Verbascum virgatum Stokes: an addition to the flora of Indiana, with comparison to *Verbascum blattaria* L.

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Introduction

Experience in many countries has shown that one can easily find numerous rare plants along railroad tracks. Large unused lots in railyards and adjacent to rail lines are often luxuriously overgrown with vegetation that is quite rich in species (9). One such lot in downtown Terre Haute at the corner of First and Spruce streets is the site of collection of the first specimens of *Verbascum virgatum* Stokes found in Indiana.

Verbascum L. is a European genus, five species of which have become established in the northeast United States and four others of which have been reported (3). The species are biennials, producing a rosette the first year and a tall flowering stem the next (4). *Verbascum virgatum* is distributed along roadsides from Cape Breton to southern Ontario, south to South Carolina, Ohio and Texas and in western states, as an adventive, according to *Gray's Manual of Botany* (2). The Ohio record is a single specimen collected in Franklin County in 1891 (7). It is considered a rare adventive in Illinois, where it was collected in Coles and Pulaski counties (8). These three specimens are housed in the herbarium of the Illinois Natural History Survey (ILLS). It is infrequent in the coastal plain of South Carolina and in Moore and Montgomery counties in North Carolina (11). It is reported as adventive along roadsides in Arizona and Utah (12). Abrams reports it as naturalized in southern California along roadsides (1) and Munz reports it also from Frasier County in northern California (10). Large established populations occur on the campus of Occidental College in Los Angeles (13). *Verbascum virgatum* is not considered established anywhere in the northeast United States (3, 4).

Verbascum virgatum strongly resembles the yellow form of *V. blattaria*, and is so described by most authors of floral references (2, 3, 4, 8, 10, 11). Diagnoses are given by Abrams (1) and by Rydberg (12). *V. virgatum* is biennial, the second year stem 5 to 12 dm. in height, simple or virgately branched, glandular puberulent, green to purplish in color. Basal leaves are oblanceolate to spatulate, 10 to 30 cm. in length, somewhat pubescent or glabrous. Cauline leaves are sessile or clasping, lanceolate, 7 to 15 cm. in length, and, along with the basal leaves, have sinuate-dentate to crenate margins. The inflorescence is an open raceme, pedicels one to four per node, shorter than or equaling the ovate bracts. Calyx lobes are lanceolate, 5 to 6 mm. long. The corolla is yellow, the lobes slightly unequal, 25 mm. wide. Stamens are violet villous, with reniform, medifixed anthers. The capsule is globose, 7 to 8 mm. long (1, 12). The karyotype is $2n = 32$ (10).

Methods and Materials

The original specimen, collected in June, 1980 (TER 3643), was determined using available keys (4) and entered into the herbarium of Indiana State University. The authors returned to the site of collection and took photographs of other *V. virgatum* individuals and individuals of the sympatric *Verbascum blattaria* L., a common, established species (2, 3, 4). Floral material of both species was collected

and stored in buffered glutaraldehyde fixative for subsequent scanning electron microscopy. Letters were sent to all registered and known herbaria and plant collections in Indiana to inquire about previous collections and other specimens housed in the state. The herbaria ILL and ILLS were searched for specimens. Electron micrographs of the abaxial and adaxial corolla surfaces, calyx lobe abaxial surfaces, stamens, and pollen of both species were taken using 10 KV at various magnifications on the Amray 1000A scanning electron microscope at Indiana State University. The materials were simultaneously frozen in liquid nitrogen and lyophilized in a Pearse-Edwards tissue-dryer and sputter-coated with gold-palladium alloy, prior to microscopy.

Results

The responses to our letters and telephone calls revealed that no previous collection of *Verbascum virgatum* was made in Indiana. Two specimens are housed at Indiana institutions, one at the Indiana University Herbarium, the other at the Kriebel Herbarium of Purdue University, both collected in Clarendon County, South Carolina, by Leonard and Radford on June 2, 1968. The herbaria ILL and ILLS have no *V. virgatum* from Indiana. The specimen from Terre Haute is thus a state record, and has been so reported in the state registry.

Verbascum virgatum strongly resembles *V. blattaria* in size, habit, and inflorescence pattern. Key characters for separating the species in the field are the greater pedicel length in *V. blattaria*, exceeding the bract and capsule lengths (Figure 1), compared to *V. virgatum* where the pedicel is shorter than the bract or capsule (Figure 2), and the presence of up to four pedicels at some lower nodes of the inflorescence in *V. virgatum* (Figure 3) which does not occur in *V. blattaria*.

Scanning electron micrographs reveal additional differences. The abaxial corolla surface of *V. virgatum* bears, simple, branched, and glandular trichomes (Figure 4) which are lacking in *V. blattaria* (Figure 5). The adaxial corolla surface in *V. virgatum* is smooth (Figure 6) and much rougher in *V. blattaria* (Figure 7). The calyx lobes of *V. virgatum* are densely covered with glandular trichomes, with glands no more than twice the width of the stalk, and numerous filamentous trichomes (Figure 8) whereas *V. blattaria* calyx lobes bear sparser, glandular trichomes only, these with proportionately larger glands (Figure 9). These correspond exactly with *V. blattaria* leaf trichomes described by Hare (5).

Stamen filament trichomes of both species have clavate tips, which are larger, longer, and of more tapered shape in *V. virgatum* (Figure 10) than in *V. blattaria* (Figure 11). Pollen of *V. virgatum* is smaller and more oblate, with colpae meeting at a more acute angle (Figure 12) than *V. blattaria* pollen which is spherical (Figure 13). The wall surface pattern is a finer mesh in pollen of *V. virgatum* than in pollen of *V. blattaria*.

Discussion

The differences in microscopic characters found cannot be considered artifacts of preparation, since the specimens were collected simultaneously, stored together under identical conditions, and processed together. The characters found were verified by reexamination of herbarium material under the dissecting microscope, where the corolla trichomes are barely seen at maximum magnifications. Despite the large superficial similarity of the two species, there is no doubt regarding identification. Although pollen is usually morphologically similar within a genus, the pollen of *V. blattaria* is easily distinguished from pollen of *V. virgatum* in our samples. The amount of rough coating on the corolla and leaf surface is prob-

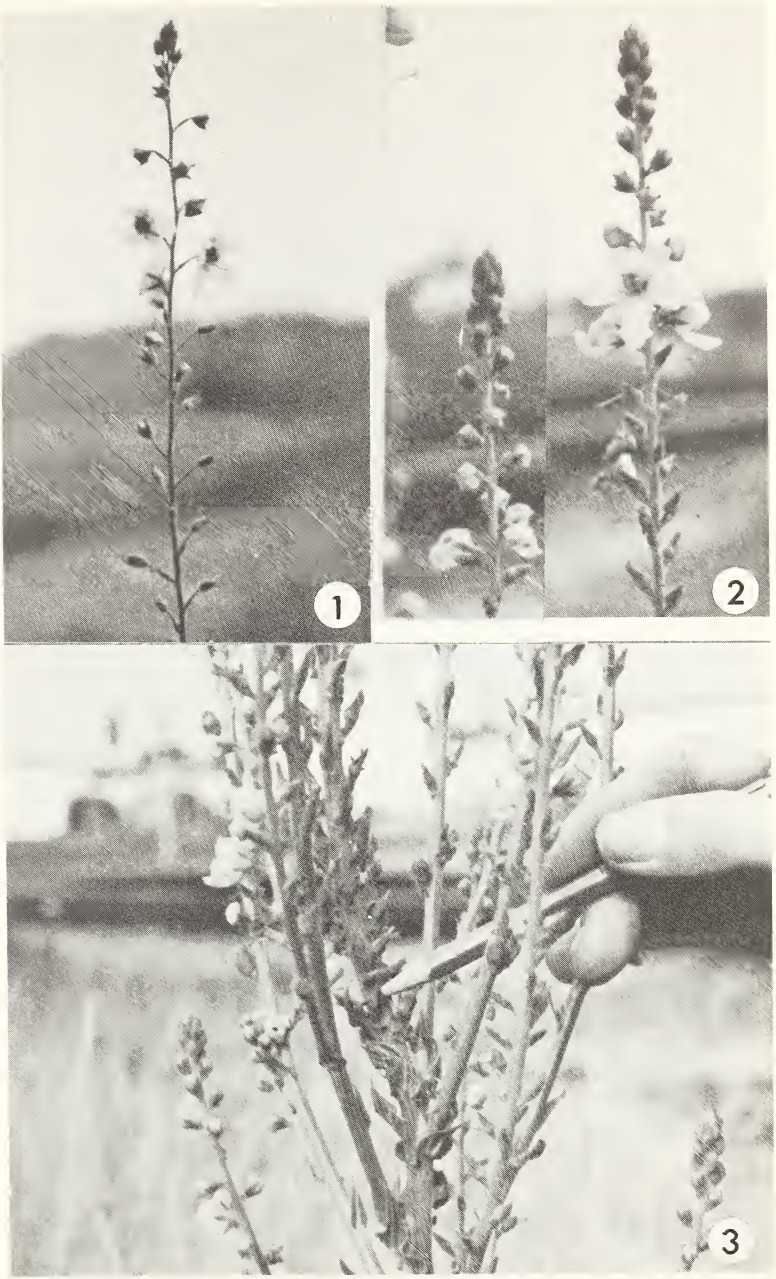

FIGURE 1. Verbascum blattaria *inflorescence*
FIGURE 2. Verbascum virgatum *inflorescence*
FIGURE 3. *Lower node of* V. virgatum *inflorescence with two pedicels*

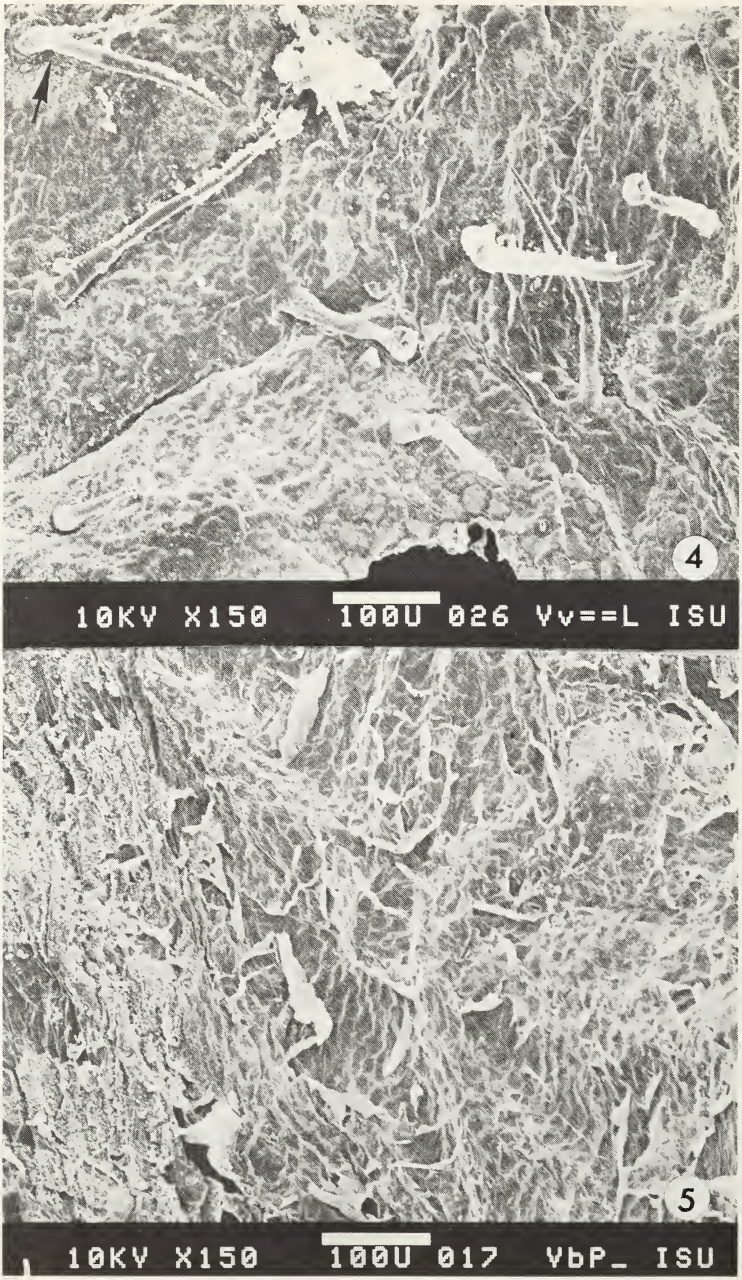

FIGURE 4. V. virgatum *abaxial corolla surface with simple, branched (arrow) and glandular trichomes, X 150*

FIGURE 5. V. blattaria *abaxial corolla surface with blunt-tipped glandular trichomes, X 150*

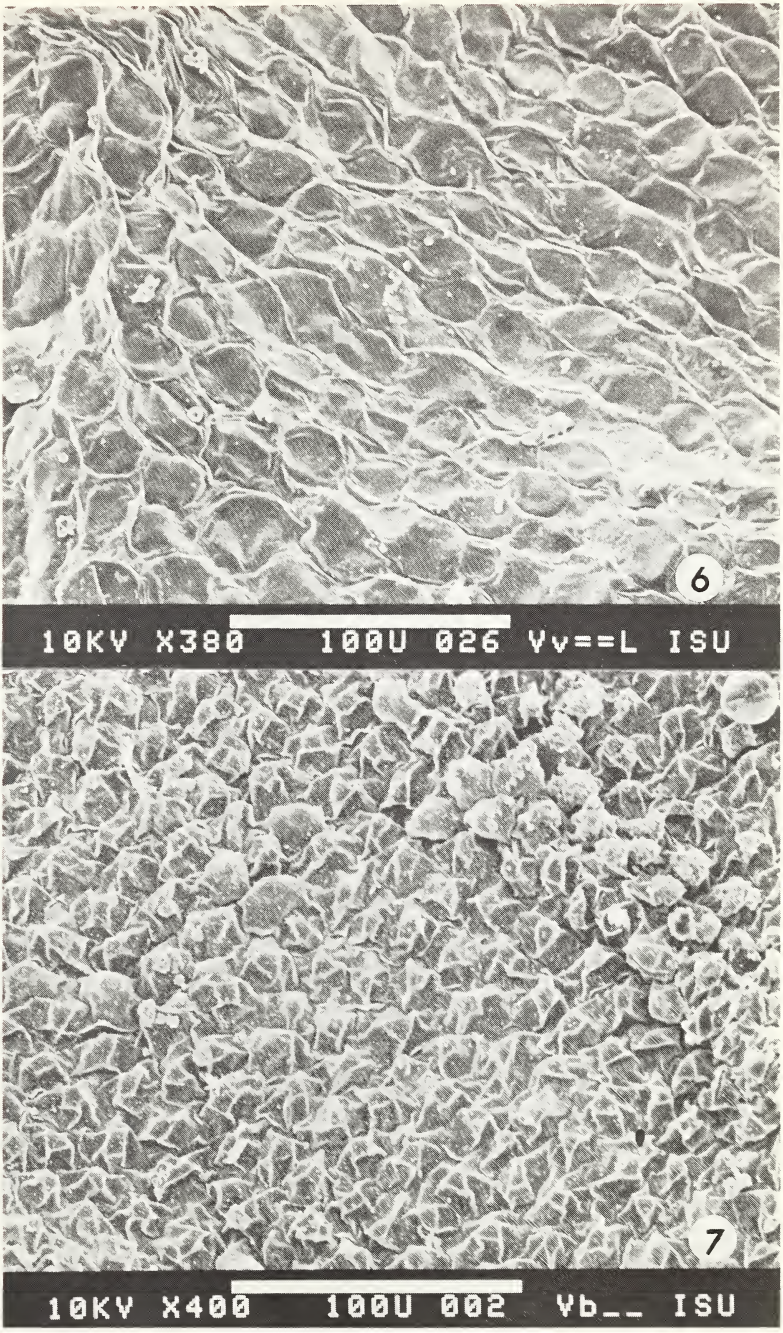

FIGURE 6. V. virgatum *adaxial corolla surface X 380*
FIGURE 7. V. blattaria *adaxial corolla surface X 400*

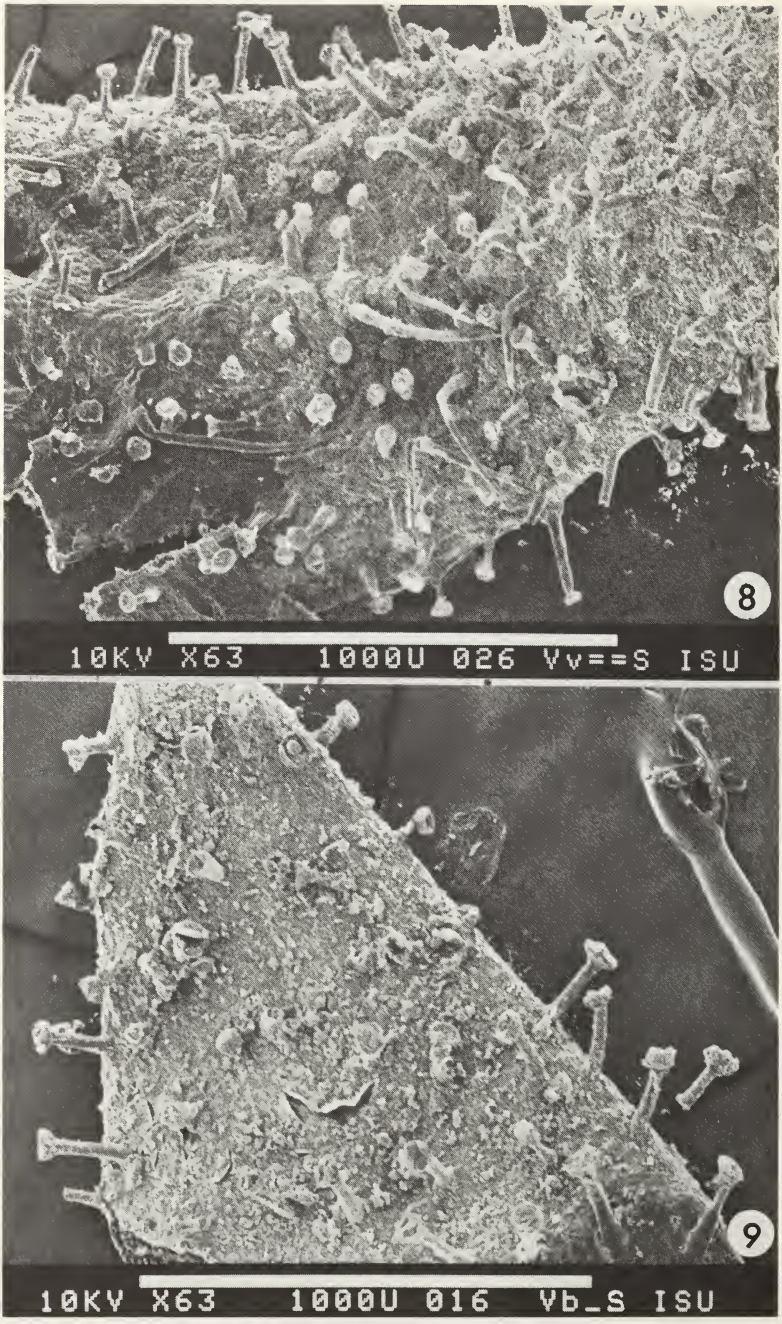

FIGURE 8. V. virgatum *abaxial calyx lobe surface X 63*
FIGURE 9. V. blattaria *abaxial calyx lobe surface X 63*

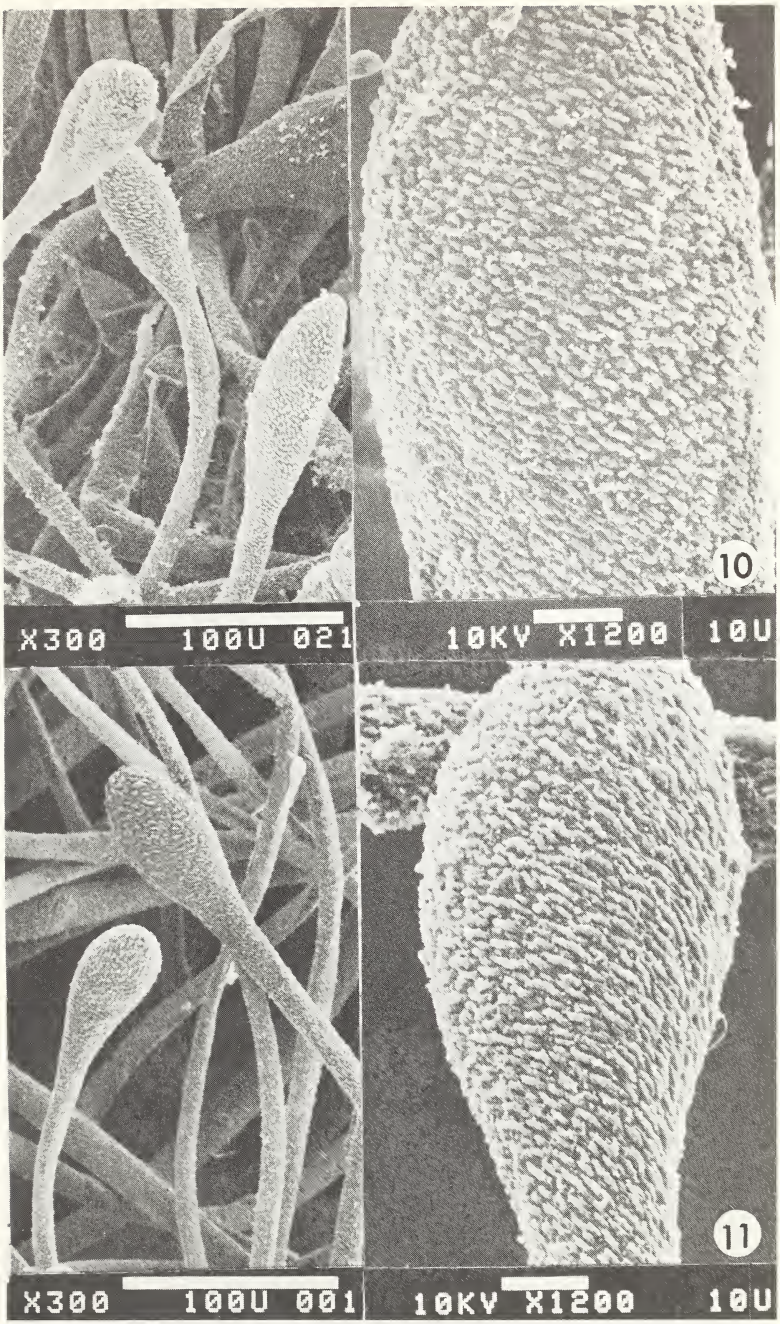

FIGURE 10. V. virgatum *stamen trichomes X 300, tip X 1200*
FIGURE 11. V. blattaria *stamen trichomes X 300, tip X 1200*

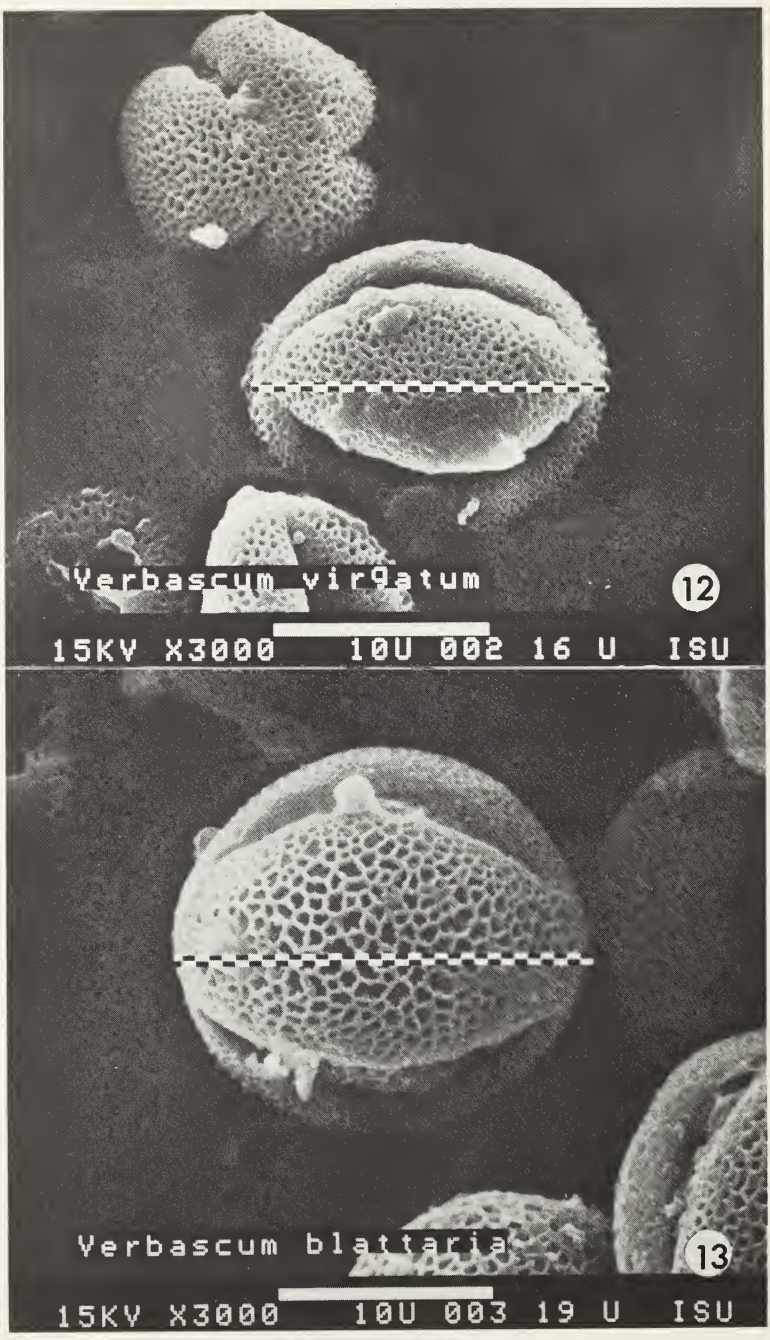

FIGURE 12. V. virgatum *pollen grain X 3000, measurement bar 16 microns*
FIGURE 13. V. blattaria *pollen grain X 3000, measurement bar 19 microns*

ably related to age or weathering of the sample rather than a true species character as it is shown in the micrographs (Figures 8 & 9) to be in patches. The wrinkling of the corolla surface (Figures 6 & 7) may represent either a true species character or differences in maturity or weathering.

A second specimen of *Verbascum virgatum* was collected at the same site in August 1981, and is also housed at Indiana State (TER 3991). Since the species is biennial, we provisionally consider the species established at the Terre Haute site, since it must have been present in rosette form in 1979. If the species flowers again next year at the site we can accept the fact of establishment with reasonable certainty.

Comparison of the seeds of the two species was not possible since the first specimen was collected before capsule maturity and the second was collected late, and the only apparently mature capsules remaining contained no seeds, only weevils and fungi. Poor seed production may be a factor in the failure of *V. virgatum* to become established widely. The seed production of *Verbascum blattaria*, in contrast, is copious, and hundreds of seeds were found by opening a half dozen capsules, and most capsules appear to mature properly on most plants. *V. blattaria* also retains seed viability for very long time, being the only species still germinating in the ninety-year trial in Dr. Beal's seed viability experiment in Michigan (6). These two facts together, fecundity and longevity, explain the success with which *V. blattaria* has become naturalized, in contrast to *V. virgatum*.

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