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OLIGOMERY AND VASCULATURE IN THE ANDROECIUM OF MOLLUGO NUDICAULIS LAM. (MOLLUGINACEAE)

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SUMMARY

The androecial morphology and vascular anatomy of *Mollugo nudicaulis* Lam. are examined in serial transverse sections. Androecia of this species can be arranged in a reduction series. The position and vasculature of stamens in some transitional cases show that oligomery is likely to proceed from fusion rather than non-production or abortion of primordia.

1. INTRODUCTION

Oligomery may, in many cases, be thought to be the result of a reduction of the number of members of a floral whorl. The reduction is usually supposed to have proceeded from non-production or abortion, and not from fusion of primordia. Generally, the morphology and vasculature of mature oligomerous floral whorls do not allow conclusions as to the mode of the presumed reduction.

The flowers of the small annual tropical weed *Mollugo nudicaulis* Lam. (Molluginaceae) have five tepals and, normally, three to five stamens. In the course of a morphological and vascular-anatomical study of this species indications were found of an androecial oligomery effected by the fusion of stamen-primordia.

2. MATERIAL AND METHOD

Mollugo nudicaulis Lam. is cultivated at Haren (Gn.), in the Hortus Botanicus "de Wolf" of the State University of Groningen. Inflorescences and flowers at various stages of maturity were collected and preserved in FPA and, via TBA-dehydration, embedded in paraplast, according to the standard technique. Serial 10 μm thick transverse sections were stained with astra blue – auramine – saffranine (Maácz & Vágás 1963).

3. OBSERVATIONS

3.1. Morphology

The flowers of *Mollugo nudicaulis* Lam. have five free, essentially sepaloid, quincuncially arranged tepals. The tepals will be numbered here according to their relative position in the aestivation. Although the mature tepals constitute

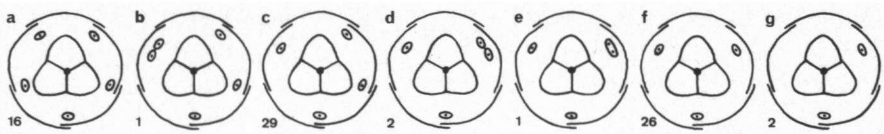

Fig. 1. Floral diagrams; number of cases observed (flowers with sinistrorse aestivation included in reverse).

a whorl, the organogeny suggests an arrangement in a sinistrorse or dextrorse two-fifth spiral: tepal 1 is produced first, followed by tepal 2 and 3, and, after that, by tepal 4 and 5. Petals or staminodes are absent. the superior, tricarpellary, basally trilocular gynoecium is, in transverse section, rounded equilaterally triangular, with the locules in the angles (MÜLLER (1908) recorded dimerous gynoecia in a *M.* cf. *nudicaulis*). One of the locules/carpels faces tepal 2.

The flowers of *M. nudicaulis* normally have three to five stamens. Reports of smaller or larger numbers are unknown to us. During the present study 2, 27, 31 and 17 out of 77 flowers were found to have 2, 3, 4 and 5 stamens, respectively. The number of stamens does not appear to be connected with the position of the flower in the inflorescence. The stamens are basally adnate with the gynoecial base. They constitute one whorl, as is shown by their equal size, insertion and vascularization at the same level, and approximately simultaneous arisal.

If there are five stamens, they are alternitepalous, the one alternating with tepal 1 and 3 being alternicarpellous as well (*fig. 1a* and *2a*). In the four-staminate flowers the two stamens alternating with tepal 4 are replaced by one alternicarpellous stamen in front of the tepal (*fig. 1c* and *2bc*). In the flowers with three stamens, in addition, the two stamens alternating with tepal 5 are replaced by one alternicarpellous stamen facing tepal 5 (*fig. 1f* and *2e*). In two flowers the alternicarpellous stamen alternating with tepal 1 and 3, and that situated in front of tepal 5, are the only stamens present (*fig. 1g*). Four transitional cases were found: a five- and two four-staminate flowers in which two stamens, instead of alternating with tepal 4, or 5, respectively, are basally connate, alternicarpellous, and situated in front of the tepal (*fig. 1bd*); and a flower with three stamens in which the alternicarpellous stamen facing tepal 5 has a wider filament containing, up into the connectivum, two vascular strands (*fig. 1e, 2d* and *4*).

3.2. Vasculature

In the present material of *Mollugo nudicaulis* Lam. the pedicels normally contain five collateral vascular bundles, each in the median plane of a tepal (a continuous pedicellar vascular cylinder was observed by SHARMA (1963)). The pedicel bundles give off their respective contributions to the perianth vascular supply at small and acropetally decreasing intervals, according to the relative position in the quincuncial aestivation of the tepal in front (according to SHARMA inter-tepal vascular internodes would be present in *M. pentaphylla* L., but not in *M. cerviana* (L.) Ser. and *M. nudicaulis*). Above the attachment of the

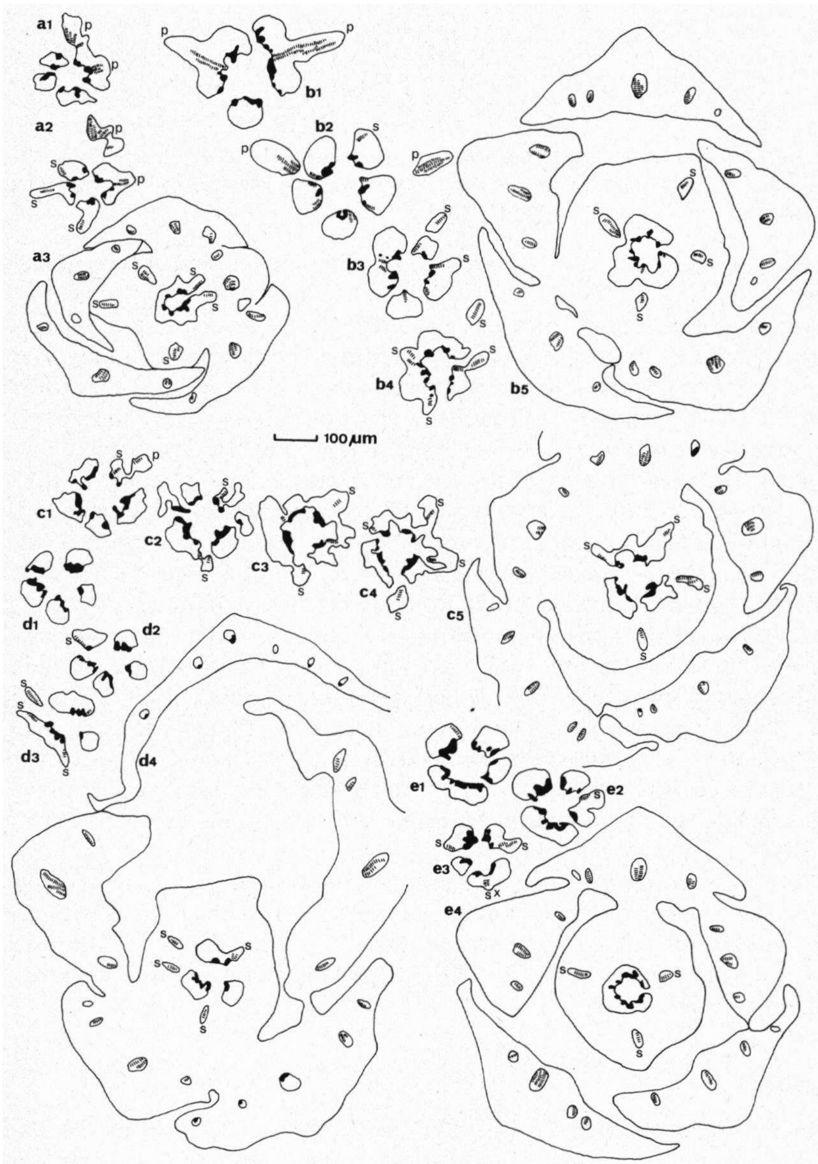

Fig. 2. Five sets of transverse sections (10 μm thick, alternately drawn in each series) showing the androecial vasculature (lignified xylem black when transversely, and striped when longitudinally cut; p: perianth trace; s: stamen trace).

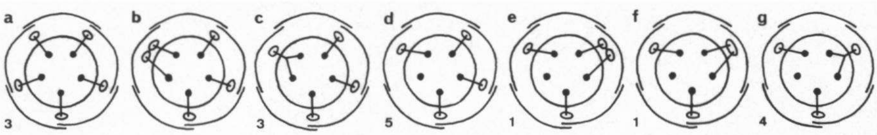

Fig. 3. Diagrams of the androecial vasculature; number of cases observed (b: hypothetic. Flowers with sinistrorse aestivation included in reverse). The five dots represent the stelar bundles above the attachment of the perianth vascular strands.

perianth vascular strands the stele contains five collateral alternitepalous bundles.

The androecial vasculature was examined in 17 flowers. In two of the four above-mentioned transitional cases, and in the two flowers with only two stamens, the vascular tissue was not yet sufficiently differentiated to allow such a study. Usually, the stamen traces are given off laterally from the stelar bundles. However, this is not always the case (e.g. x in *fig. 2e*). If there are five stamens, the trace of each of them arises from the facing bundle in the stele (*fig. 2a* and *3a*). In the four-staminate flowers the trace of the stamen in front of tepal 4 is connected either with both bundles alternating with the tepal (*fig. 2b* and *3c*), or with the one alternating with tepal 2 and 4 (*fig. 2c* and *3d*); this is not dependant on the age of the flower. The three remaining traces are provided like in the five-staminate flowers. In the flowers with three stamens the trace of the stamen facing tepal 5 is connected with both bundles in the stele alternating with the tepal (*fig. 2e* and *3g*); the two remaining traces are provided like in the four-staminate flowers of the second type. The latter also applies to the two transitional cases studied (*fig. 2d, 3ef* and *4*); in these flowers the traces of the two basally connate stamens, and the stamen with the wider filament, respectively, each arise from one of the stelar bundles alternating with tepal 5.

Above the attachment of the stamen traces the central vascular tissue appears as a continuous, somewhat equilaterally triangular cylinder, with one of the angles facing tepal 2. The three portions in the angles provide the vascular strands of the gynoecial wall; the remaining lateral portions those of the central column and the ovules.

4. DISCUSSION

With regard to the number, position, and width of the stamens the studied flowers of *Mollugo nudicaulis* Lam. can be arranged as in *fig. 1*. It appears justified to place the flowers with five alternitepalous stamens at the base of the series, and to consider oligomery of the androecium the result of a reduction. Presumably, the reduction proceeds either from non-production or abortion, or from fusion of primordia.

The position of the stamens in the normal four- and three-staminate flowers (*fig. 1cf*) gives no clue as to the mode of the reduction. It may be explained by the fusion of two adjacent, originally alternitepalous primordia at a time

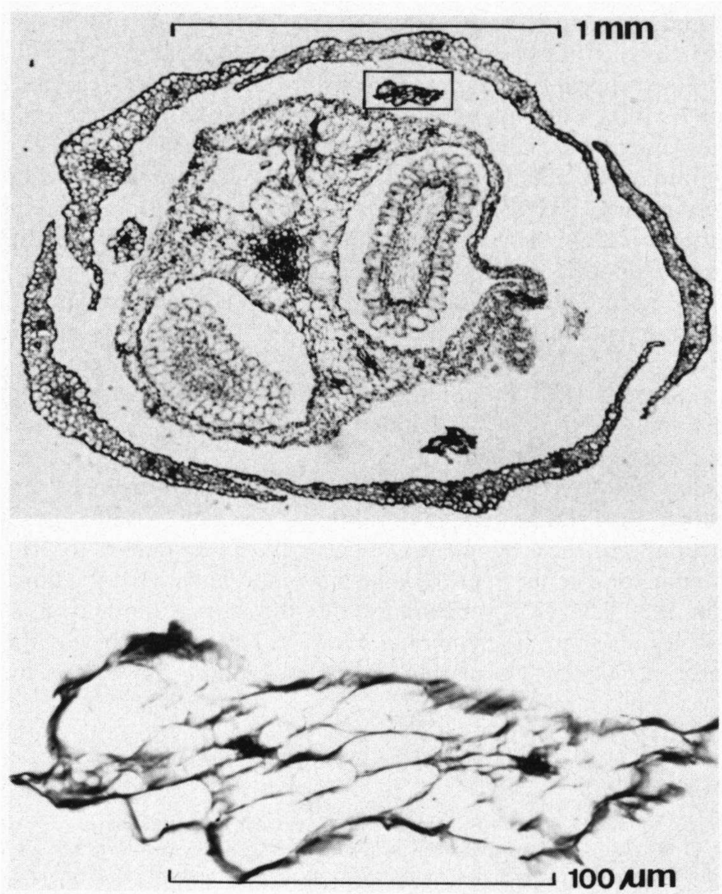

Fig. 4. Transverse section; one filament (box) is somewhat wider than the other two; the enlargement shows two vascular traces.

into one alternicarpellous, "pseudo-epitepalous" one, but equally by the non-production or abortion of one of the pair and shifting of the other. The same applies to the androecial vasculature in these flowers (*fig. 3cdg*). Conditions like in *fig. 3c* (left) and *3g* (right) may be explained either by the fusion of two primordia and vascular "conservatism" or "opportunism", or by non-production or abortion of one of the pair and shifting of the other and vascular opportunism. A situation like in *fig. 3d* (left) and *3g* (left) might result from the non-production or abortion of the primordium alternating with tepal 1 and 4, shifting of the one alternating with tepal 2 and 4, and vascular conservatism; but equally from non-production or abortion of one of the pair, shifting of the other, and vascular opportunism; or from fusion of the two primordia and vascular opportunism.

The occasional presence of two basally connate stamens gives more grip. The position and vasculature of these stamens (*fig. 1bd* and *3e*) indicate a shifting towards each other of two adjacent, originally alternitepalous primordia; other interpretations appear far-fetched. The position and vasculature of the one stamen found with a wider filament containing two vascular traces (*fig. 1e* and *3f*) cannot easily be explained otherwise than by the incomplete fusion of two such primordia. If the androecial reduction is thought to proceed from fusion of primordia, these aberrant cases can effortlessly be incorporated in the series, as transitions; if the reduction is presumed to be caused by non-production or abortion of primordia, they cannot.

Thus, the normal androecial reduction in *M. nudicaulis*, resulting in four- and three-staminate flowers, is likely to proceed from fusion rather than non-production or abortion of primordia (without histogenetic study the kind of fusion (cf. SATTLER 1978) cannot be determined). However, the exceptional further reduction, resulting in flowers with two stamens (*fig. 1g*), is doubtlessly caused by non-production or abortion.

Accepting HOFMEISTER's (1868) conclusion that available space is an important factor in the arrangement of floral parts, we might assume the "aim" of the reduction to be the attainment of a better fit of the stamens to the triangular gynoecium, or a better fit of the stamen-primordia between the three carpel-primordia. It is, then, easily understood that the stamen alternating with tepal 1 and 3 is not involved: it already fits. However, it is not clear why the reduction affects the stamens alternating with tepal 4 before those alternating with tepal 5.

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