

NOTES ON THE STIGMA MORPHOLOGY AND FLOWERING BEHAVIOUR IN BRITISH SALICORNIAE

By I. K. FERGUSON
Trinity College, Dublin

ABSTRACT

Moss transferred *S. perennis* Mill. to the genus *Arthrocnemum*. This paper sets out to show that two of the characters, the shape of the stigma and the sequence of maturation of the reproductive organs, that Moss used to separate the genera *Salicornia* and *Arthrocnemum* are very variable in plants from the British Isles. If this is accepted it would seem that the criteria for the definition of the genus *Arthrocnemum* will need reconsideration once more.

INTRODUCTION

In a posthumously published paper primarily concerned with South African Chenopodiaceae Moss (1948) transferred *S. perennis* Mill. to the genus *Arthrocnemum*, and I understand that the combination *A. perenne* is being taken up in *Flora Europaea*. This paper draws attention once more to the confused and unsatisfactory position with regard to the delimitation of these two genera.

Arthrocnemum was first proposed by Moquin (1840), who included *S. perennis* Mill. in his original delimitation of the genus. Moquin uses the absence of albumen in the seed and of wings on the perianth, together with the mode of insertion of the florets, as characters to separate the genus from *Salicornia*. It seems doubtful however, whether these characters possess the validity which he attributed to them as they have been adopted by few subsequent botanists. The absence of albumen in the seeds does not seem to be constant throughout the traditional limits of the genus (Moss 1954). De Fraine in an extensive investigation of the anatomy of the genus *Salicornia* makes no reference to any difference in the insertion of the florets between *S. perennis* Mill. and the annual species in the British Isles. In my own observations I have found that small differences do exist between *S. perennis* Mill. and the annual species of *Salicornia* in the British Isles in the shape of the florets and in the degree to which the central floret separates the laterals and also in the arrangement of the wings of the perianth. However, the former characters are very variable among the annual *Salicornia* that I have seen and it is doubtful whether they are sufficiently constant to serve as a basis for generic separation.

In a later paper Moss (1954) redefined the genera according to the following criteria.

Arthrocnemum: perennial; protogynous; stigma bifid; some of the branches not terminating in an inflorescence.

Salicornia: annual; protandrous; stigma tufted; branches all terminating in an inflorescence.

Salicornia perennis Mill. certainly differs from the annual species of the British Isles in the first and last of these four characters. This paper sets out to show, however, that in the shape of the stigma and in order of maturation of reproductive organs of the flower, no clear separation is possible. If this is accepted it would seem that the criteria for the definition of the genus *Arthrocnemum* will need reconsideration once more. I hope, at a later stage, to undertake a limited investigation of these criteria throughout the range of the two genera.

STIGMA MORPHOLOGY

The stigma in *S. perennis* Mill. may be bifid or trifid; the branches are usually about 1 mm in length and often persistent after fertilization (Fig. 1). In annual species of *Salicornia* the stigmas are variable even within the same plant, being 'tufted' (that is very shortly branched with branches often unequal in length), bifid, or trifid, and often persistent

(Fig. 1 and Plate 1a). The stigmas of annual material collected in the field are usually shorter than those of *S. perennis*, with branches usually about 0.5–0.7 mm in length. Tetraploid plants cultivated from seed from six populations resembling *S. lutescens* Ball & Tutin, however, produced stigmas with very long branches of more than 1 mm in length and indistinguishable from those of *S. perennis* (Fig. 1). In diploid plants referable to *S. europaea* agg. and *S. pusilla* Woods the branches of the stigmas are usually shorter and more slender than those of *S. perennis* but are very variable, and in cultivation they may be indistinguishable from those of *S. perennis*.

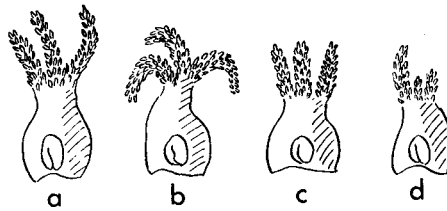


Fig. 1. Stigmas of *Salicornia*, $\times 10$ approx. (a) *S. perennis*. (b) from an annual tetraploid plant in cultivation. (c) and (d) from annual tetraploid plants in the field.

These observations are in harmony with the illustrations in Smith's *English Botany*, where *S. perennis* (t. 1691) and an annual species closely resembling *S. lutescens* Ball & Tutin (t. 415) are both depicted with trifid stigmas, though the branches of the former are longer. A third illustration (t. 2475) shows another annual species with a tufted stigma. Tutin (1952) describes the stigmas in *S. perennis* as bifid and those in the annual species as tufted. Later (Tutin 1962) he retains the description of the stigma in *S. perennis* as bifid but omits any description of those in the annual species.

FLOWERING

I have found from observations in the field that *S. perennis* Mill. is protogynous; this is in agreement with Moss (1954) and Dalby (1962).

Among the annual species I have observed that in tetraploid plants resembling *S. lutescens* Ball & Tutin and *S. dolichostachya* Moss, both in the field and in cultivation, either the stigmas protrude just before the undehisced anthers are exerted (Plate 1b, seen in the two lateral florets of the lower segment) or the anthers and stigmas emerge simultaneously (Plate 1c and d). It thus appears that some annual *Salicorniae* are weakly protogynous or homogamous. This view to some extent supports Dalby (1962) who says 'usually it seems that *Salicornia* is weakly protogynous and sometimes it may be markedly so (as for example *S. perennis*)'. Plate 1b further supports Dalby's view 'that it is very likely that many of the annual forms are self-pollinated in nature, as ripe dehiscing anthers may be seen in contact with presumably receptive stigmas, and their pollen spilling on to the stigmatic papillae (see Fig. 1)'. However, his figure does not show this very clearly.

In some diploid plants I have confirmed the observations of Ball & Tutin (1959) that the flowers may be cleistogamous. In others the anthers are exerted after dehiscence; it is difficult, however, to observe the sequence of development in either of these conditions. Further observation is required.

I have observed that plants in cultivation and in the field may sometimes have unisexual flowers, either of the organs failing to develop. I have also observed that the stigmas frequently elongate and persist after fertilization. Elongation must occur after fertilization has taken place as the stigmatic papillae have always been found to have collapsed when it commences. These phenomena may have contributed to misinterpretation in the past of the sequence of development of the anthers and stigmas.

ACKNOWLEDGMENTS

I wish to express my thanks to Prof. D. A. Webb for assistance and advice. The work was done during the tenure of postgraduate awards from the Department of Education and the Board of Trinity College, Dublin.

REFERENCES

- BALL, P. W. & TUTIN, T. G. (1959). Notes on annual species of *Salicornia* in Britain. *Watsonia* **4**, 193-205.
- DALBY, D. H. (1962). Chromosome number, morphology and breeding behaviour in the British Salicorniae. *Watsonia* **5**, 150-162.
- DE FRAINE, E. (1912). The anatomy of the genus *Salicornia*. *J. Linn. Soc. (Bot.)* **41**, 317-348.
- MOQUIN, A. (1840). *Chenopodearum monographica enumeratio*, 111-116. Paris.
- MOSS, C. E. (1948), in Barker, W. F., *et al.*, *Plantae novae africanae*, ser. 28. *J. S. Afr. Bot.* **14**, 29-40.
- MOSS, C. E. (1952), in Adamson, R. S. The species of *Arthrocnemum* and *Salicornia* in southern Africa. *J. S. Afr. Bot.* **20**, 1-22.
- SMITH, J. E. (1807, 1815). *English Botany*, vols. 6, 24 & 35. London.
- TUTIN, T. G. (1952), in Clapham, A. R., Tutin, T. G. & Warburg, E. F. *Flora of the British Isles*. ed. 1. Cambridge.
- TUTIN, T. G. (1962), in Clapham, A. R., Tutin, T. G. & Warburg, E. F., *Flora of the British Isles*. ed. 2. Cambridge.

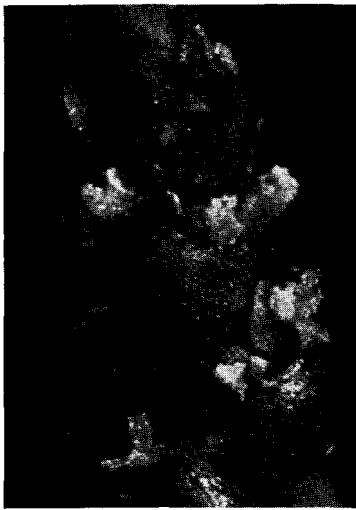
PLATE 1



(a)



(b)



(c)



(d)

Inflorescences of annual tetraploid *Salicornia* spp., $\times 7$ approx. (a) Variation in stigma morphology. (b) In the two lower lateral florets the stigmas are protruding before the anthers; in the central florets immediately above, the anthers are dehiscing in contact with their stigmas. (c) Simultaneous development of anthers and stigmas in the lower central floret and in the dissected floret. (d) A further inflorescence showing simultaneous development of anthers and stigmas.