

3-1-1910

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I. H. Burkhill

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Recommended Citation

Burkhill, I. H., "Notes on the Pollination of Flowers in India. Note No. 7 A few observations made in the Central Provinces and Berar" (1910). *Bu*. Paper 22.

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8. Notes on the Pollination of Flowers in India. Note No. 7. A few observations made in the Central Provinces and Berar.

By I. H. BURKILL.

The following observations were made on tours in the Central Provinces and Berár, in 1908 and 1909. The first of the tours comprised a visit to the hill of Asirgarh in Nimár (26-28. ix. 08) and a journey by road from Ellichpur over the Sátpras through the forests of the Melghát to Lewáda where the Sipna valley opens towards the river Tápti, (3-19. x. 09): the second comprised a visit to Nágpur (14-22. ii. 09) and the third an excursion into the Melghát from Akot, along the Ban valley and to Jálgaon in the Buldána district (16-26. ix. 09). The weather during the last tour was unsettled.

The notes are fragmentary; but years may pass before an opportunity occurs for making them more complete. The chief point in them is connected with the cotton plant,—chief, because for those who are trying to breed out of our cottons improved races, it is essential to recognise the extent of that cross-pollination in the field which will level down what they are raising up.

The insects have been determined for me by Messrs. H. Maxwell-Lefroy, E. Brunetti and C. A. Paiva, to whom I offer my best thanks.

A Bee as a regular visitor to Cotton flowers, and some other visitors.

There is evidence that in the Ganges valley, the races of cotton, when grown mixed, are crossed naturally with some freedom. The literature is in three places. Firstly, in the *Agricultural Ledger* No. 8 of 1895, p. 10, Professor T. H. Middleton set forward his belief that seed of the Behar cottons—'Bhogila' and 'Deshi'—gave rise to hybrids in his experimental plot at Baroda. Secondly, in this journal for 1907, pp. 517-526, I called attention to the insects which visit cotton flowers in Behar in May and to the presence of apparent hybrids in the crops there. Thirdly, Mr. Martin Leake (this Journal, 1908, p. 18) felt himself justified in saying that indirect evidence exists in abundance for regarding the crossing of cottons in nature as of common occurrence: and he recorded a few observations made by himself on the variability of progeny from seed collected when precautions were not taken to prevent natural crossing.

Fyson (*Memoirs Dept. Agric.* ii, no. 6) has more recently

stated on similar grounds that in Madras at least some natural crossing occurs.

All this evidence is opposed to Gammie's view, based on observation at Poona, that cotton does not get cross-fertilised in nature (*Memoirs Dipt. Agric.* ii, no. 2). Certainly Gammie's view cannot be made a generalisation for India as a whole.

In this connection it is now interesting to record, as an apparently regular insect-visitor to cotton flowers in parts of Berár, a bee, which by reason of its large hairy body is admirably adapted for carrying pollen from flower to flower. This insect is *Megachile albifrons*, Smith. It is, however, not very active in moving from flower to flower. I first observed the bee on the afternoon of September 22nd, 1909, sheltering in cotton flowers during rain at Pingli, which is a village lying just under the hills in the north-east corner of the Buldána district. By a search through a field four more individuals were found. On the next day between Pingli and Wasáli, during the morning, nine insects were seen, and in the afternoon at Wasáli eight more.

No observations were made on September 24th owing to rain; and on the 25th between showers no bees were seen on the cotton flowers during a march from Jamod to Jálgaon; but on September 26th, four miles south of Jálgaon, two more individuals were seen on cotton flowers. This makes a total of 24 individuals seen on cotton flowers in six days. On the 26th I left the district.

The common cotton of north-eastern Buldána is the yellow flowered Jari (*Gossypium neglectum*, Tod., var. *vera*, Gammie). Grown mixed with it, is a considerable quantity of white flowered Jari (*G. neglectum*, Tod., var., *rosea*, Gammie) and a not inconsiderable amount of Dharwar American cotton (*G. hirsutum*, Mill.). No individuals of *Megachile albifrons* were seen on *G. neglectum*, var. *rosea*, and only one on *G. hirsutum*: all the others were on *G. neglectum*, var. *vera*.

From the insects' point of view these three cottons may be very unlike; for *G. neglectum*, var. *vera*, has large yellow flowers which nod as a rule and open rather widely; *G. neglectum*, var. *rosea*, has smaller rose-white flowers which generally ascend slightly from the horizontal and open but little; *G. hirsutum* has upright pale yellow flowers which open earlier than the other two, and widely.

Bani (*G. indicum*) has flowers exactly as *G. neglectum*, var. *vera*, but not a single plant was noticed in north-eastern Buldána, where the *Megachile* was seen, whereby to prove (as might well be the case) that the bee would go from *G. neglectum*, var. *vera*, to it.

G. neglectum, var. *vera*,—Jari,—in north-eastern Buldána spontaneously self-pollinates within an hour or two of opening; and the flowers are fertile to their own pollen: so that the bolls set whether insects go to the flowers or not.

It is the habit of the *Megachile* to fly into the flowers and at first to seek for honey at the base,—whether generally found or not, I was unable to ascertain: that done the insect turns round and with its head towards the light sits on the anthers and eats pollen. When caught its hairy body is always abundantly dusted with pollen: and it certainly carries it from one flower to another, and probably produces the occasional cross which seems to be the rule with so many plants.

Over the period during which the cotton was under observation, a few butterflies were observed on the flowers. *Catopsilia crocale*, Cramer, was seen at Wasáli, and again to the south of Jálgaon on *G. neglectum*, var. *rosea*, generally going to the extra-floral nectaries but sometimes to the intra-floral nectaries. Its constancy to the white flowers was marked.

Papilio polytes, Linn., was seen on two days near Jálgaon going both to extra- and intra-floral nectaries of *G. neglectum*, var. *vera*, and *G. neglectum*, var. *rosea*.

A *Terias* visited flowers of *G. neglectum*, var. *vera*, between Jamod and Jálgaon. Commoner still than any of these was *Parnara colaca*, Moore. Seven individuals were seen going to the intra-floral nectaries of *G. neglectum*, var. *vera*, between Pingli and Wasáli on September 23rd, eleven between Jamod and Jálgaon on September 25th, one on September 26th on the south of Jálgaon, and another at Nandura—making a total of 20. Further, on September 25th, between Jamod and Jálgaon, one went to the extra-floral nectaries of *G. neglectum*, var. *vera*, and six to the intra-floral nectaries of *G. hirsutum*.

Thus there were seen:—

	To <i>G. neglectum</i> var. <i>vera</i> .	To <i>G. neglectum</i> var. <i>rosea</i> .	To <i>G. hirsutum</i> .
<i>Megachile albifrons</i> .	23 individuals entering the flowers.		1 individual in flowers.
<i>Catopsilia crocale</i> .		5 individuals generally at extrafloral nectaries.	
<i>Papilio polytes</i> .	1 individual.	1 individual.	
<i>Terias</i> sp.	1 individual entering flower.		
<i>Parnara colaca</i> .	20 individuals, all but one entering the flowers: that one at extra-floral nectaries.		6 individuals entering a flower.

Parnara and *Papilio* were also seen on yellow Cotton flowers between Nandurbár and Táloda in West Khándesh on September 29th, 1909: but flower-visiting insects, except the injurious beetle, *Glycyphana versicolor*, Fabr.,—were there exceedingly rare.

Elæodendron glaucum, Pers.

The yellow-green somewhat massed flowers have a large disc, bearing a considerable amount of honey. They open widely, facing upwards or horizontally. At first they are male, the stamens standing up as in the upper figure: then they become female, the filaments, having bent as in *Rhamnus*, and the style elongated. The lower figure represents the flower in the second stage.

A few hours of leisure spent at Wasáli, Buldána district, on September 23rd, while waiting for the carts that were bringing my camp-furniture, enabled me to collect the following visitors at honey on the flowers.

DIPTERA.—SYRPHIDÆ. *Eristalis arvorum*, F. ♂ and ♀ plentiful. *Megaspis crassus*, F. ♀. *Syrphus* sp. MUSCIDÆ. *Lucilia dux*, Erichs., plentiful. *Musca* sp. near *M. domestica*, L. TACHINIDÆ. 1 sp.

Hardwickia binata, Roxb.

Hardwickia binata is an anemophilous Leguminosa, with the light foliage and flexible branchlets of a birch tree. On these thin flexible branchlets are produced in September the panicles of yellow green flowers. Apparently the flowers open chiefly at night. As the sepals part, the stigma is thrust out by the straightening of curves in the style: it straightens slowly, retaining a knee, by means of which the stigma is carried to a lateral position. After the stigma has thus been removed to a position and is no longer under the flower, the anthers emerge and dehisce.



FIG. 2.—On the left younger stages—ovary and style and stigma: on the right opening and wide open flower, $\times 2$.

[N.S.]

The sequence is sufficiently illustrated by the figures above, for further description to be unnecessary. The stigma is 5-angled, thick and raised into ridges: it is without papillae.



FIG. 3.—Stigma seen from above and in section, much enlarged.

Dalbergia Sissoo, Roxb.

In February, 1909, during nine days (14th to 22nd) spent in Nágpur, I had opportunities of making observations on *Dalbergia Sissoo*, because my tent was pitched under a tree in full flower. *Apis dorsata*, Fabr., visited this tree in great numbers, coming with the dawn, and leaving in the twilight, but not working steadily all day. That it should come in the grey of the first dawn and go in the dim light when night had nearly closed in, is interesting, for in Britain the hive bee—*Apis mellifica*, Linn.—does not leave its hive except in broad daylight; and even the longer-working wasp is never out in the twilight. Once halting in a 'ziat' (a shelter without walls) at the village of Pa-ngat, in Tenasserim, during the month of March, I heard from 4-30 A.M. into daylight a steady continuous humming overhead as of numerous bees, and when it was possible to see, *Apis* was found to be diligently visiting the white flowers of a tree of *Mesua ferrea*, Linn., overhanging the ziat. The observation does not prove that *Apis dorsata* is nocturnal at times, but suggests it: and on rare occasions in Calcutta and in other places, *Apis* has flown to my lamp as I read after dinner.

The following is the history of a Sissoo flower as exemplified on the tree in Nágpur. The flower opens in the early afternoon, between noon and 2 P.M. As more and more new flowers open, more and more bees (*Apis dorsata*) come to it, and they work diligently until night has almost closed in. All the next day these flowers are open, and through the night to the morning after, when, after sunrise—after a duration of forty-four hours—they fade, and most of them fall off the tree. The mornings are times when many bees are busy: they work hard from the time when the east is only just red until about 9 A.M.: after which they desert the trees for the most part until afternoon.

Sissoo flowers secrete plenty of honey, which *Apis dorsata* readily reaches. *Apis florea*, Fabr., visited the flowers in less numbers with the *Apis dorsata*, but at hours neither so early

nor so late. A Pierid butterfly was also seen on the flowers in the broad sunlight.

A few further observations from Asirgarh and the Melghát.

The following observations are all, additional to the above, that I could make over twenty-six days spent almost entirely in the open. They show how few insect-visitors can be observed in the Sâtpura hills at the season of my tours: and they suggest that the scarcity of visitors to crops like cotton grown under the Melghát is due to the poverty of the country side in flower-visiting insects. At the time of my tours in the Melghát, few trees were in flower, but under the trees occurred sporadically the large blossoms of several species of *Barleria*, a *Strobilanthes*, other *Acanthaceæ*, *Crotalaria*s, etc.; and in other places an abundance of *Indigofera glandulosa*, *Tridax procumbens*, *Ageratum conyzoides*, and *Impatiens balsamina*; while on the plateaux *Linum*, *Tradescantia*, *Pimpinella*, *Senecio*, etc., were in flower—flowers sufficiently conspicuous to attract many insects in Britain, during an equal period.

Xylocopa fenestrata, Bingham, was seen in Asirgarh (25—26. ix. 08) at honey on *Celosia cristata*, Linn., and *Zinnia elegans*, Jacq.; and *X. aureipennis*, Lepel., in the Sipna valley (10—13. x. 08) on *Anisomeles ovata*, R. Br., *Crotalaria albida*, Heyne, *Sopubia delphinifolia*, G. Don, and *Celosia cristata*, Linn.

Megachile anthracina, Smith, which is a somewhat similar insect, was seen in the Ban valley (19. ix. 09) in great numbers on *Crotalaria juncea*, Linn., and also freely on flowers of *Sesbania aculeata*, Pers. *Anthophora zonata*, Bingham, was seen abundantly on flowers of *Leucas urticæfolia* just where the Ban river debouches on to the plains (22. ix. 09): the association of this insect with small labiates is noticed in Lefroy's Indian Insect Life (Calcutta, 1909, p. 222). *Apis florea*, Fabr., on the pass near Ghátang (10. x. 08) visited in great numbers for honey the flowers of *Kydia calycina*, Roxb., and in the Ban valley (19. ix. 09) it was seen in hundreds on the greenish-white flowers of *Aspidopterys cordata*, A. Juss., which smell like those of *Sambucus nigra*, Linn.

Apis dorsata, Fabr., was seen in the Sipna valley collecting pollen on the anthers of *Andropogon contortus*, Linn. (17. x. 08). No other Apiids were seen on flowers.

Of butterflies numbers were seen on the flowers of *Celosia cristata*, Linn., in all parts of the hills north of Ellichpur and in Asirgarh (25. ix—08. x. 18). They included species of *Papilio*, *Danaïs* and *Parnara*.

Papilio ? polytes, Linn., was seen also on the flowers of *Zinnia elegans* in Asirgarh (25—26. ix. 08) and a Sphingid was seen on *Ipomœa coccinea*, Linn., in the Sipna valley (17. x. 08).

Flies were very rare: except a *Calliphora* on *Kydia calycina*, Roxb., near Ghátang (10. x. 08), and *Pangonia rufa*, Macq., in the tube of *Barleria grandiflora*, Dalz., near Kohána (5. x. 08), none were observed in the hills. The *Pangonia* had forced its way half down the 22 mm. long tube of the *Barleria*: what it—a biting fly—was doing there, it is hard to say.