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SOME ASPECTS OF FLORAL BIOLOGY OF *CASSIA FISTULA* LINN. (THE INDIAN LABURNUM)—PART I

P. PARDHA SARADHI AND H. Y. MOHAN RAM
Department of Botany, University of Delhi, Delhi 110 007, *India*

ABSTRACT

The ten stamens of *Cassia fistula* occurring in two whorls are of three sizes : 3 long, 4 medium and 3 short. In some trees the short stamens are sterile. Although the Fabaceae are said to be characterized by starchless pollen grains both starchy (27·5 to 47·0%) and lipid-rich (53 0 to 72·5%) pollen have been identified in the same flower of *Cassia fistula*. Starchy pollen are abundant in the anthers of the inner whorl and lipid-rich pollen occur in the stamens of outer whorl.

Of the 0·65 million pollen produced on an average by a flower, only about 250–350 pollen are used for pollination. The pollen were detected only in the hollow apical part of the style which acts as the stigma and not on the outer surface of the stylar tip. It is quite likely that pollination in *Cassia fistula* is effected by some heavy bodied insects which push the pollen into the hollow stigma with some force. This requires confirmation.

INTRODUCTION

CASSIA FISTULA (Fabaceae) is a beautiful deciduous ornamental tree bearing golden yellow flowers in pendulous, chandelier-like racemes during summer months. The zygomorphic, pentamerous, bisexual and hypogynous flowers bear 10 stamens in two whorls (of five each) in three sizes. According to Venkatesh[11] all the stamens are fertile. The pollen of this plant are reported to be allergenic (Saha and Kalyanasundaram[8]; Chanda *et al*[3]). In this paper, attention has been paid to the production, structure and contents of the pollen grains and the biology of pollination. It was of interest to determine whether stamen heteromorphy has any role in the biology of the flower.

Material and Methods

Flowers from ten trees of *Cassia fistula* growing in the campus of the University of Delhi were selected for study. Uniform pollen suspensions were made in known amounts of 40% glycerine, by crushing the anthers. Quantitative estimation of the pollen was done using a haemocytometer. Microchemical tests were carried out for starch using IKI (Jensen[6]), for lipids using Sudan III and for proteins with aniline blue black (Fisher[4]). Herr's clearing fluid [composed of 85% lactic acid, chloral hydrate, phenol, clove oil and xylene in the ratio 2:2:2:2:1 (by weight) respectively (Herr[5])] and 10% KOH were used for clearing the anthers, ovaries and styles and for counting the number of ovules. The diameter of the pollen grains was measured by using an ocular micrometer.

Observations

Stamens

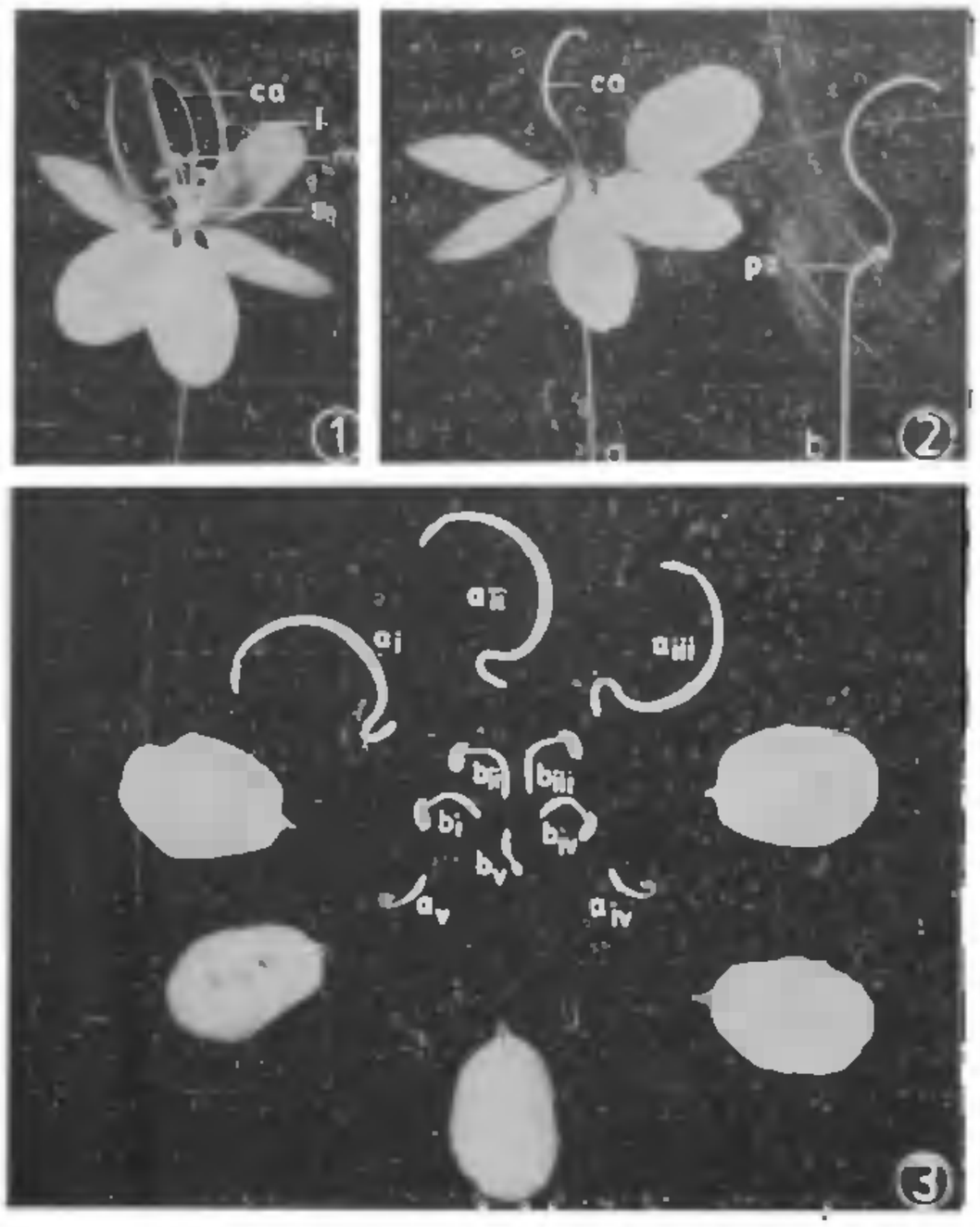
Of the five stamens belonging to the outer whorl, three are long, curved (Fig. 3a_i–a_{iii}) and anteriorly placed (Fig. 1) and two are short and posteriorly oriented (Fig. 1) with the filaments coiled at the tips (Fig. 3a_{iv} and a_v). The anthers of this whorl are ellipsoidal and flattened with blunt ends, showing incomplete longitudinal dehiscence at their tips by means of short slits. Four of the stamens of the inner whorl are medium sized (Fig. 1 and Fig. 3 b_i–b_{iv}) and the fifth is short (Fig. 1 and Fig. 3 b_v). The anthers of this whorl are pear-shaped with sub-basal pores, through which pollen are dispersed. Anthers borne by the short stamens in both the whorls are small. Pollen are tricolporate, irrespective of the size of the stamens. The average diameter of the pollen grains, in all the anthers, excepting those belonging to short stamens of the outer whorl, is 33 μm (ranging between 31–36 μm). The pollen grains borne by the short stamens of the outer whorl are smaller (22–39 μm).

Pollen Production

The total number of pollen grains produced by a flower varied from 6,41,830 to 6,62,360. Of this number, nearly 60–62% of the pollen was contributed by the medium stamens and 35–37% by the long stamens. The two short stamens of the outer whorl showed no pollen in three trees and contained just 1–2·5% of the total in the remaining seven trees; the share of the pollen from the single short stamen of the inner whorl was 1–1·5% (Table 1).

Microchemical Tests

The following qualitative differences were observed in the nature of the reserve materials contained in the pollen. The pollen (90–100%) from stamens of the outer whorl showed high lipid contents and low to negligible amount of starch, as ascertained by specific reactions. In the medium stamens 60–70% of the pollen were rich in starch and poor in lipids. A large number (50–98%) of the pollen belonging to the single short stamen of the inner whorl showed high starch and low lipid content, the remaining pollen were poor in starch and rich in lipids. The pollen had a low amount of protein and no visible differences were observed in the protein content of starchy and lipid-rich pollen.



FIGS. 1–3. Fig. 1. An open flower showing relative disposition of various parts. Fig. 2. *a*, A flower in which stamens have abscised; *b*, A carpel after abscission of all the other floral parts. Fig. 3. The ten stamens and five petals of a flower are arranged to show their morphology. a_i–a_{iii} represent the 3 long, and a_{ii} and a_v the two short stamens with coiled filament at the tip in the outer whorl; b_i–b_{iv} are the 4 medium stamens and b_v is the short stamen of the inner whorl. (*ca*, carpel; *l*, long stamens; *m*, medium stamens; *s*, short stamens.)

Carpel

The style is hollow and has at its tip horizontal papillae (in relation to the long axis) both outside and inside. The carpel surface shows sparsely dispersed trichomes towards the upper portion and densely dispersed trichomes along the ovary. On an average 78 campylotropous ovules (ranging from 76 to 100)

TABLE 1

Pollen productivity and pollen analysis

Type of stamens	Number	Percentage of pollen production	Number of pollen per anther	Percentage of pollen rich in starch	Percentage of pollen rich in lipids
Outer whorl					
1. Long	3	35–37	76,000 to 82,000	0–10	90–100
2. Short	2	0–2·5	0 to 7,900	0–10	90–100
Inner whorl					
1. Medium	4	60–62	97,000 to 1,02,500	60–70	30–40
2. Short	1	1–1·5	7,500 to 10,100	50–98	2–50

(Data collected from 400 flowers : 40 from each tree)

arranged on marginal placentation were present in the ovary.

A careful examination of the surface of the style showed no pollen grains. However, groups of pollen grains varying from 7–1,000 (generally 250–350) were seen embedded in the hollow stigma. The exact mode of pollen insertion into the stigma has not been established. The insects visiting the flowers have been collected and identified as follows : honey bee (*Apis indica*, Apidae); black ant (*Camponotus compestris*, Formicidae); common wasp (*Polistes herbaceous*, Vespidae); and thrips (yet to be identified, Thysanoptera). Interestingly, a large number of thrips were seen crawling along the style with pollen loads. In some instances they were also seen entering the stigmas.

Abscission

Shedding of floral parts starts on the same day as anthesis. The longer stamens are the first to abscise, followed by the stamens of the other two sizes. Sepals are the next to abscise, either by themselves or along with the rest of the flower (especially if pollination fails to occur) at a well-marked pre-determined zone (Fig. 2). Sometimes in an unpollinated flower the entire carpel abscises leaving the petals behind. The corolla is shed in a day or two. In the pollinated flowers the petals also drop off, following abscission of the sepals, leaving back the carpel.

DISCUSSION

The present observations support the earlier report by Venkatesh[11] that all the anthers of the outer whorl dehisce by incomplete longitudinal slits and that all the anthers of the inner whorl have sub-basal pores for pollen dispersal. However, Singh and Sharma[9] state that the anthers of short stamens of the flower are non-dehiscent. Whereas Venkatesh[11] noted that all the ten anthers in a flower are fertile, the present investigators have observed that this is not universal; in three trees the anthers of short stamens of the outer whorl are sterile.

The family Fabaceae was included among the families characterized by starchless mature pollen grains (Baker and Baker[1]). The present observations clearly show the presence of both starchy and non-starchy mature pollen grains even within the same flower of *Cassia fistula*. The percentage of starchy and starchless pollen produced was shown to be 27·5–47·0 and 53·0–72·5, respectively. Whether the different types of pollen produced within the same flower serve different functions as shown in some members of subfamily Lecithidoideae of Lecythidaceae (Mori *et al.*[7]) is to be ascertained. No significant differences were seen in the sizes of starchy and starchless pollen grains as seen in some instances (Baker and Baker[1]), although some variations are seen in the size of the pollen grains of the shorter stamens of the outer whorl.

An exercise carried out to determine the production and utility of pollen, showed that out of about 0·65 million pollen produced per flower, only 250–350 pollen are used for pollination. The remaining pollen might be acting as food for the visiting insects (pollinators). Hence, as 78 ovules are seen usually per carpel, the number of pollen utilized per ovule is only 3–6.

In general starchy pollen are dispersed by air. Assuming a similar situation for *Cassia fistula*, the starchy pollen produced by it might be responsible for the allergenic effects. This would, however, need further evidence in the form of collection of samples of air-borne pollen, determination of their starch or lipid content and actual tests for allergy causing ability. The results of such studies when considered along with the data on pollen production, types of pollen and mode of dissemination presented in this paper would help in the classification of *Cassia fistula* in terms of their allergenicity.

As no pollen grains could be seen adhering to the outer surface of the style and as groups of pollen were seen only inside the hollow apical part of the style, the receptive surface of the stigma seems to be embedded inside the style.

It has been reported in *Cassia quiedonilla* (Buchmann[2]) and in *Cassia fasciculata* (Thorp and Estes[10]), that certain bees bring about pollination, either by their buzzing or vibratory behaviour. Dulberger (personal communication) has also noted that in *Cassia didymobotrya* and *C. auriculata*, pollen are pushed into the stigma by heavy-bodied insects. Though some heavy-bodied insects (honey bee and common wasp) have been observed visiting the flowers, their actual role needs to be carefully examined. Presence of about 250–350 pollen in a single group, within the hollow style, clearly indicates that they might be inserted into it with some force. Although thrips have been seen crawling over the styles and even entering the stigmas along with some pollen, the possibility of only thrips being pollen vectors is quite unlikely as thrips are too small to account for the presence of a large number of pollen noted in most of the stigmas.

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MEASUREMENT OF THE RATIO OF THE NUMBER OF *X* CHROMOSOMES TO SETS OF AUTOSOMES IN *DROSOPHILA MELANOGASTER*

RAGHAVENDRA GADAGKAR, V. NANJUNDIAH*, N. V. JOSHI AND H. SHARAT CHANDRA**
Centre for Theoretical Studies, Indian Institute of Science, Bangalore 560 012, *India*

ABSTRACT

In *Drosophila melanogaster* both sex determination and dosage compensation are governed by the ratio of the number of *X* chromosomes to sets of autosomes. We propose a mechanism by which this ratio can be measured at the cellular level. The mechanism helps in understanding the effects of, and interactions among, mutants affecting the processes of sex determination and dosage compensation.

IN the fruitfly, *Drosophila melanogaster*, the rate of transcription of the *X* chromosome in the male is about twice that of each of the two *X* chromosomes in the female. As a result, the amount of gene product per cell in a male, which normally has one *X* chromosome, and that per cell in a female, which has two *X* chromosomes, is nearly the same. This method of compensating for the difference between the two sexes in the number of *X* chromosomes has been called *dosage compensation*[1–3].

It has been known for a number of years that sex in *Drosophila* is determined by the ratio of the number of *X* chromosomes (*X*) to sets of autosomes (*A*)[4].

* Molecular Biology Unit, Tata Institute of Fundamental Research, Bombay 400 005, India.

** CTS, Microbiology and Cell Biology Laboratory and ICMR Centre for Genetics and Cell Biology.