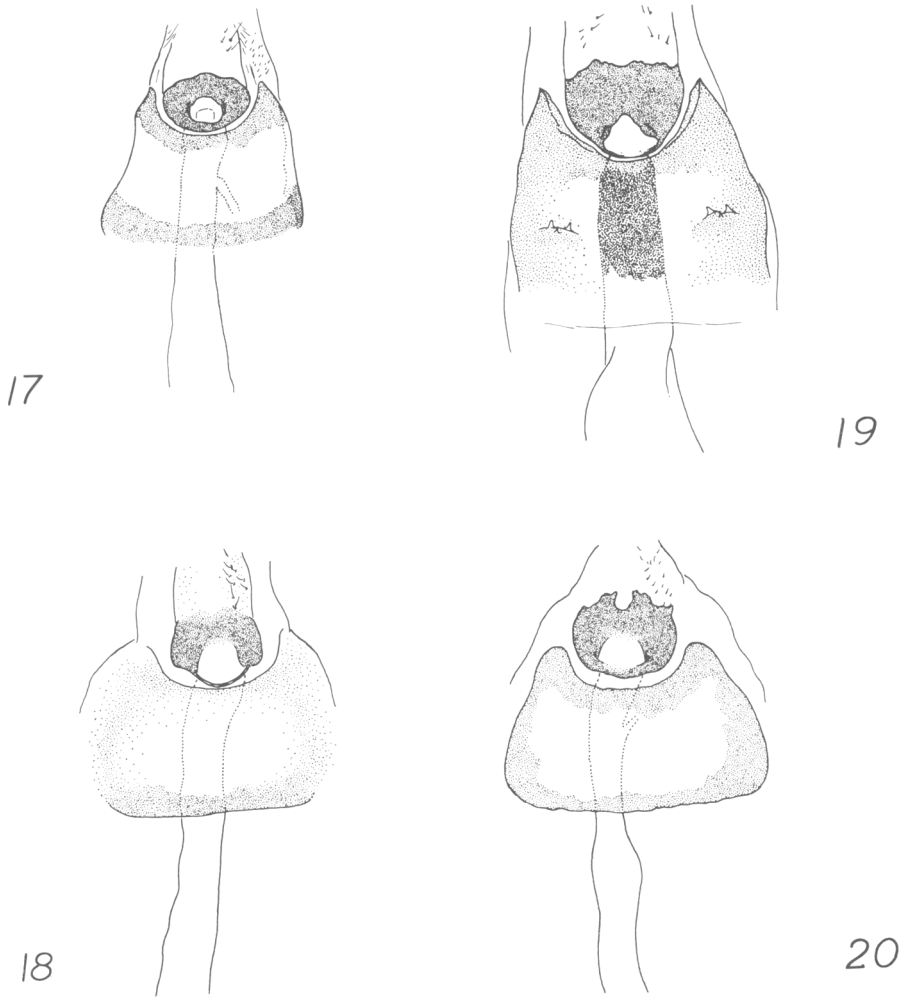


Plate VI. *Eucosma* species, female genital structures associated with VIII abdominal segment. **Fig. 17.** *E. tocullionana* Heinrich. **Fig. 18.** *E. monitorana* Heinrich. **Fig. 19.** *E. franclemonti* Powell. **Fig. 20.** *E. siskiyouana* (Kearfott).

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