Pollen Morphology of the New Species
_Mimulus shevockii_ and a Possibly Related Species, _M. barbatus_ (Scrophulariaceae)

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ABSTRACT — The pollen grains of _Mimulus shevockii_ and _M. barbatus_ have three long, equally spaced, meridionally oriented apertures with transversely ruptured membranes, and the pollen walls are microreticulate with smooth muri. The pollen evidence (pollen size and shape, rupturing pattern and ornamentation of the aperture membrane, size and spacing of lumina, and ornamentation of muri) is applied to comparisons between the pollen of _M. shevockii_ and that of other species in section _Paradanthus_. These data are consistent with a proposed relationship between _M. shevockii_ and _M. barbatus_ of the _M. rubellus_/ _M. palmeri_ group.

Introduction

In 1985 L. R. Heckard, University of California at Berkeley, sent me pollen from eight plants of a remarkable new species of _Mimulus_, _M. shevockii_ Heckard and Bacig., which has a corolla unlike that of any other _Mimulus_ (1 and personal communication). The present note provides the first illustrated descriptions of the pollen of this and a perhaps related species, _M. barbatus_ Greene, as a supplement to previously published surveys of the pollen of _Mimulus_ on a worldwide basis (2, 3, 4).

Heckard and Bacigalupi (1) place _M. shevockii_ in section _Paradanthus_. Although the morphology of its corolla is unique, its calyx and vegetative morphology most closely resemble that found in several members of the _M. rubellus_/ _M. palmeri_ group (5) of this section, for example, _M. barbatus_, _M. androsaceus_ Curran ex Greene, _M. gracilipes_ Robinson, and _M. purpureus_ A. L. Grant (1). Indeed, some early collections of _M. shevockii_ that failed to show the corolla clearly were tentatively identified as _M. barbatus_ (1).

Nevertheless, the infrasexual relationships of _M. shevockii_ are still considered problematical (1). The possible bearing of the pollen evidence on this problem will be examined on a preliminary level for all members of the section for which SEM data are available.

Materials and Methods

Collection data and pollen measurements are summarized in Table 1. Pollen grains for scanning electron microscopy (SEM) were either not acetolyzed or acetolyzed (6) gently for one hour at room temperature and examined using a Hitachi S-450 scanning electron microscope. Brightfield and Nomarski interference contrast observations of acetolyzed and unacetolyzed whole pollen grains mounted in glycerine jelly were made using a Zeiss microscope (N.A. 1.32, apochromatic objective X100). Pollen was available from one and eight plants of _M. barbatus_ and _M. shevockii_, respectively (Table 1). Pollen diameters, including polar (P) and equatorial (E) axes, are based on a minimum of 20 fully developed unacetolyzed grains per species (Table 1) measured at X1000 under oil immersion. Measurements of pollen surface details are based on scanning electron micrographs (SEMGs) of as few as five grains, and because of this small sample size, should be treated with reserve. Terminology is defined as it is introduced and is derived from Erdtman (7), Praglowski and Punt (8), and Walker and Doyle (9).

Results and Discussion

The pollen grains of _M. shevockii_ and _M. barbatus_ are single, more or less spheroidal (Table 1), isopolar, and radially symmetrical with three long, equally spaced, meridionally oriented apertures (Figures 1, 4). The aperture membranes, covered by labile material in unacetolyzed pollen (Figure 1), have a rough surface (Figures 3, 6) and usually show one to three or more irregular transverse ruptures in unacetolyzed grains examined by brightfield and Nomarski interference contrast. The outer surface, or tectum, of the pollen wall consists of a mesh-like network of interconnecting rods called muri (Figures 2, 5). These surround open areas or lumina and are supported from below by radially oriented rods called columellae. The columellae, in turn, are attached internally to a third wall layer, the nexine (not illustrated), with an orientation "parallel" to that of the tectum. Important morphological features of the pollen walls in _M. shevockii_ and _M. barbatus_ include muri that are smooth (psilate) and subtended by a single file of columellae (simplicolumellate) and lumina that are wider than the muri but less than 1.0 μm in diameter (microreticulate). In _M. shevockii_ the lumina are 0.8 (range 0.4-1.2) μm in diameter with a lumina to muri ratio of 2.3 (range 2.1-2.5). The respective values for _M. barbatus_ are 0.8 (range 0.4-1.8) μm and 2.0 (range 1.8-2.3). Lumina are slightly reduced in size in both species near the apertures (Figures 3, 6).

The characters summarized above and in Table 1 place the grains of both _M. shevockii_ and _M. barbatus_ in a pollen group...
versus rough or granular), the size of the lumina, and the ratio

considered were the texture of the aperture membrane (psilate

6

conspicuous transverse ruptures in the aperture membrane in

tions of

= 13 compare). Numerical character differences were accepted as

considered preliminary. Furthermore, the taxonomic

of the lumin diameters to muri widths, as well as the

Using

unacetolyzed pollen examined by light microscopy. Also

unions of species recognized by Grant (5). Thus, although the

overa ll mean percentage similarity value between

2 Mean

1 Measurements are in micrometers (um)

2 Mean followed by range in parentheses.

previously described as type IIb (2). This type is distinguished

from other triaperturate pollen of section Paradanthus chiefly

by the absence of supramural spinules or granules (2, 4).

Among the 27 species of section Paradanthus with triapertu­

rate pollen that have thus far been examined by SEM, 13 have

pollen of this type. Fourteen others have pollen grains with

dense supramural ornamentations and are designated type IIc

(2, 4). Each of these pollen types, however, embraces a

macromorphologically nonhomogeneous assemblage of

species, and a further resolution of differences is needed if the

pollen evidence is to be applied to an analysis of infrasec­

tional relationships.

To this end, the pollen data for all triaperturate members of

section Paradanthus have been reassessed based on pollen

size (JP x E), pollen shape, and the presence or absence of

conspicuous transverse ruptures in the aperture membrane in

unacetolysed pollen examined by light microscopy. Also

considered were the texture of the aperture membrane (psilate

versus rough or granular), the size of the lumina, and the ratio

of the lumina diameters to muri widths, as well as the occur­

rence of psilate versus ornamented muri (See 2, 4 for data).

Using an equal weighting of these characters, a percentage

similarity value (S) was calculated for all pairwise combina­

tions of M. shevockii and other taxa of section Paradanthus (S =

100 x number of characters shared/number of characters

compared). Numerical character differences were accepted as

significant at the 95% level.

The limited number of independent pollen characters

available for analysis and, in some cases, the restricted

number of samples examined require that the results be

considered preliminary. Furthermore, the taxonomic signifi­
cance, if any, of the characters analyzed has not been estab­
lished within this group. Such significance has, however, often

been demonstrated elsewhere in the delimitation of subgen­
era, sections, and/or species of Mimulus and other taxa of

tribe Mimuleae (2, 3, 4, 10, 11, 12, 13).

Clues to relationships within section Paradanthus based

on pollen morphology are equivocal in terms of the group­

ings of species recognized by Grant (5). Thus, although the

overall mean percentage similarity value between M. shevockii

and examined members of the M. rubellus/M. Palmeri group

is a relatively high 87% (M. discolor A. L. Grant, 93%; M.

rubellus Gray ex Torr., 86%; M. suksdorffii Gray, 79%; M. barba­
tus, 100%; and M. bioletti Eastw., 79%) and although this

compares to mean values ranging from 52-72% for other

species groups of section Paradanthus, a number of species

assigned to these other groups have pollen grains that differ

very little from those of M. shevockii. For example, the grains

of M. didyma L. Grant of the M. moschatus group and M.

shevockii show a percentage similarity of 86%.

On the other hand, the grains of M. barbatus fail to differ

from those of M. shevockii in any of the traits mentioned, and

Heckard and Bacigalupi's (1) tentative association of these

species based on similarities in their vegetative morphology

(See Introduction) is consistent with the pollen evidence. M.

discolor, which Grant (5, Figure 1) apparently considered

closely related to M. barbatus (as M. deflexus Wats.), is also

very similar to M. shevockii in pollen morphology (See

above). However, the resemblance of the pollen grains of M.

androscæus, M. græcilîps, and M. purpureus to those of M.

shevockii remains to be explored (cf. 1).

Thus, although final assessment of the infrasectional

relationships of M. shevockii must await additional studies,

the preceding preliminary analysis implies that two independ­

ent sources of provisional evidence, the data from pollen and

vegetative morphology, may converge upon the same resolu­

tion. Such concordance provides a focus for further investiga­

tions within a complex where existing cypatorium informa­

tion is minimal (1) and where other lines of inquiry such as

experimental biosystematic and chemotaxonomic studies

have yet to be initiated.

Acknowledgements

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ined and for sharing unpublished information. I also thank

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Minnesota Herbarium, E. Stadelmann, the late John Hall, and

the Department of Horticultural Science, University of Minne­

sota, for auxiliary research facilities. The SEM phase of this

investigation was conducted in the Electron Microscope

Laboratory of the Department of Genetics and Cell Biology,

University of Minnesota.

Table 1. Measurements and collection data for pollen of Mimulus shevockii and M. barbatus

<table>
<thead>
<tr>
<th>Species of Mimulus</th>
<th>Collector, collection no., and locality</th>
<th>N</th>
<th>Polar axis (p)1, 2</th>
<th>Equatorial axis (E)1, 2</th>
<th>P/E2</th>
</tr>
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<tbody>
<tr>
<td>M. shevockii</td>
<td>Shevock 10368, Kern Co., CA</td>
<td>10</td>
<td>36.9 (34-41)</td>
<td>38.4 (35-41)</td>
<td>0.96 (0.86-1.08)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>36.6 (33-40)</td>
<td>37.3 (34-40)</td>
<td>0.98 (0.86-1.11)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>38.2 (33-44)</td>
<td>38.7 (34-44)</td>
<td>0.99 (0.89-1.28)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>33.8 (31-35)</td>
<td>38.6 (34-41)</td>
<td>0.89 (0.75-1.00)</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>36.9 (34-39)</td>
<td>38.2 (35-40)</td>
<td>0.97 (0.88-1.11)</td>
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<tr>
<td></td>
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<td>37.5 (31-41)</td>
<td>37.2 (34-40)</td>
<td>1.01 (0.87-1.23)</td>
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<td>36.2 (34-39)</td>
<td>40.5 (39-41)</td>
<td>0.90 (0.83-0.98)</td>
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<tr>
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<td></td>
<td>38.5 (36-42)</td>
<td>38.2 (34-41)</td>
<td>1.04 (0.95-1.11)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>37.0 (31-44)</td>
<td>38.4 (34-44)</td>
<td>0.97 (0.75-1.28)</td>
</tr>
</tbody>
</table>

M. barbatus Twisselmann 13402, Kern Co., CA

20 | 37.0 (31-44) | 34.5 (32-39) | 1.07 (0.78-1.29) |

1 Measurements are in micrometers (um)

2 Mean followed by range in parentheses.
Figures 1-6. SEMGs of pollen of *Mimulus shevockii* and *M. barbatus*. Unacetolyzed (Figure 1) or acetolyzed for one hour at room temperature (Figures 2-6). **Figures 1-3.** *Mimulus shevockii*. 1. Polar view. X2000. 2. Close-up of pollen wall. X12460. 3. Close-up of aperture. X4640. **Figures 4-6.** *Mimulus barbatus*. 4. Oblique polar view. X2310. 5. Close-up of pollen wall. X12270. 6. Close-up of aperture. X4360.

References


