Detection of protandry and protogyny in Sycamore (*Acer pseudoplatanus* L.) from infructescences

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ABSTRACT

In Sycamore (*Acer pseudoplatanus* L.), trees may be protandrous when their inflorescences start with a sequence of male flowers followed by a sequence of female flowers, or protogynous when the reverse sequence occurs. The sex expression on an inflorescence may change more than once and, in Ireland, five modes of sex expression have been observed. When studying such heterodichogamous species it is essential to determine their sexual morphs. A method to sex Sycamore using infructescences only is described. Using a variety of characters such as fruit size, percentage parthenocarpy, infructescence length, size of terminal bud scar and position of the fruit on the first secondary axis, it is possible to distinguish between protandrous and protogynous individuals.

INTRODUCTION

In Sycamore, *Acer pseudoplatanus* L., all flowers are functionally unisexual and appear sequentially on a single inflorescence. When male anthesis takes place before the stigmas become receptive, the inflorescence is described as protandrous, and is protogynous when the reverse sequence occurs. Likewise individual trees may be either protandrous or protogynous. Such a sexual dimorphism is called heterodichogamy (Stout 1928). On a single inflorescence the sex of sequentially opening flowers may differ more than once in time, and de Jong (1976) described eleven different modes of sex expression within an inflorescence, of which five have been observed in the north of Ireland (Fig. 1).

Protogynous individuals will produce inflorescences of Mode B and very rarely a few of Mode G. Protandrous individuals are far more variable as they have inflorescences of Mode C, D, or E, or a mixture of these. Male-flowering trees are described as protandrous because in some years some or even all their inflorescences have female flowers. Similarly protandrous individuals will exhibit large annual variation in the proportion of inflorescences of Mode C, D, and/or E (de Jong 1976). Scholz (1960) has reported the existence of female-flowering individuals. There is no evidence that trees will change their modes of sex expression with age.

In heterodichogamous species certain characters, such as fruit production, percentage of fertilized fruits and the number of carpels per fruit, may vary between morphs (Binggeli, unpublished). In order to explain such variations it is then essential to know the sexual morph of the trees studied. Because sexing the flowers of trees in spring is rather time-consuming and/or impractical on tall specimens, a method using the morphological characters of the infructescence was developed.

RELIABILITY OF METHOD

The method for the identification of the sex expression of the inflorescences using infructescences was developed in 1983, and was tested with 95% success when comparing the flowering data of 240 trees obtained in spring and the determination of the sex expression using infructescences in the autumn. The test was repeated in 1984 with 100% success.

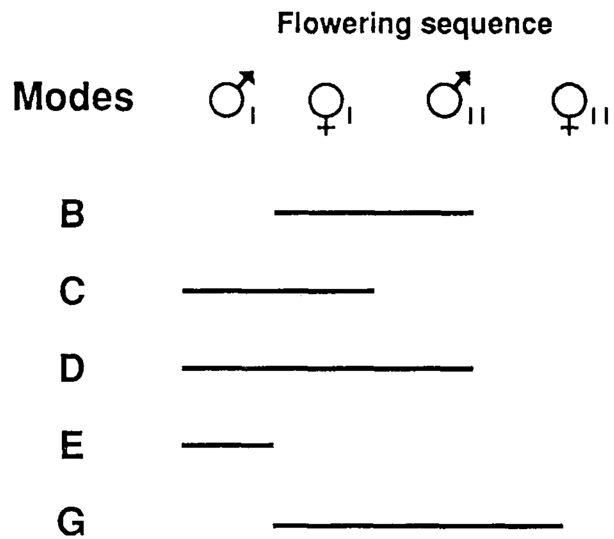

FIGURE 1. Modes of sex expression observed on Sycamore inflorescences in the north of Ireland. Flowering sequences are represented by male (♂) and female (♀) type flowers. A roman numeral subscript one (I) represents an initial flowering period, a roman numeral subscript two (II) a subsequent flowering of the same type. Modes according to de Jong (1976).

DESCRIPTION

Using fruiting material only, one can differentiate between protandrous and protogynous individuals and also between infructescences of Mode B and Mode G of the latter group using the characters listed in Table 1 and as shown diagrammatically in Fig. 2. In Mode G the structure and position of the fruits of the first part of the stalk is similar to the normal protogynous infructescence (Mode B), but it is longer and it bears a few small parthenocarpic fruits at its end (Fig. 2C). It is, however, impossible to distinguish between infructescences from Mode C and D. The very few male-flowering individuals (Mode E; less than 1% in Ireland) will not be recognised with this method and only the shoot morphology will provide indications of their existence. In these, soon after flowering,

TABLE 1. MORPHOLOGICAL DATA FROM INFRUCTESCENCES DIFFERENTIATING BETWEEN PROTANDROUS AND PROTOGYNOUS INDIVIDUALS, AND ALSO BETWEEN MODE B AND MODE G OF THE LATTER GROUP

		Protogynous	
Character	Protandrous	Mode B	Mode G
Fruit size (length of samara in cm)	2·5–3·5	3·0–4·0	3·0–4·0 & (1·5–2·5 terminal)
Parthenocarpy[a]	30–90%	10–40%	10–40%
Length of infructescence	>10 cm	<10 cm	>10 cm
Terminal scar (diameter in mm)	0·5–1·0	1·0–2·0 Usually diagonal	0·5
Position of fruit on 1st secondary axis	On a tertiary axis (2nd axis ends with a scar)	Terminal	Terminal

[a] Parthenocarpy is assessed as the percentage of empty samaras. In the field they are recognized by their smaller size and also by their distinctly empty nutlet.

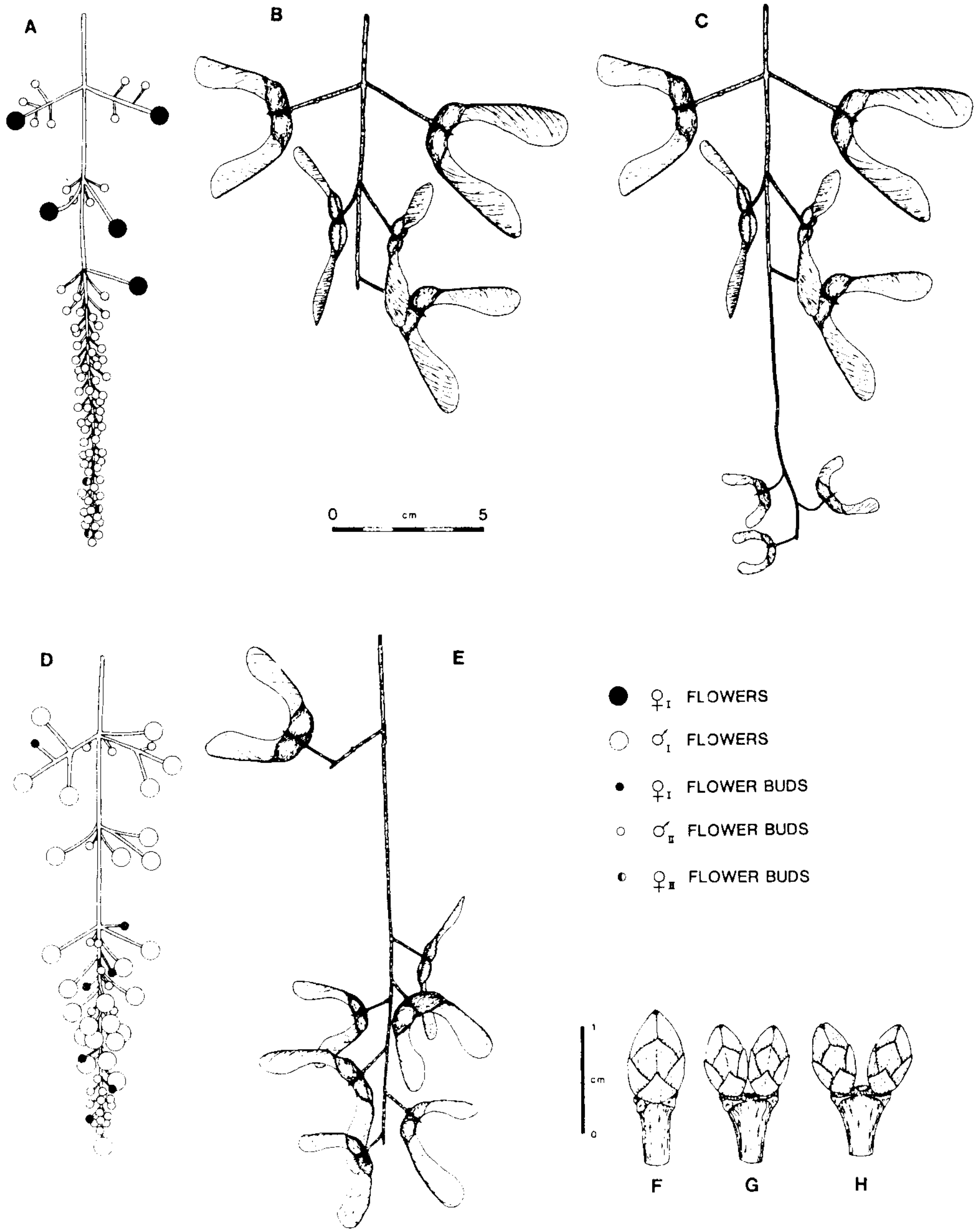

FIGURE 2. Architectural differences between protandrous and protogynous inflorescences and infructescences (see Table 1 for other diagnostic features) and shoot morphology after leaf and infructescence fall in Sycamore. A, Protogynous inflorescence (♀$_{II}$ flowers (◐) of Mode H are ♂$_{II}$ in Mode B (○)). B, Protogynous infructescence, Mode B. C, Protogynous infructescence, Mode H. D, Protandrous inflorescence. E, Protandrous infructescence. F, Vegetative shoot. G, Flowering shoot (Mode E). H, Fruiting shoot (Flowering Modes B, C, D, & G).

the inflorescences will fall and the two growing terminal buds will be closely appressed (Fig. 2G). On the other hand in other modes of flowering, female flowers, even if unfertilized, will produce fruits, because of a high parthenocarpic tendency in maples. Such infructescences will remain on the trees most of the summer leading to two well separated terminal buds (Fig. 2H). It should be noted that some small flowering side shoots may not produce any buds.

Only practice allows one to determine the sex expression of the individual with accuracy from infructescence material, and whilst the majority of the individuals examined fit easily into one or other of the two morphs, nevertheless some trees have features which do not always fit entirely the description given in Table 1 and Fig. 2. For instance some infructescences of Mode B do have a terminal fruit, but this is never the case for protandrous modes of flowering.

The size of fruits and infructescences, and the number of fruits per infructescence given in Table 1 are applicable to Sycamores encountered in most of the British Isles and the Alps. However in areas with a very favourable climate (e.g. some parts of lowland Switzerland) measurements of fruit and infructescence size and the number of fruits per infructescence may be higher, and therefore the values listed in Table 1 may be misleading.

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