

Review of Ochsenheimeriidae
and the Introduction of the
Cereal Stem Moth
Ochsenheimeria vacculella
into the United States
(Lepidoptera: Tineoidea)

DONALD R. DAVIS

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ABSTRACT

Davis, Donald R. A Review of Ochseneimeriidae and the Introduction of the Cereal Stem Moth *Ochseneimeria vacculella* into the United States (Lepidoptera: Tineoidea). *Smithsonian Contributions to Zoology*, number 192, 20 pages, 31 figures, 2 maps, 1975.—The biology, zoogeography, and systematics of the tineoid family Ochseneimeriidae is reviewed for the world. A synoptic list of 23 specific names currently applicable to this family is provided, which includes a summary of the distribution and plant hosts of each. The species "*Ochseneimeria*" *horridula* Zeller was examined and consequently transferred to the genus *Xylesthia*, of the family Tineidae (new combination). A complete description, accompanied by diagnostic illustrations and photographs, of *Ochseneimeria vacculella* F. R. is provided along with the first report of its introduction into North America.

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Introduction

Over the past few years it has become increasingly evident that a new and potentially serious pest of cereal grasses has been accidentally introduced and established within the continental United States. The species has been identified as the cereal stem moth, *Ochsenheimeria vacculella* F. R., an important pest of certain economic grasses through much of Eurasia. It belongs to the small and little known family Ochsenheimeriidae, which, until recently, was restricted to the Palearctic region. Because of possible economic implications as well as to the relative obscurity of the family to American entomologists, a review of the family is here provided, including a listing of all known species with their hosts and general distribution.

Because of the economic importance of certain members of this family and the great morphological similarity among most of the species, a critical revision of the group is greatly needed. Such a study should, of course, involve a careful examination of all type material and the selection of lectotypes and

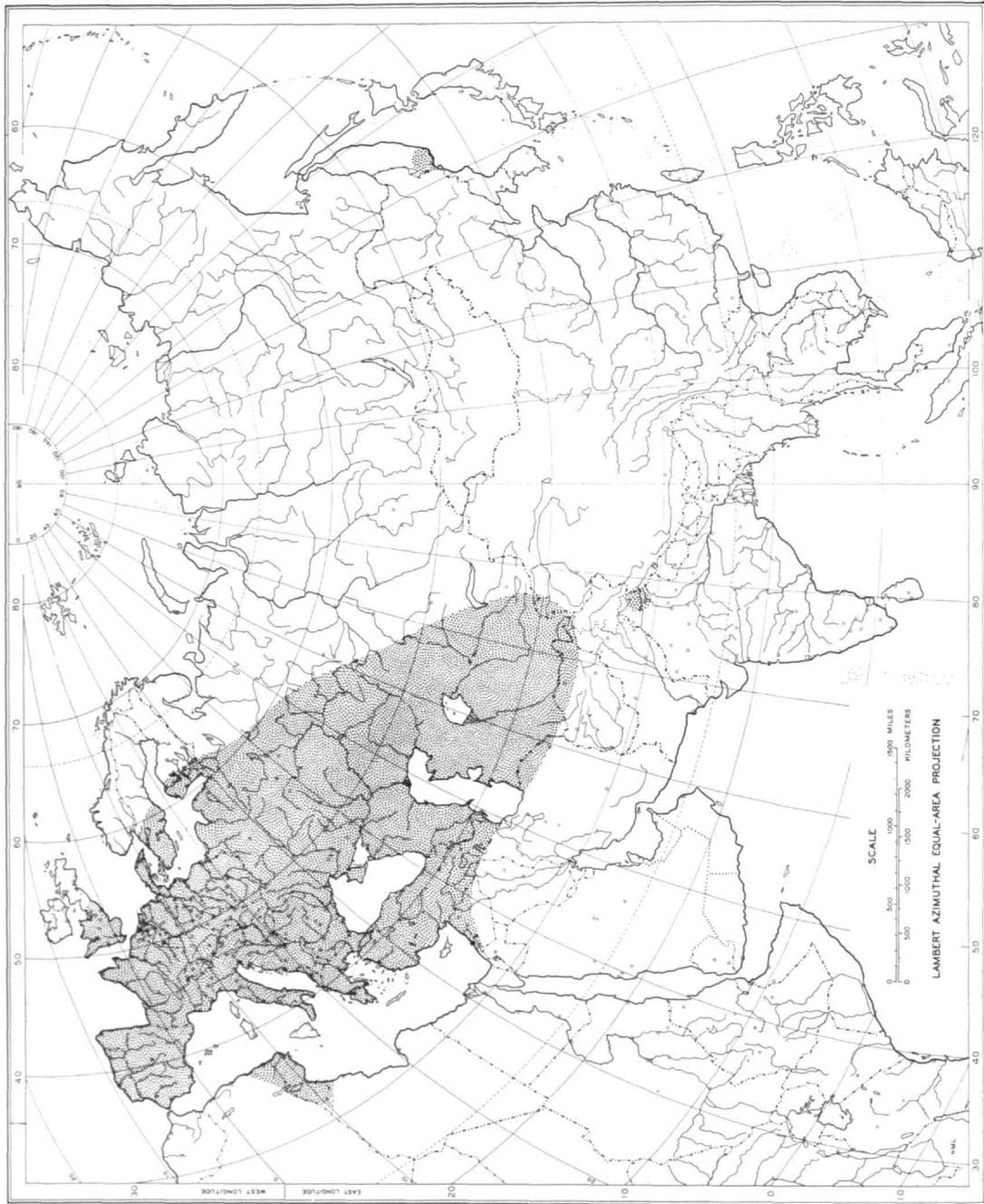
neotypes whenever necessary in order to achieve taxonomic stability. I have refrained from expanding the present review into a more thorough revision of the family, because such a study is believed already underway by Dr. A. K. Zagulajev of the Zoological Institute of the Academy of Sciences in Leningrad. I am indebted to Dr. Zagulajev for his helpful assistance with several inquiries of mine, as well as to Dr. John Bradley of the Commonwealth Institute of Entomology at the British Museum (Natural History). Dr. Bradley also assisted me by arranging loans of critical specimens.

I also wish to express my gratitude to Mr. George Venable, staff artist for the Department of Entomology, Smithsonian Institution, for the excellent line drawings; to Mr. Victor Kranz of the Smithsonian Photographic Laboratory and Miss Mary Mann of the Smithsonian Scanning Electron Microscope Laboratory for their helpful assistance with the photographs.

Biology

DISTRIBUTION (Maps 1-2).—Until the discovery of *Ochsenheimeria vacculella* from Geauga County, Ohio, in 1964, no member of this family was known

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MAP 1.—Palearctic distribution of the family Ochsenheimeriidae.

to occur beyond the Palearctic region. A species originally described as *Ochsenheimeria* from Colombia ("*O.*" *horridula*) and another one questionably from Australia ("*O.*" *squamicornis*) have been erroneously placed in this family.

In the Old World, the various members of this family are found only between 30°N and 60°N latitude; they occur in Great Britain, across central Europe to central Russia and northwestern India. Species have also been found in parts of North Africa (Algeria and Tunisia), Lebanon, and one recently has been described from the Province of Primorsk in eastern Russia. The actual distribution of the family is probably even more extensive than indicated, and future collecting, particularly in Asia, may show this. Through accidental introduction, it is possible that certain species also may become established eventually in such remote areas as the grasslands of South Africa and the pampas of South America.

In addition to obvious oceanic barriers, the present distribution of the group seems to have been effectively limited in Africa by the Sahara Desert and in southern Asia largely by the Himalayas; however, some species (e.g., *O. kisilkuma*) do prefer very arid situations, and *O. hugginsi* has been collected in the Himalayas at altitudes above 15,000 feet.

Hosts.—Only three families of monocots are known to be utilized as hosts by larvae of Ochsenheimeriidae. Of these, the Cyperaceae and Juncaceae are of relatively minor importance with only *Ochsenheimeria bubalella* and *O. lovyi* attacking them. The Poaceae are of greater importance with a wide variety of grasses represented as hosts—the genera *Bromus*, *Secale*, and *Triticum* are especially favored. It should be pointed out, however, that the food plants are unknown for approximately half of the species of *Ochsenheimeria*.

As the specific epithet suggests, *O. hederarum* was originally associated with ivy (*Hedera* sp.), but this probably does not represent its true host. Similarly, Zagulajev (1966) reports that adults of *O. kisilkuma* were commonly observed around *Haloxylon* (Chenopodiaceae).

LIFE HISTORY.—Toward the end of summer the eggs are deposited on overwintering grasses, but they may be deposited in a variety of places such as refuse piles, haystacks, and granaries. In some species eclosion occurs in approximately a week with

the larva quickly seeking a hibernation chamber by boring into a grass stem. Other species overwinter as eggs containing formed larvae. After emerging in the spring, the first instar larvae often engage in "ballooning," if necessary, to reach a suitable host. Long strands of silk are secreted, which are picked up by the wind, thereby transporting the larvae to possible feeding sites.

Upon reaching a young plant, the larvae usually begin mining the leaves; after a week or so, they bore into the stem and proceed up the plant. From this stage on, the larvae are capable of passing from one stem to another. In this manner, a relatively small population of larvae is capable of producing more damage than would normally be expected. Furthermore, the larvae of some species frequently gnaw immediately below or directly into the developing fruits causing these to dry up and become whitened. These damaged, whitened fruits (or "ears") are then easily recognized among the green healthy plants. This injury in wheat and other cereal grasses has been referred to as "white ear."

Usually around the end of June and the early part of July the larvae pupate in an elliptical cocoon of whitish silk situated between the leaves or in the sheath; the adult emerges in approximately one to two weeks. Although most species are univoltine, Zagulajev (1971) reports two generations for some.

The adults of all known species are strictly diurnal. This behavior is suggested further by the relative reduction of the compound eyes and perhaps by the retention of ocelli. Stainton (1873) notes a very specific midday activity for *O. birdella*, with the moths ceasing to fly by 4:00 P.M. *Ochsenheimeria vacculella* likewise is reported to be most active between 11:00 A.M. and 2:00 P.M. Several authors have reported the presence of adults in houses during late summer. This habit has been particularly noted by Stainton (1873) for *O. vacculella*, although Pavlov (1961) mentions no instance of adult overwintering for this (or any) species.

Systematic Review

The family Ochsenheimeriidae is "monobasic," containing only the genus *Ochsenheimeria*. Two other genera, *Lepidocera* Curtis (1831) and *Phygas* Treitschke (1833), were subsequently described,

but both were soon relegated to synonymy (Stainton, 1854).

The genus *Ochsenheimeria* was proposed by Huebner in 1825 for two previously described insects, *Tinea bubalella* Huebner and *Tinea taurella* Schiffmueller. The uniqueness of the genus was early recognized by Heinemann (1870), who erected the family Ochsenheimeriidae; however, several later authors (e.g., Meyrick, 1928, and Kloet and Hincks, 1945) persisted in following the much earlier practice of grouping the genus with the Tineidae, a family with which it actually shares little in common. There is now little doubt that the members of *Ochsenheimeria* deserve a separate family status. Actually, the group is so unusual in its morphology, due to the extinction of annectant forms, that it is now difficult to determine its relative position within the Lepidoptera. Probably influenced in part by their larval biology, Réal (1966) believed they were related to the Elachistidae and, perhaps on the basis of certain structural similarities in the male genitalia, to the "Hyponomeutidae" [sic]. Such a placement is somewhat puzzling, since the latter two families are themselves only distantly related.

Zagulajev (1973) considered the Ochsenheimeriidae to be closely related to the Deuterotineidae, particularly with regard to their ecological requirements, and placed the two groups within the Tineoidea. He further regarded both families as predominantly prairie- or steppe-dwelling derivatives of the largely forest-dwelling Tineidae and Euplocamidae.

On the basis of most morphological features, particularly wing venation, the Ochsenheimeriidae are most akin to the Tineoidea. In the forewing, vein R5 terminates at the apex, above the termen, as it does in most tineoid families. In contrast, this vein normally extends to the termen, well below the apex, in all Yponomeutoidea and Gelechioidea. The base of the medial vein, although frequently absent in the forewings of *Ochsenheimeria*, is preserved in the hindwings. This further suggests a tineoid relationship, as this vein is often present in that superfamily but typically absent in the Yponomeutoidea and Gelechioidea. Similarly, the elongate, rodlike saccus in the male genitalia and the long, extensible ovipositor of the female are very characteristic of many tineoid genera.

The members of Ochsenheimeriidae demon-

strate their relative uniqueness in several ways. The head is rather distinct in possessing relatively small compound eyes and a very broad frons (Figure 7). Although the eyes appear smooth (i.e., without setae) under the stereoscopic microscope, an examination at higher magnifications with a scanning electron microscope reveals a dozen or so minute setae (Figure 9). These arise from well-defined sockets widely distributed over the central area of the eye. All species possess a pair of prominent ocelli, which, although present in a few primitive psychid genera, are lacking in the Tineidae and in nearly all other tineoid families. The head vestiture (Figure 8) of *Ochsenheimeria* is perhaps as roughly scaled as in any other group of moths; this condition again suggests a tineoid relationship. The frons, although frequently obscured by the confusion of hairlike scales from above, is contrastingly covered by unusually broad, rounded scales (Figure 7). The ultrastructure of these scales (Figure 10) is quite similar to that of the wings in possessing a basically contiguous, parallel series of minute, transverse striae, ranging from 2.0 to 2.5 μm in length, between the slightly raised longitudinal ribs. The transverse striae are sparsely interrupted at sporadic intervals by minute lacunae whose diameters are less than 0.1–0.2 the distance between the longitudinal ribs. This basic type of scale structure occurs in several families of Lepidoptera but is most characteristic of the Incurvarioidea, Tineoidea, and certain Yponomeutoidea.¹ The antennae are characteristically covered for most of their length with rough scaling, thereby imparting a rather shaggy, or much stouter appearance to the flagellum. This feature, along with a behavioral tendency to hold the antennae out from the head in a peculiar, sinuate attitude resembling horns, has prompted authors to christen several species with bovine names (e.g., *O. bisontella* Zeller, *O. bubalella* Huebner, and *O. taurella* Schiffmueller). The venation is unusual in that vein CuA2 is typically absent in both fore- and hindwings.

Several specialized modifications characterize the male genitalia and associated abdominal sclerites. Prominent among these are the deeply bilobed, setose uncus and the darkly sclerotized anal tube. The shape of the tube is sometimes

¹ This subject will be discussed further by the author in a forthcoming review on the scale structure in Lepidoptera.

helpful in specific determinations. The heavily setose lobes of the uncus may actually be homologous to the socii. The tegumen is also unusual in being divided anteriorly for nearly half its length into a pair of rounded lobes. The vinculum is reduced to a narrow, ventral ring but is extended cephalically to form an elongate, rodlike saccus. The valvae of most species are quite similar, with the notable exception of the chaetotaxy on the basal, saccular lobe, which may be diagnostic for some species; however, this character can vary (as in *O. vacculella*) and must be used with discretion. *Ochsenheimeria hugginsi*, from the Himalayas of India, is interesting in possessing the most divergent valvae of any of the known species.

As suggested above, the male genitalia of *Ochsenheimeria* resemble to some extent those of certain Yponomeutidae. Their resemblance to two cave-dwelling species of Oinophilidae (*Wegneria cavernicola* Diakonoff and *Opogona villiersi* Viette) is even more remarkable. In nearly all other features, however, both the Yponomeutidae and Oinophilidae appear only remotely related to the Ochsenheimeriidae.

Another characteristic in the males of this family is the presence of a pair of lateral hair pencils situated on the eighth abdominal segment. These arise from large internal pockets that can be forcibly expanded along each side of the genitalia.

The morphology of the female genitalia is even more conservative than the male and offers little in the way of diagnostic characters for specific determination. The eighth, ninth, and tenth segments are greatly lengthened and are capable of a type of telescopic extension characteristic of most genera of Tineidae. This mechanism enables the female to probe and deposit her eggs in various crevices of grass sheaths, refuse piles, and buildings.

The immature stages of this family have virtually been unstudied. The most detailed account on the larval morphology of *Ochsenheimeria* was by Dumont (1930) for *O. lovyi*. The sole illustration included with that description, however, is poorly executed, inaccurate, and consequently useless. The family Ochsenheimeriidae is included in the extensive larval study by Gerasimov (1952), and his key does seem to suffice for identification.

The larva of only one species of *Ochsenheimeria* was available for this study, and the specific identity of that specimen remains unknown; how-

ever, as a much needed contribution to the larval systematics of this family, a description of that species has been summarized in the discussion of the family.

As characterized by the sole species examined, as well as by Gerasimov's key characters, the larvae of *Ochsenheimeria* appear to be almost as unusual in their morphology as the adults. One of the most diagnostic features of the larva is the reduced number of crochets arranged in a single longitudinal series. Although the specimen I examined possessed 2-4 crochets on the first four abdominal prolegs, this number may vary from zero (Gerasimov, 1952) to as high as 14 (Dumont, 1930). The larvae may further be recognized by their long, slender form and almost complete absence of pigmentation, except for the conspicuous dark, oblong spots surrounding the spiracles.

The only description of the pupal stage for a member of this family was also by Dumont (1930) for *O. lovyi*. Dumont illustrates the cephalic end as being rather conical, with a small, subacute frontal spine (cocoon-cutter). The caudal end as figured by Dumont appears most peculiar in possessing a series of short, stout, black-tipped spines arranged as follows: 4 ventral, 2 lateral, and 4 dorsal. Presumably, two of the ventral spines represent the cremaster, although this is not clear.

A search of the literature has revealed that 23 names have been properly referred to this family. Even though several of these names are regarded as synonyms in the current literature, a synoptic list of all available names is presented later in this paper, pending a critical reexamination of the type material. As early pointed out by Stainton (1873), *Ochsenheimeria birdella*, *O. mediopectinella*, and *O. urella* are probably conspecific; however, if such is true, then the oldest name, *O. mediopectinella*, and not *O. birdella*, as treated by Stainton and others, should be the correct name for the taxon. Similarly, *O. baurella*, which was described by Zagulajev from England as recently as 1966 on the basis of a unique male, may also be a synonym of *O. mediopectinella*. The same author has recently described *O. danilevskii* from central Russia; however, Zagulajev's diagnoses for this insect appears to fall within the normal variation of *O. vacculella* as discussed later. Three names proposed in 1848 by Tengstrom from Finland (*O. hirculella*, *O. porphyrella*, and *O. scabrosella*) were treated by

Wocke (1871) as varieties of *O. bisontella*. All three were later listed as synonyms by Rebel (1901) and are currently treated this way by European workers.

Two species, previously listed in the literature under *Ochsenheimeria*, were examined by the author and found to pertain to other families. I early suspected the systematic placement of these particular species, since both were described from areas remote from the normal Palearctic distribution of the group. "*Ochsenheimeria* (?)" *horridula* was described by Zeller in 1877 on the basis of a single male collected in Barranquilla, Colombia. An examination of the holotype revealed that the species is a distinct member of the tineid genus *Xylesthia* (new combination). "*Ochsenheimeria*?" *squamicornis* was also based on a single specimen (a female) and questionably placed in its genus. Felder (1875) did not provide a description of the moth, but he did figure it in color along with hundreds of other insects collected by the *Novara* expedition. The origin of "*O.*" *squamicornis* was questionably listed by Felder as Australia. Walsingham (1889) later correctly proposed a new genus, *Pseudaegeria*, for *squamicornis* and listed the species as occurring in Fiji as well as Australia. *Pseudaegeria* exhibits no close affinities with *Ochsenheimeria* and is currently included in the gelechioid family Stathmopodidae (Common, 1970).

OCHSENHEIMERIIDAE

ADULT.—Small, relatively slender to stout-bodied moths. Wing expanse: ♂, 9–15 mm; ♀, 9–17 mm.

Head: Vertex extremely rough, densely covered with long, divergent hairlike scales. Frons very broad, smooth (though barely visible in *O. bubal-ella*). Eyes rounded, small; vertical diameter less than 0.5 the interocular distance; microsetae scattered among a few facets, weakly developed, maximum length less than 0.5 the diameter of a facet. Ocelli well developed, narrowly separated from margin of eye. Antennae simple, short, less than 0.6 the length of forewing; scape greatly lengthened; basal 0.6–0.8 of antenna roughly scaled above, smoother ventrally; pectin absent. Mandibles absent. Maxillary palpi short, 2-segmented; galeae short, approximately 0.8–1.3 the length of labial palpi; mostly naked. Labial palpi 3-segmented, porrect; apical segment slender, nearly ob-

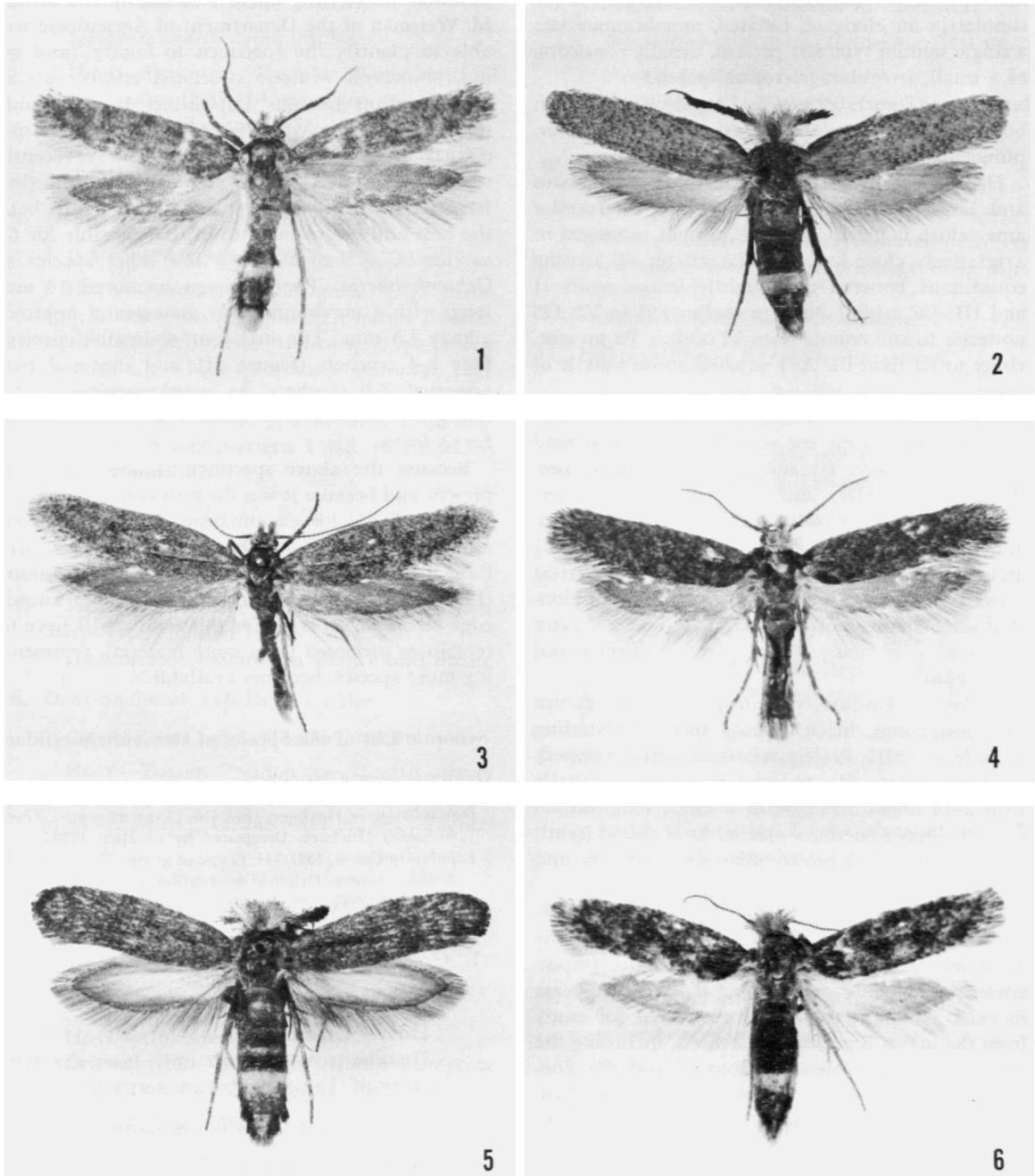
scured by enlarged, triangular brush of scales from apical half of second segment.

Thorax: Dorsum covered with smooth, relatively broad scales. Prothoracic legs less than 0.5 the length of metathoracic legs; epiphysis absent; mesothoracic tibia with a single pair of apical spurs; metathoracic tibia with an apical and a medial pair of spurs; a small, stout spine usually situated immediately above (basad of) each pair of spurs. Wings relatively slender, fully scaled; dorsal scales of discal cell of forewing broad, with apex deeply serrated (Figure 11). Forewings usually 11-veined, sometimes 12-veined; M1 either separate or stalked with R4 and 5; accessory cell normally present; discal cell elongate, with or without evidence of base of medial veins; CuA2 usually absent; 1A and 2A separate at base, then fused for outer half. Hindwings variable, ranging from 6- to 8-veined; Rs and M1 either forked near apex or completely fused; base of medial vein usually visible within cell; CuA2 rarely present (in *O. baurella*?).

Abdomen: Basal sternite tineoid in form, with a slender pair of sternal rods extending forward to thorax. Dorsum of sixth segment often whitish to pale yellow (especially in female), thus forming a conspicuous light band across abdomen (Figures 1, 5, 6). Eighth segment of male with a pair of large lateral hair pockets.

Male genitalia: Uncus setose, usually deeply lobed with lateral margins partially enclosing a darkly sclerotized anal tube; apex of tube varying from acute to nearly truncate. Gnathos well defined, fused ventrally. Tegumen elongate with cephalic margin deeply divided from 0.5 to 0.7 its total length into two rounded lobes. Vinculum reduced to a narrow ring ventrally with an elongate, slender, tubular saccus abruptly arising midventrally. Valvae relatively simple, consisting essentially of a stout apophysis curving anteriorly from the base of the costal margin; a triangular well-defined saccular lobe, bearing 2–6 stout, peglike spines; and a broad, setose, usually rounded cucullus. Aedeagus elongate, approximately $\times 1.5$ the length of saccus, relatively stout, usually curved slightly; cornuti absent, or present and minute.

Female genitalia: Ovipositor elongate, extensible; posterior apophyses long and slender, approximately 0.5 the length of bursa copulatrix; anterior apophysis similar but slightly shorter and more stocky. Lamella postvaginalis well developed, flat-



FIGURES 1-6.—Adults of *Ochseneimeria* (wing expanse): 1, *O. bisontella* Zeller, 10 mm; 2, *O. bubatella* (Huebner), 17 mm; 3, *O. capella* Moeschler, 12.5 mm; 4, *O. mediopectinella* (Haworth), 11 mm; 5, *O. taurella* Schiffermueller, 14 mm; 6, *O. vaculella* F. Roesslerstamm, 12.5 mm.

tened. Ostium enlarged, relatively simple. Bursa copulatrix an elongate, inflated, membranous sac; a single signum typically present, usually consisting of a small, irregular, sclerotized patch.

LARVA (Figures 23-31).—Length 18-27 mm; body slender, essentially naked, whitish in color, pinnacula indistinct.

Head: Entirely dark brown, or pale stramineous and largely unpigmented except for interocellar area, which is black. Six ocelli present, arranged in a relatively close but irregular circle; O1 arising equidistant between and slightly below ocelli II and III; O2 arising closer to ocellus I than VI; O3 posterior to and remote from VI ocellus. P2 present, closer to L1 than P1. AF1 situated above middle of frons.

Thorax: Pronotum either dark brown or largely unpigmented except for small black area around XD2 and spiracle. D1 and 2 arising high on prothorax; XD2, SD1, and SD2 grouped together; three prespiracular setae present (L1-3). Meso- and metathorax with small black area around L1 and 2. Legs well developed (Figure 25), tarsal claws simple, relatively short, with a pair of elongate setae arising dorsally near base and a shorter pair arising ventrally. Coxal plates indistinct, not contiguous.

Abdomen: Uniformly white (in alcohol) except for conspicuous, black, oblong spots surrounding spiracle and SD2. Prolegs relatively well developed; crochets (Figure 31) reduced in number, usually with 2-14 hooks arranged in a single longitudinal row; crochets sometimes absent. Anal shield (tenth tergite) either dark brown or barely discernible and pale stramineous.

DISCUSSION.—Although the larvae of some *Ochsenheimeria* species have been mentioned in the economic literature as crop pests of major importance, no adequate diagnosis of this stage appears to exist. Attempts to borrow specimens for study from the major European collections, including the British Museum (Natural History) and the Zoological Institute of the Academy of Sciences (Leningrad), have proved futile. Similarly, attempts to collect larvae of the introduced *O. vacculella* within the United States, particularly from Slippery Rock, Pennsylvania, have been unsuccessful.

The only known larva available for this study was an unidentified specimen originally sent to the United States Department of Agriculture for de-

termination. Relying upon Gerasimov's key, Mr. D. M. Weisman of the Department of Agriculture was able to identify the specimen to family (and genus); however, without associated adults, specific determination remains impossible. It is possible that this larva may represent the introduced species *O. vacculella*. The specimen was recently reared from a wheat stem at the Plant Protection Research Institute in Adana, Turkey. Thus, both the host and origin fall within that possible for *O. vacculella*, as well as for a few other species of *Ochsenheimeria*. The specimen measured 18 mm long, with a maximum body diameter of approximately 1.5 mm. The first four abdominal prolegs bore 2-4 crochets (Figure 31), and the anal pair possessed 2-6 crochets. As noted previously, this number is considerably lower than that recorded for *O. lowyi*.

Because the above specimen is unidentified at present and because it was the only ochsenheimeriid larva available for examination, it seemed preferable to summarize its characteristics, along with those mentioned by Dumont (1930) and Gerasimov (1952), in the family description. Thus, our knowledge of the larval stage for this family will have to remain as proposed until more material, representing more species, becomes available.

Synoptic List of the Species of Ochsenheimeriidae

Ochsenheimeria Huebner

Ochsenheimeria Huebner, 1825:416. [Type of genus: *Tinea bubalella* Huebner. Designated by Fletcher, 1929.]

Lepidocera Curtis, 1831:344. [Type of genus: *Tinea taurella* Schiffenmueller. Original designation by Curtis, 1831.]

Phygadeuon Treitschke, 1833:73. [Type of genus: *Tinea taurella* Schiffenmueller. Monobasic.]

1. *Ochsenheimeria algeriella* Zagulajev

Ochsenheimeria algeriella Zagulajev, 1966:150.

HOST.—Unknown.

DISTRIBUTION.—Known only from the type locality of Teniet-el-Had in northern Algeria.

2. *Ochsenheimeria baurella* Zagulajev

Ochsenheimeria baurella Zagulajev, 1966:153.

HOST.—Unknown.

DISTRIBUTION.—Known only from the unique holotype that was collected at an unspecified locality in England.

3. *Ochsenheimeria birdella* (Curtis)
Lepidocera birdella Curtis, 1831:344.
 Host.—Poaceae: “*Dactylis glomerata* L.,” Heinemann, 1870. “*Alopecurus* sp.; *Bromus* sp.; *Poa* sp.,” Stainton, 1973.
 DISTRIBUTION.—England, east to Germany and Switzerland.
4. *Ochsenheimeria bisontella* Zeller
Ochsenheimeria bisontella Zeller, 1846:274.
 Host.—Poaceae: “wheatgrass [*Agropyron* sp.]; brome grass [*Bromus* sp.]; barley [*Hordeum vulgare* L.]; melic [*Melica* sp.]; rye [*Secale cereale* L.]; wheat [*Triticum aestivum* L.],” Zagulajev, 1971.
 DISTRIBUTION.—Widely distributed from England east to southwestern USSR (Kazakhstan) and south to Italy.
5. *Ochsenheimeria bubalella* (Huebner)
Tinea bubalella Huebner, Verzeichniss . . . [1810-1813]:276 [sic, 376].
 Host.—Juncaceae: “*Juncus* sp.; Cyperaceae: *Scirpus* sp.,” Spuler, 1910.
 DISTRIBUTION.—Southern France and Spain.
6. *Ochsenheimeria capella* Moeschler
Ochsenheimeria capella Moeschler, 1860:275.
 Host.—Poaceae: “winter rye [*Secale cereale* L.]; millet [? *Setaria italica* (L.) Beauv.]; feather grass [*Stipa* sp.]; various wild grasses,” Zagulajev, 1971.
 DISTRIBUTION.—Ranges from Hungary through much of the western USSR to northern Kazakhstan.
7. *Ochsenheimeria danilevskii* Zagulajev
Ochsenheimeria danilevskii Zagulajev, 1972:332.
 Host.—Unknown.
 DISTRIBUTION.—Reported from European USSR, Kazakhstan, and Central Asia.
8. *Ochsenheimeria distinctella* Zagulajev
Ochsenheimeria distinctella Zagulajev, 1972:334.
 Host.—Unknown.
 DISTRIBUTION.—Known only from the type locality of Suifun, Primorsk Province, in eastern USSR.
9. *Ochsenheimeria glabratella* Mueller-Rutz
Ochsenheimeria glabratella Mueller-Rutz, 1914:426.
 Host.—Unknown.
 DISTRIBUTION.—Recorded from Switzerland and Austria.
10. *Ochsenheimeria hederarum* Millière
Ochsenheimeria hederarum Millière, 1874:249.
 Host.—Unknown. Adults observed near “ivy [Araliaceae: *Hedera* sp., probably *helix* L.],” Millière, 1874.
 DISTRIBUTION.—Southern France.
11. *Ochsenheimeria hirculella* Tengstrom
Ochsenheimeria hirculella Tengstrom, 1848:113.
 Host.—Unknown.
 DISTRIBUTION.—Reported only from the type locality, Åbo, Sahlberg, Finland.
12. *Ochsenheimeria hugginsi* Bradley
Ochsenheimeria hugginsi Bradley, 1953:832.
 Host.—Unknown.
 DISTRIBUTION.—Known only from the type locality, Tehri-Garhwal, Rudugira Gael, located in the central Himalayas (approximately 31°N, 78°30'E), of the state of Uttar Pradesh, India.
13. *Ochsenheimeria kisilkuma* Zagulajev
Ochsenheimeria kisilkuma Zagulajev, 1966:148.
 Host.—Unknown. Adults observed around “saxaul” [Chenopodiaceae: *Haloxylon* sp.], Zagulajev, 1966.
 DISTRIBUTION.—Known only from the type locality, located in Tamda County, on the Kyzyl Kum Desert in Uzbekistan, USSR.
14. *Ochsenheimeria lovyi* Dumont
Ochsenheimeria lovyi Dumont
 Host.—Juncaceae: “*Juncus maritimus* Lam.,” Dumont, 1930.
 DISTRIBUTION.—Southern Tunisia.
15. *Ochsenheimeria mediopectinella* (Haworth)
Ypsolophus mediopectinellus Haworth, 1828:545.
 Host.—Poaceae: “*Dactylis glomerata* L.,” Wakely, 1965.
 DISTRIBUTION.—England.

16. *Ochsenheimeria porphyrella* Tengstrom
Ochsenheimeria urella var. *porphyrella* Tengstrom, 1848:114.
 HOST.—Unknown.
 DISTRIBUTION.—Reported only from the type locality, Abo, Sahlberg, Finland.
17. *Ochsenheimeria rupicaprella* Moebius
Ochsenheimeria rupicaprella Moebius, 1935:24.
 HOST.—Unknown.
 DISTRIBUTION.—Switzerland.
18. *Ochsenheimeria scabrosella* Tengstrom
Ochsenheimeria scabrosella Tengstrom, 1848:113.
 HOST.—Unknown.
 DISTRIBUTION.—Reported only from the type locality, Abo, Sahlberg, Finland.
19. *Ochsenheimeria talhouki* Amsel
Ochsenheimeria talhouki Amsel, 1947:3.
 HOST.—Unknown.
 DISTRIBUTION.—Known only from the type locality, Iditah, Lebanon.
20. *Ochsenheimeria taurella* Schiffermueller
Ochsenheimeria taurella Schiffermueller, 1775:142.
 HOST.—Poaceae: "*Alopercurus pratensis* L.; *Poa trivialis* L.; *Secale cereale* L.," Réal, 1966. "Poaceae: barley [*Hordeum vulgare* L.]; oats [*Avena sativa* L.]; wheat [*Triticum aestivum* L.]," Zagulajev, 1971.
 DISTRIBUTION.—Widespread throughout most of Europe (except the Arctic regions), Russia (except Siberia), North Africa, Turkey and Iran.
21. *Ochsenheimeria trifasciata* Wocke
Ochsenheimeria trifasciata Wocke, 1871:276.
 HOST.—Unknown.
 DISTRIBUTION.—Recorded from southern France to Central Italy.
22. *Ochsenheimeria urella* Fischer von Roesslerstamm
Ochsenheimeria urella Fischer von Roesslerstamm, 1842:211.
 HOST.—Unknown.
 DISTRIBUTION.—Germany.

23. *Ochsenheimeria vacculella* Fischer von Roesslerstamm

Ochsenheimeria vacculella Fischer von Roesslerstamm, 1842:213.

HOSTS.—Poaceae: "crested wheatgrass (*Agropyron cristatum* (L.) Guertn.); quackgrass (*Agropyron repens* (L.) P.B.); couch grass (*Agropyron tenerum* Vasey); upright brome (*Bromus erectus* Huds.); awnless brome (*Bromus inernis* Leyss.); meadow grass (*Poa* sp.); Siberium lyme grass (*Roegneria canina* (L.) Nevski); winter rye (*Secale cereale* L.); winter wheat (*Triticum aestivum* L.)," Pavlov, 1961. "Meadow fescue [*Festuca elatior* L.]; ryegrass [*Lolium* sp.]; timothy grass [*Phleum pratense* L.]," Zagulajev, 1971.

DISTRIBUTION.—Widely distributed over Eurasia, from Great Britain east to southern Finland and south-central USSR (Kazakhstan); recently introduced into the northeastern United States.

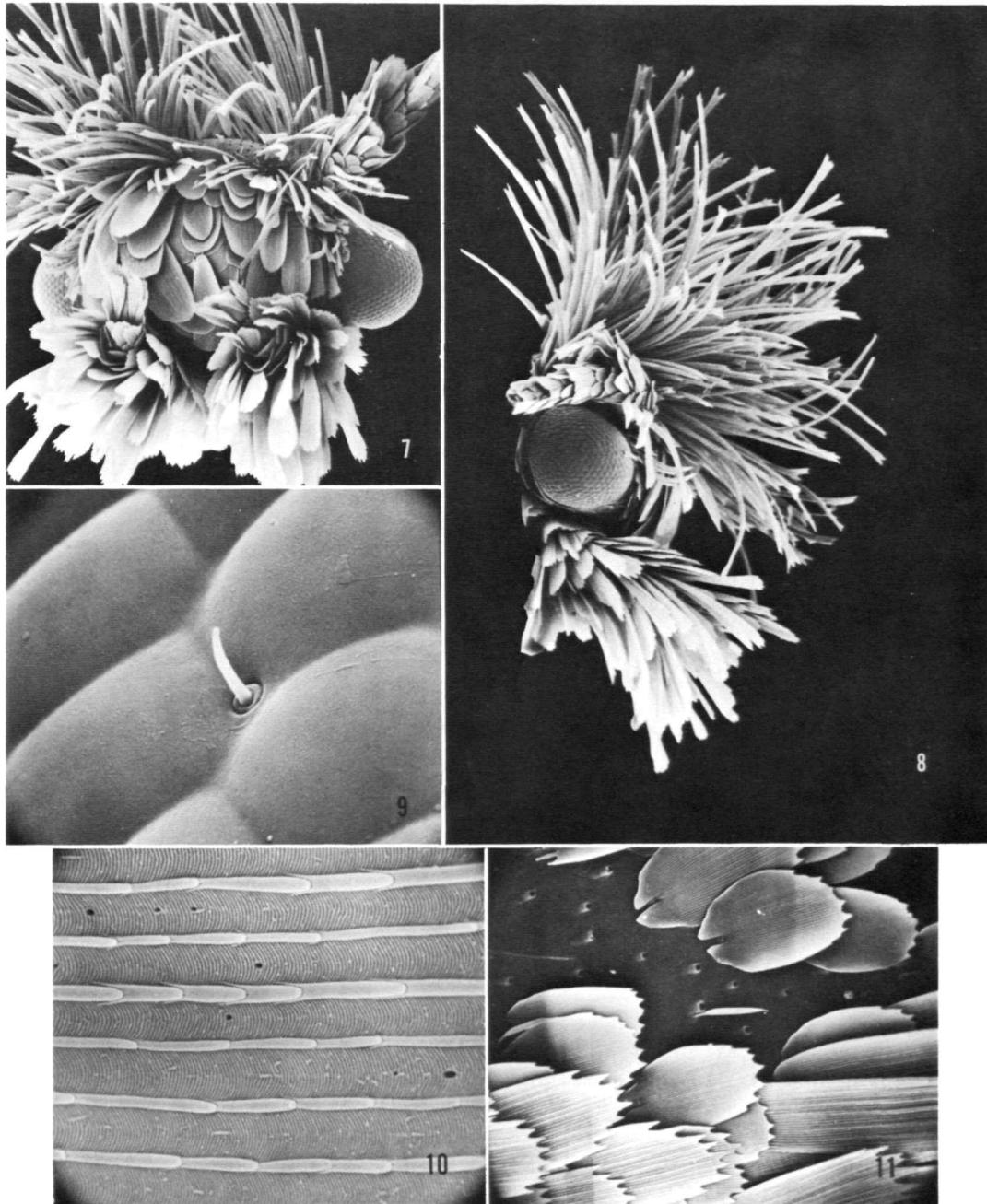
Ochsenheimeria vacculella F. von Roesslerstamm

FIGURES 6-22, Map 2

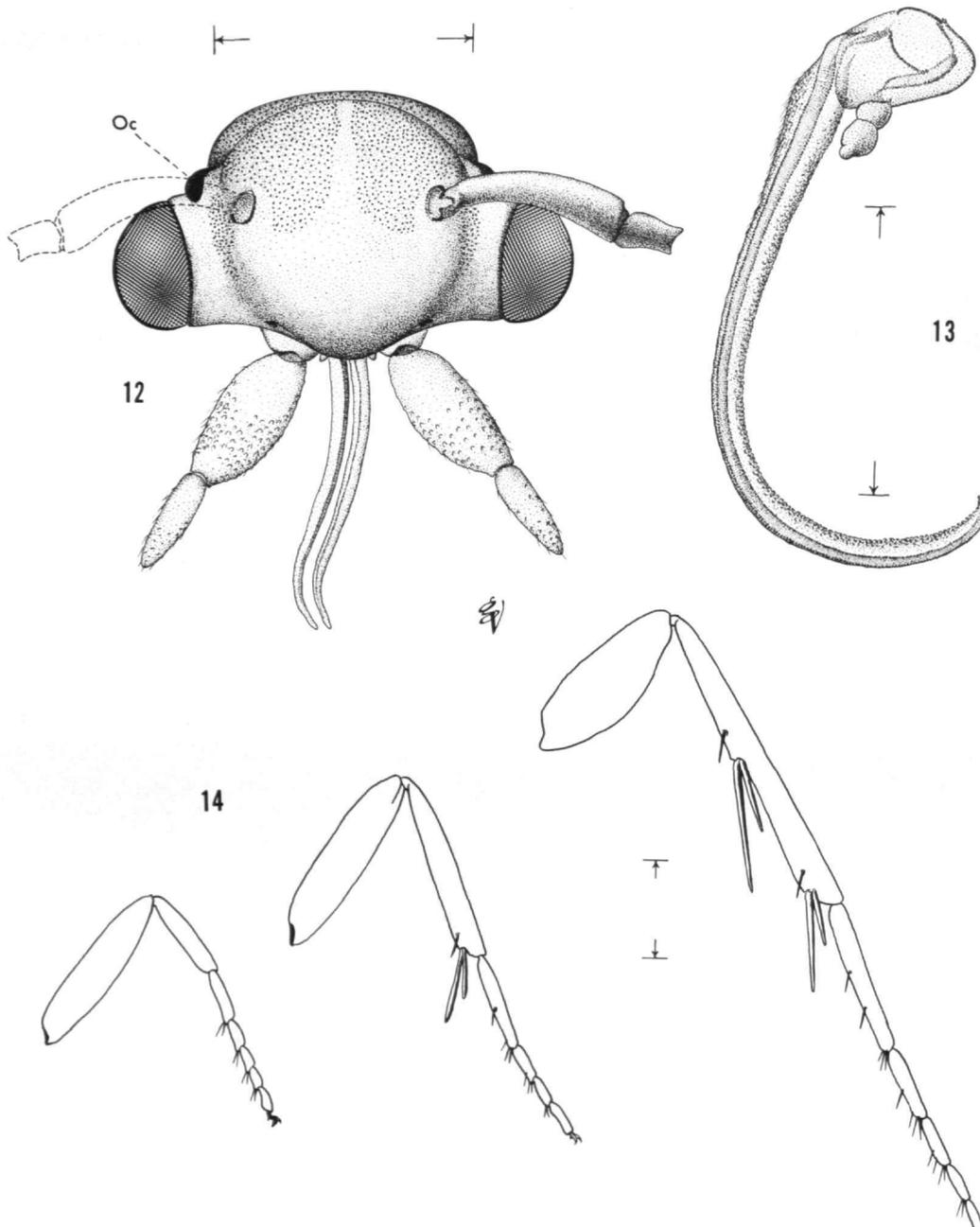
Ochsenheimeria vacculella F. von Roesslerstamm, 1842:213—Herrich-Schaeffer, 1848 (5):108, 109, 110.—Stainton, 1854:23.—Heinemann, 1870:91.—Wocke, 1871:275.—Stainton, 1873:4, 8, 18, 20.—Snellen, 1882(1):503.—Rebel, 1901:232.—Spuler, 1910:300.—Mueller-Rutz, 1914:427; 1922:234.—Meyrick, 1928:833.—Moebius, 1936:134.—Benander, 1946:66.—Pavlov, 1961:461.—Heslop, 1964:84.—Réal, 1966:255.—Zagulajev, 1971:41.

ADULT (Figure 6).—Small, relatively slender-bodied moths. Wing expanse: ♂, 11–12 mm; ♀, 12–14 mm.

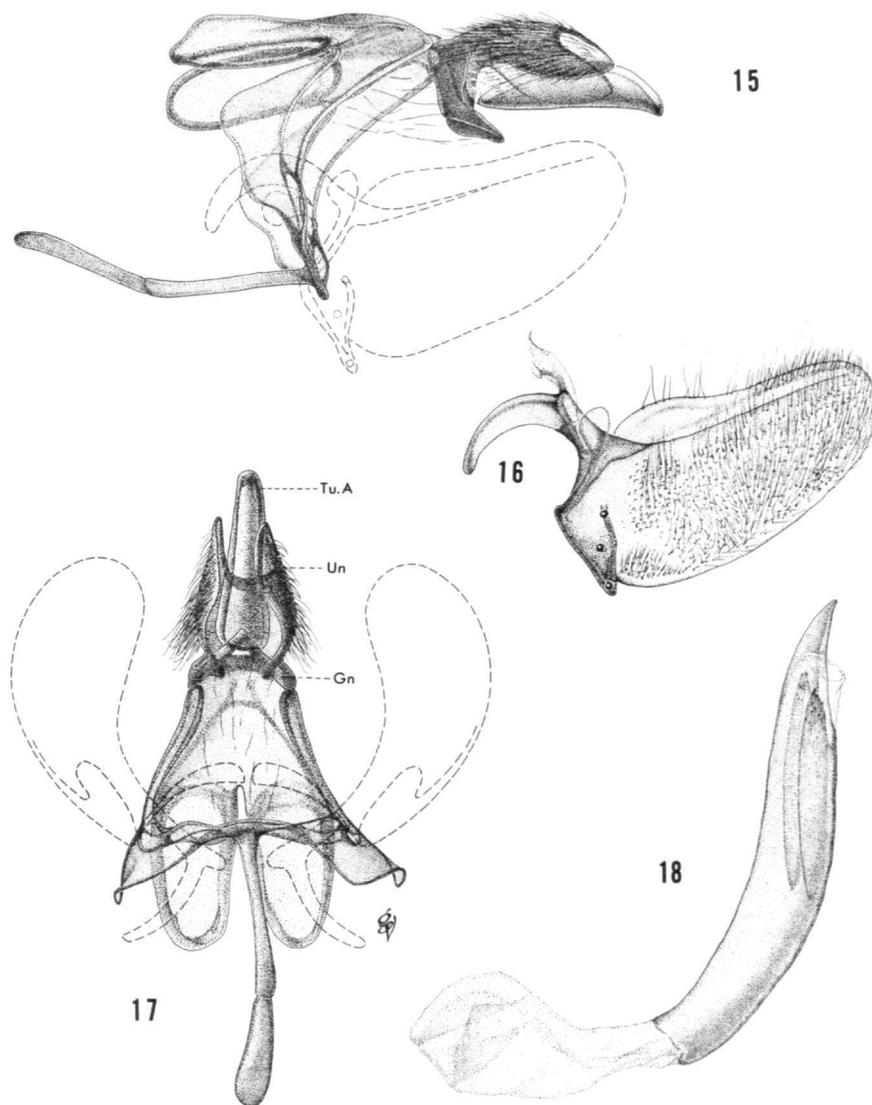
Head (Figures 7–9, 12–13): Vertex extremely rough, covered with long, slender scales with bidentate apices; scales stramineous to whitish at base, becoming fuscous at apex; frons very broad, smooth, covered with very broad, whitish to light brown, imbricated scales with rounded, entire apices (Figure 7). Eyes rounded, relatively small; vertical diameter of eye approximately 0.4 the interocular distance. A pair of rather large ocelli present above and lateral to antennal socket and removed from margin of eye approximately 0.5 their diameter. Antennae approximately 0.4 the length of forewing, 28–30 segmented, simple; scape elongate, slightly



FIGURES 7-11.—*Ochsenheimera vacculella* F. Roeslerstamm, adult head and scale structure: 7, frontal view of head, $\times 72$; 8, lateral view of head, $\times 67$; 9, microseta of compound eye, $\times 2900$; 10, detail of dorsal view of broad frontal scales (frons), $\times 3600$; 11, dorsal scales from discal cell area of forewing, $\times 215$.



FIGURES 12-14.—*Ochsenheimeria vacuella* F. Roesslerstamm: 12, frontal view of head (Oc = ocellus, scale = 0.5 mm); 13, detail of left maxilla (scale = 0.25 mm); 14, chaetotaxy of legs (scale = 0.5 mm).



FIGURES 15-18.—*Ochsenheimeria vacculella* F. Roesslerstamm, male genitalia: 15, lateral view; 16, right valve; 17, ventral view (Tu.A = tuba analis, Un = uncus, Gn = gnathos); 18, aedeagus.

rough-scaled; flagellum mostly smooth, segments fuscous, banded with stramineous. Maxillary palpi reduced, usually consisting of two short, ovoid segments; galea reduced, usually naked, approximately equaling labial palpi in length. Mandibles absent. Labial palpi relatively short, porrect; second seg-

ment the longest, rough beneath with a prominent apical tuft which often obscures apical (third) segment; scales stramineous with fuscous apices.

Thorax: Dorsum predominantly fuscous, slightly mottled with light brown. Venter paler, with more light-brown scales. Prothoracic tibiae without

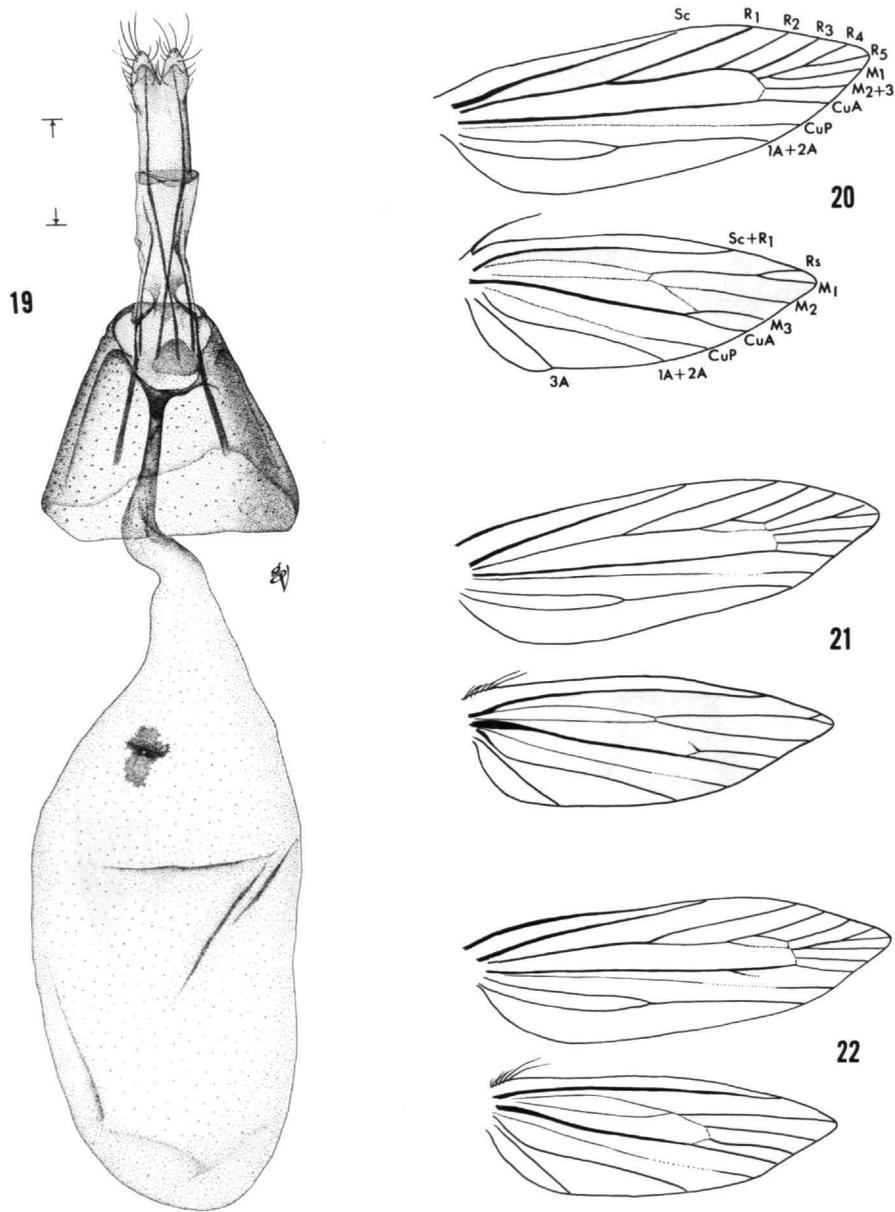
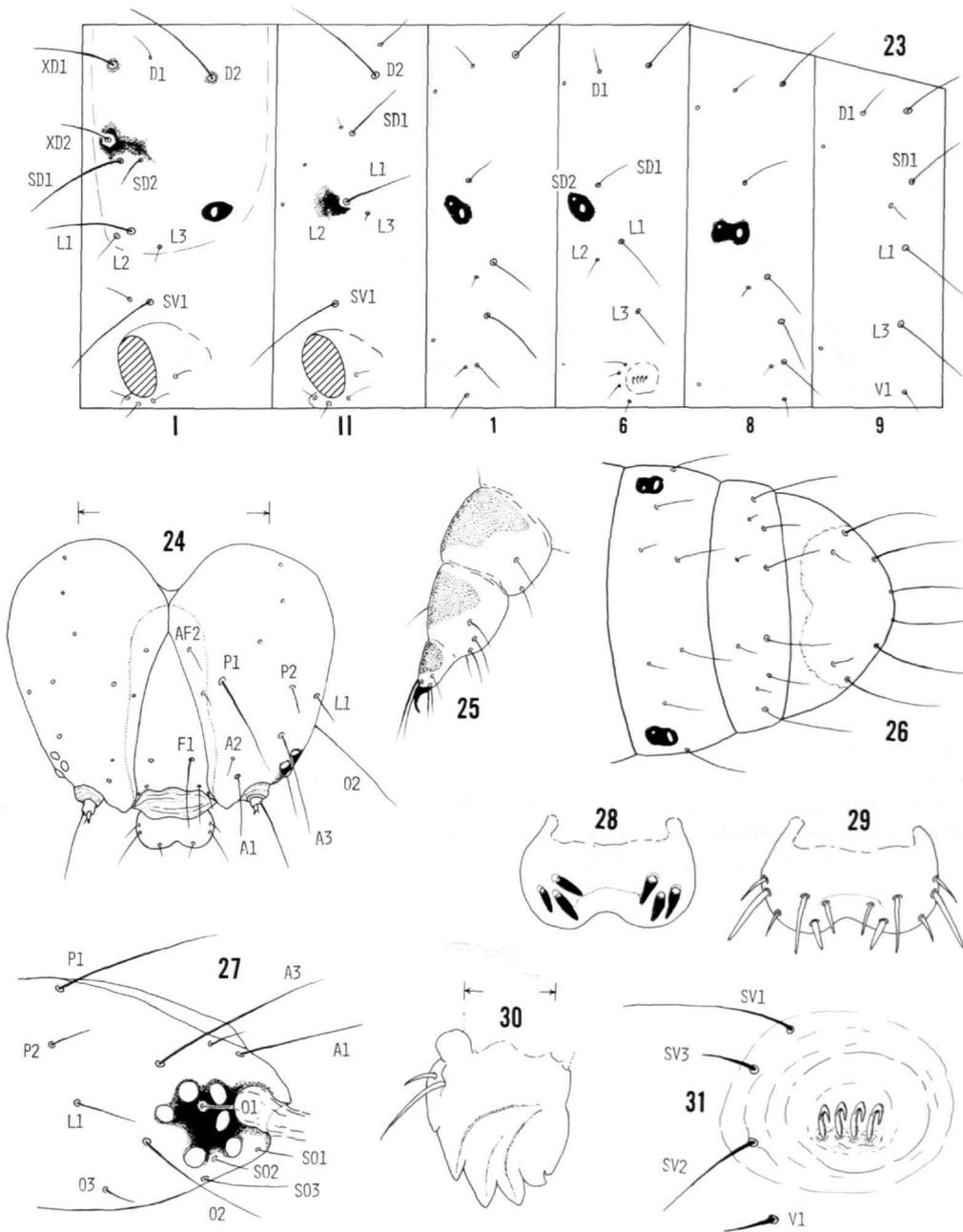


FIGURE: 19-22.—*Ochsenheimia vacculella* F. Roesslerstamm: 19, ventral view of female genitalia (scale = 0.5 mm); 20-22, wing venation, Slippery Rock, Penna.

epiphysis; all legs fuscous, heavily irrorated with stramineous. Forewings fuscous, slightly mottled with light brown; venation variable, typically 10-veined; all radial veins arising separate except R4

and 5, which are stalked more than half their length; M1 usually shortly stalked to R4 + 5 but sometimes separate (Figure 21); M1 + 2 completely fused; accessory cell usually present, sometimes



FIGURES 23-31.—Chaetotaxy of larva, *Ochsenheimeria* species: 23, lateral view of prothorax, mesothorax, and abdominal segments 1, 6, 8, and 9; 24, dorsal view of head (scale = 0.5 mm); 25, prothoracic leg; 26, dorsal view of abdominal segments 8-10; 27, ocellar region of right side of head; 28, ventral view of labrum (Figures 28-30 drawn to same scale = 0.1 mm); 29, dorsal view of labrum; 30, ventral view of left mandible; 31, left proleg of sixth abdominal segment.

absent; intercalary cell and base of medial vein absent; CuA2 usually absent, vestige rarely present (Figure 22); 1A + 2A separate for half their length basally. Hindwings whitish over basal half, light fuscous over outer half; either 6- or 7-veined; Rs and M1 variable, either completely fused or separated near apex of wing; M2 and 3 arising separate from cell; base of medius weakly preserved; CuA2 absent; 1A + 2A completely fused.

Abdomen: Fuscous above; stramineous below, irrorated with fuscous; dorsum of sixth segment pale yellow.

Male genitalia (Figures 15–18): Uncus deeply lobed, lateral lobes partially enclosing elongate, darkly sclerotized anal tube; apex of anal tube not truncate, rounded. Tegumen elongate, cephalic margin deeply divided into 2 rounded lobes slightly longer than undivided caudal half. Saccus slender, tubular, nearly as long as valvae. Saccular lobe of valvae sharply triangular, with 2 or 3 stout spines. Aedeagus elongate, relatively stout and slightly curved; a pair of large vesicular pouches present, each containing numerous, elongate setae.

Female genitalia (Figure 19): Lamella postvaginalis triangular. Position of ostium slightly asymmetrical and situated to the left of median. A single signum present, consisting of an irregular and slightly sunken sclerotized area in the caudal half of the bursa.

DISCUSSION.—Although present records are scant, the available evidence strongly suggests that the introduction of *Ochsenheimeria vacculella* into this country occurred sometime prior to 1964 via shipping through the St. Lawrence Seaway. The initial point of introduction may have been Cleveland, Ohio, with a steady, though perhaps rapid dispersion from that point.

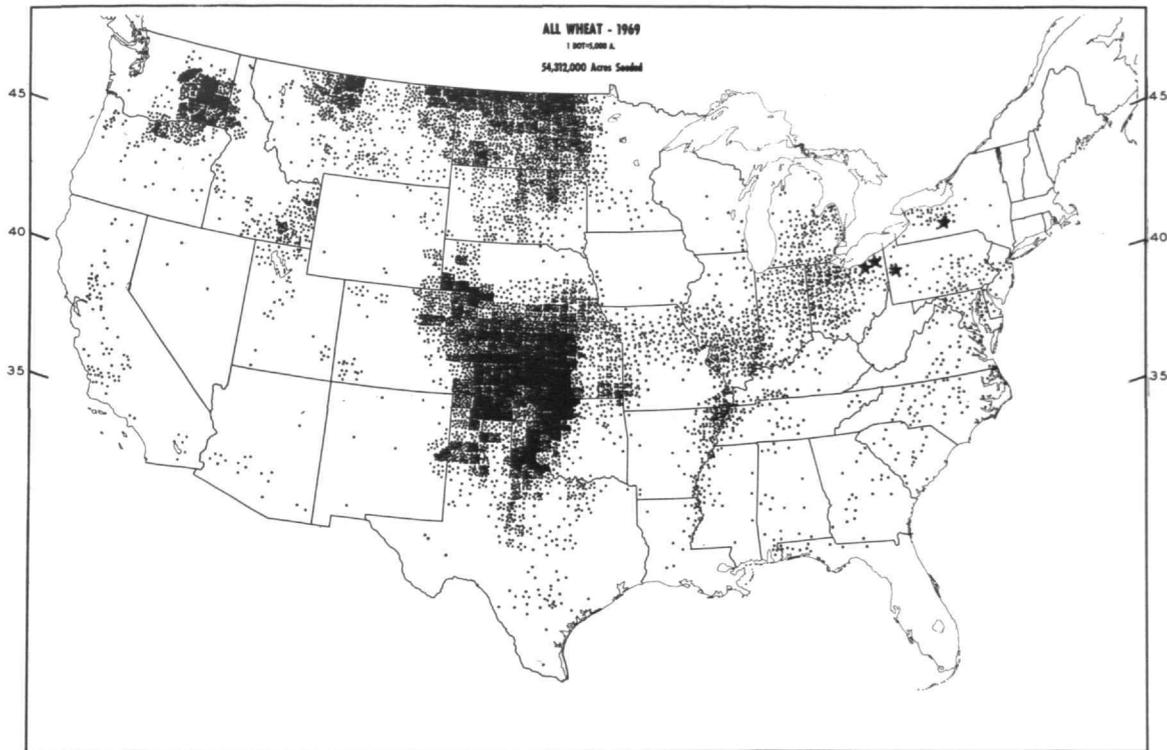
I first became aware of the presence of this insect in the United States in 1964 when two specimens, collected from an unspecified locality in Geauga County, Ohio, were referred to me for identification. A definite determination was not possible at that time because of the very poor condition of the specimens. Later, in 1967, additional material in a better state of preservation was received which made generic identification possible. The latter specimens were collected in an attic of a home located in Cuyahoga County, Ohio. Again, the specific origin was not given, but it is probably significant that this county is adjacent to that of the

first collection, Geauga County. One year later, I received a few more specimens for determination from Dr. John Franclemont of Cornell University. These were collected from an unspecified locality in New York. In August 1973, Dr. Franclemont sent more specimens of the same species collected on an exterior wall of a private home near Ithaca, New York. The moths were reported resting on the wall in large (200–300) numbers.

The greatest quantity of specimens was received recently from Mrs. J. H. Kind of Slippery Rock, Pennsylvania. Approximately 100 moths were collected by Mrs. Kind in and around the windows of her home during August 1971. This large series, in addition to making specific identifications possible, has provided us with a clear warning as to the relative abundance of the insect in the eastern United States.

With almost no other information to rely upon, it is difficult at present to estimate exactly how serious this pest will become in this country, or to hypothesize how great its range will extend. Pavlov (1961) mentions winter wheat, as well as winter rye, as being heavily attacked in southwestern Russia. It is possible, because of similarities in cultivation, etc., that the moth may likewise restrict its principal damage to these two crops within the United States. More than likely, *O. vacculella* will become a serious pest in some areas, particularly after it has become established in the major wheat and rye growing areas of North America. In Eurasia, most of the distributional range of *O. vacculella* occurs between 45° and 60° north latitudes. As seen on Map 2 (compiled by the Agricultural Research Service, 1972), a comparable range in North America would include all the major wheat growing areas of Canada but would lie somewhat to the north of our largest wheat growing area in the central United States. According to the U. S. Department of Agriculture's *Agricultural Statistics for 1972*, the heaviest concentration of rye production in the United States lies within the north-central region, with South Dakota being the greatest producer in that area. A projected range of *O. vacculella* would probably include most of this area. Two other leading growers of rye, Texas and Georgia, however, are probably south of the moth's projected maximum range in this country.

The best account of the biology and control of *O. vacculella* is by I. F. Pavlov (1961). Although



MAP 2.—Nearctic distribution of *Ochseneimeria vacculella* F.R. (stars) in relation to the principal wheat growing areas (dots) within the United States (adapted from Reitz et al, 1972).

originally published in Russian, the article is also available in the standard English translation of the journal.

Pavlov reports that the eggs of this species are deposited in straw heaps in the fields, in thatched roofs, crevices in the grain bins of barns, and on grass. The eggs are normally laid several at a time, usually adhering together in rows. It was noted that eggs are not laid in buildings or other areas where grain had not been stored. Consequently, a principal method of control is to clean or chemically treat areas where grain or straw is stored before or immediately following oviposition (late summer). The eggs are reportedly elongate, oval, 0.6–0.8 mm long and 0.3–0.5 mm in diameter.

The larvae do not emerge from the eggs until spring. As is true for other species of *Ochseneimeria*, the newly emerged larvae disperse by secreting long strands of silk, which are caught by the wind. Heavy infestations can easily be noted at

this early stage by the abundance of silken strands scattered over the fields or nearby buildings. Pavlov found that dispersion by this method is possible up to 3 km from the probable source of the eggs; however, away from human populated areas (i.e., buildings), dispersal is usually much less extensive.

Pavlov describes the larva of *O. vacculella* as being dark yellow in the early instars with indistinct bands on the dorsum, which usually disappear toward maturity. The head and occipital area are black, and the pronotum bears two (probably lateral), large, brownish-black areas. The mature larva is lighter in color but still retains the two dark pronotal plates as well as a pair of dark plates on the last (ninth?) segment. The anal shield is light brown and trapezoidal in form. The abdominal prolegs normally bear 2 or 3 crochets. The larva attains a maximum length of 18–20 mm.

The larvae are known to feed upon several species of wild grasses, and Pavlov reports winter rye

and winter wheat to be severely damaged over certain areas in southwestern Russia. During the initial feeding period, the larva usually restricts itself to mining the leaf blades. Then, after about 8 to 12 days, they bore into the stem. During the boring stage, the larva is capable of transferring to another plant and may damage as many as five to nine stalks before pupating. Serious damage also results from larvae gnawing directly on the fruits, or ears.

The larva usually pupates in a whitish, silken cocoon between the leaves of the host. Pupation has been observed as early as the end of May in some parts of southern Russia with the adults emerging during the first half of June. Oviposition occurs during August and September and the adults die around the end of September.

One of the species most closely related to and thus most likely to be confused with *O. vacculella* is *O. taurella*; however, the two may be easily separated by the vestiture of their antennae—that of *O. taurella* roughly scaled and that of *O. vacculella* relatively smooth. The chaetotaxy of the sacculus also provides an easy means of separating the males. The sacculus of *O. taurella* usually possesses about 5 to 7 small spines compared to 2 or 3 in *O. vacculella*.

The large series of specimens representing a single locality in Pennsylvania has made it possible to comment to some extent on the variation of this species. Such information can be particularly valuable in evaluating the species of *Ochsenheimeria*, many of which have been founded on relatively minor morphological differences. The forewings of *O. vacculella* normally possess a distinct accessory cell, but in one specimen (Figure 20) this was lacking. Similarly CuA2 is typically absent in the *Ochsenheimeriidae*, but the base of this vein is preserved in one specimen from Slippery Rock (Figure 22). In the hindwings, Rs and M1 are usually forked near the apex; however, the degree of fusion varies slightly in nearly every specimen examined with complete fusion observed in some

(Figure 22). In the male, the chaetotaxy of the sacculus normally varies from 2 to 3 spines. This slight variation can sometimes be observed within a single specimen between the right and left valvae. Because these latter two characters were heavily relied upon by Zagulajev (1972) in separating *O. danilevskii* from *O. vacculella*, it is possible that the two are synonymous.

COMMON NAME.—Because *O. vacculella* will probably become a pest of some importance on various cereal grasses in this country, some thought should be devoted early concerning an acceptable common name for the species. This would avoid possible future confusion in the event that the early reports of the species in this country were to utilize different common names.

The adults of the genus as a whole are often referred to as stem moths and the larvae as stem borers. The selection of common specific names is somewhat complicated by the fact that the biologies of those species that have been studied are rather similar and the host preferences of some overlap considerably. The two species of greatest economic importance are *O. taurella* and *O. vacculella*. These have been referred to respectively as the rye stem (or culm) moth and the cereal stem (or culm) moth by Zagulajev (1971). Pavlov (1961) simply referred to *O. vacculella* as the stem moth. In his checklist of the British Lepidoptera, Heslop (1964) referred to *O. vacculella* as the middle-bull field moth. *Ochsenheimeria taurella* is the more injurious of the two, being a major pest of rye (*Secale cereale*) throughout much of southern Europe and western Russia. *Ochsenheimeria vacculella* seems to be of only minor importance in western Europe (Réal, 1966), but it has within the last two decades developed into a serious pest of cereal crops, particularly winter wheat and rye, in southwestern Russia. For these reasons, I believe it preferable to refer to *O. vacculella* as the "cereal stem moth," with the name "rye stem moth" reserved for *O. taurella* if the latter should ever become established within the United States.

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