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Vol. II, No. 10.] *Notes on the Pollination*
[N.S.]

large body fits the corolla tube exactly, and it can reach the honey with just that amount of difficulty which is necessary for the shaking out of the pollen onto its back.

This is the structure of the flower. The flower is altogether .6–.7 cm. across and about the same in height; the honey lies about 4 cm. from the mouth. The antrum into which the bee enters is .20–.25 cm. across and 1.5–2.0 cm. high from the ridge which runs along the middle of the floor to the roof. The stigma and the four stamens lie under the roof of the antrum so as to touch the back of the visiting *Xylocopa*. The stigma projects just beyond the anthers. The anthers are provided at their bases with rigid horn-like hooks and all along their margins with a fringe of long hairs; the hooks catch on the insect and cause it to shake a shower of pollen down onto its back from out of the long brushes of hairs which hold it. These horns have their tips one whole centimetre behind the edge of the lower lip of the stigma; the insect, therefore, touches the stigma at an appreciable interval before, on touching these horns, it shakes down the shower of pollen onto its back. The insect does not touch the anthers themselves as these lie in a groove. The filaments broaden to their bases, and the upper pair are interlocked at the base by a tooth and groove, making a direct road to the honey impossible. The honey chamber behind their insertion is 7–8 mm. in height and transverse diameter, and is 8–9 mm. long. The ovary stands in the middle of it, and the style passes above and between the bases of the upper pair of stamens to carry the stigma, as stated, to a position above the visiting bee's back. The nectary surrounds the ovary but is most developed below.

When I first examined the flower it seemed to me just possible that the honey could be reached by a proboscis passed between and below the lower stamens, but I soon saw that that was impossible, and after a little watching I was able, by means of small windows cut in the sides of flowers, to observe how the tongue of *X. latipes* reaches the honey. The bee settles on the floor of the

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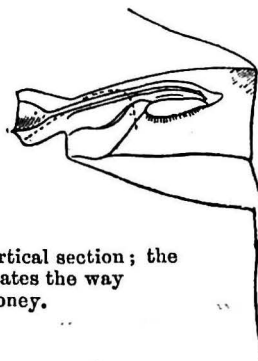


FIG. 3.—Flower in vertical section; the dotted line indicates the way to the honey.

antrum and pushes its way along it, touching first the stigma and then catching against the hooks of the anthers, and with its legs

in the effort bulging out the sides of the antrum so as to bring the roof a trifle lower; it passes its tongue between the bowed upper filaments which are only 3 mm. apart, with the style between them, passes it round to one side of the style, the space being only just big enough for it (1 mm. across) and so into the honey chamber. As it enters the chamber above, and most of the honey is below, the tongue has again to pass round the style to reach it. The total length of the honey chamber from the point where the tongue enters, to the place where the honey collects, is 10—11 mm. A tongue length of 16—19 mm. is necessary to drain the flower.

Creeping insects very rarely enter the flower, and never seem to find the honey chamber.

Visitors in Calcutta—

HYMENOPTERA ACULEATA. Apidæ. (1) *Xylocopa latipes*, Fabr., sucking honey, July, August, September, October, November. (2) *X. æstuans*, Lepel., sucking honey, August, September. (3) *Apis florea*, Fabr., collecting pollen, flying into the open antrum and settling on the anthers, leaving the flower by dropping onto the floor of the antrum, August, September, October, November. (4) *Apis dorsata*, Fabr. once an individual persistently trying to reach honey, hanging under the stamens, November. THYSANOPTERA. (5) *Thrips* sp. November.

*Visitors to the extra-floral nectaries—*Several species of ants.

I have seen this plant in the Assam forests, where it fruits fairly abundantly; but I have not had any opportunities of watching it for insect visitors. Large black ants there patrol the inflorescences feeding at the extra-floral nectaries, and at the floral nectaries just after the fall in the corolla. They do not interfere with the *Mylabris* beetles which devour the corollas from inside.

64. *Notes on the Pollination of Flowers in India. Note No. 2—The pollination of Corchorus in Bengal and Assam.*—By I. H. BURKILL.

Emile Lefrance (Ramie and jute in the United States, Washington, 1873, p. 16) says that "flies and butterflies keep away from the jute fields especially at the blossoming period. The peculiar odour of the flower and the bitter exudation of the leaves seem to be strongly repulsive to them, if not poisonous."

I find in India no support for this statement. Jute is a crop of districts much submerged during the rains, where conditions limit the insect-fauna in certain directions; but whenever there are insects on the wing, jute flowers obtain visitors from among them, though the visitors are possibly more abundant if there is land above flood level in the neighbourhood.

My work in the years 1902, 1903, 1904 and 1906 has taken me to the jute-fields all over Bengal; and as I examined crop after crop studying the races in cultivation, it has been a constant observation that two or more races may be grown in great proximity without becoming one; yet the cultivator rarely exercises discrimination in his selection of plants to be left for seed. At first I thought that I should be able to show that in the jute districts flower-visiting insects are not present in quantity, but I cannot satisfactorily do that. Instead the result of my work is to show that jute flowers do receive a considerable amount of attention from insects well built for effecting abundant cross-fertilisation. Why their influence is not distinctly apparent, I am as yet in no position to say.

I shall give my observations on *Corchorus capsularis* first, and thereafter those on the somewhat larger-flowered *Corchorus olitorius*. But first I have to express my great indebtedness to H. H. the Raja of Bardwan, and also to Babu Brajendra Kishore Roy Chowdhury of Gauripur, Mymensingh, for facilities given to me in my work at their Experimental Farms.

Corchorus capsularis, Linn.

In 1902, I visited the Bardwán Experimental Farm on August 23th. In 1903, I had a tent pitched beside the jute-plots, and was there on August 3rd, September 2nd, 3rd, 9th and 10th. In 1904, I visited the Farm on August 10th and September 22nd: and in 1906 I was there on September 15th. The first observations to be recorded were made during these visits.

Bardwán is outside the real jute area, and there is high sandy ground close to the experimental crops. Insects proved to be very abundant. There I first studied the mechanism of the flower; and afterwards I found that it does not vary from place to place.

The flowers of *Corchorus capsularis* open about 7-30 A.M.

and close in a clumsy fashion in the evening of the same day; I mean that they half close: and after midnight they cease to be shapely. By the dawn of the next day the petals are falling off. The anthers dehisce as the flowers open. They and the stigmas lie exactly at the same level. Self-fertilisation is insured in the absence of insect visitors, as I proved by means of linen wrappings whereby insect visitors were shut out.

Honey lies, half hidden, at the base of the flower, and secretion has already begun when it opens.

From about 8 A.M., throughout the day, I found the flowers to be visited at Bardwán by enormous numbers of *Apis florea* and by lesser numbers of other bees and butterflies. The *Apis* visits not without danger; for a yellow-green crab-spider was very common upon the plants and was never seen to be feeding upon any other insect; and very many individuals of *Vespa cincta*, Fabr., were hawking among the plants, flying quickly up and down through their tops and swooping down on some luckless *Apis* as it sucked, carrying it away, meanwhile apparently stinging it, and then setting on a leaf to devour it from the end of the abdomen upwards. I mention this circumstance chiefly because it illustrates the enormous numbers of individuals of the little *Apis* busy in the jute beds, and is quite opposed to Lefrance's statement that insects avoid the plant.

Apis florea began work upon the flowers immediately they opened, and was even seen trying to visit before they had opened. Its tongue is quite short and it lays its head among the anthers in the attempt to drain the flower. It turns to right and to left, frequently making three dips into one flower; and rarely it turns quite round. Some two hours after the opening of the jute flowers the butterflies named below began to visit and continued to do so through the heat of the day until evening. They are somewhat ill-suited visitors to the plant, their long tongues enabling them to reach the honey without touching the anthers and stigmas. The small bees are obviously the best agents. *Apis florea* can visit and drain the honey of 10—15 flowers per minute or 600 at least per hour, while *Apis dorsata*, which is a quicker worker, visits about 18 per minute. The skipper butterflies visit less than 10 per minute and often only one or two. A species of *Suastus* and *Telchinia violæ* were found to be fairly constant in visiting this *Corchorus* and a neighbouring yellow Composite—*Tridax procumbens*, Linn.

Visitors at Burdwan, August and September:—

HYMENOPTERA ACULEATA. Apidæ. (1) *Xylocopa latipes*, Fabr., sucking honey in 1906 only. (2) *Apis dorsata*, Fabr., sucking honey, fairly plentiful. (3) *A. florea*, Fabr., sucking honey and collecting pollen, always in great abundance. Scoliidæ. (4) *Elis* sp., sucking honey, fairly abundant. (5, 6, 7 and 8) Four small Aculeate Hymenoptera. (9) *Formicidæ*, a black ant, at honey in 1906. LEPIDOPTERA RHOPALOCERA. (10) *Terias*

sp. (11) *Telchinia violæ*, Fabr. (12) *Castalius rosimon*, Fabr. (13) *Suastus* sp. All these Lepidoptera sucking honey. HETERO-CERA. (14) One Microlepidopteron, sucking honey. DIPTERA. Syrphidæ. (15) *Helophilus* sp., sucking honey. COLEOPTERA. (16) *Coccinella* sp., sucking honey.

Until recently Orissa has been more or less outside the jute area: but jute is now taking an extension in it. From August 22nd to August 27th, 1906, I was among the jute fields of Orissa, at Cuttack, Shishua and Jájpur. There is high land, sand-hills, etc., in the immediate neighbourhood of these places.

The flowers of *Corchorus capsularis* were seen to be freely visited by insects. A large bee of the genus *Xylocopa* (probably *X. fenestrata*, Bingham) was very constant near Cuttack, and also a large black wasp, and there were four butterflies visiting the flowers, viz., a Hesperid probably of the genus *Parnara*, a *Lycuena*, a white butterfly and a *Danuis*. All were at honey. Near Shishua, a wasp of the Eumenidæ was seen at honey. At Jájpur the Lepidoptera, *Parnara* (?), *Terias* and *Lyceana*, were again seen on the flowers together with the Hymenoptera, *Apis indica*, Fabr., *Apis florea*, Fabr., and an Eumenid. The Hesperid *Parnara* (?) was a frequent visitor.

Predatory wasps of a species different to that seen at Bardwán, were hunting smaller Hymenoptera among the jute tops both at Cuttack and Jájpur.

The chief part of the valley of the Bráhma-putra in Assam has, like Orissa until recently, been outside the jute area. In it at Goálpára on September 2nd, 1906, I saw *Xylocopa aestuans*, Lepel., diligently visiting the flowers of *Corchorus capsularis* for honey, and with it were many individuals of a little blue-ringed *Anthophora* (or *Nomia*) collecting both pollen and honey. An individual of the common butterfly *Terias* was also on the flowers sucking honey. At Goálpára, hills are close to the jute-fields.

I will proceed now to give the results of observations in the districts of Northern Bengal, and the contiguous districts of the new province of Eastern Bengal and Assam. My work at Pusa (District of Darbhanga), Purneah and Kissenganj (District of Purneah) and Siliguri (District of Jalpaiguri), was done in so much rain that insect-visitors could not possibly go abroad. My work at Forbesganj and Barsoi (District of Purneah), Dinajpur (District of Dinajpur), Jalpaiguri (District of Jalpaiguri), Fulchari, Bogra and Santahar (District of Bogra), at Gafargaon, and on the occasion of my first visit to Mymensingh (District of Mymensingh), was done in showery weather with intervals between the showers in which insects might have visited the flowers: but I saw none. But at Parbatipur (District of Dinajpur) on August 15th, 1906, I observed on the flowers two individuals of an *Eristalis* sucking honey, and also a red and black Coccinellid beetle. At Balajan on September 4th, 1906, in the south-west corner of the Goalpara District, three species of butterflies were seen to visit the flowers for honey,—a *Terias*, a

Danaïs and a white butterfly. And at Jagganathganj (District of Mymensingh), on September 4th, 1904, I saw on the flowers *Apis dorsata*, an Apid not identified, and a Syrphid fly of the genus *Helophilus* at honey, while pollen was being devoured by many individuals of a red Coccinellid beetle, which was present in considerable numbers. On the occasion of my second visit, September 6th, 1906, to Mymensingh, between that place and Gauripur, I saw a *Danaïs* and a white butterfly go to the flowers.

The districts of Northern Bengal are in no way so exposed to regular floods and submersion, as the places that I come to next—places on the large rivers with no high land near, where the land for the homestead has often been artificially raised and all the fields go under water annually. They are Serájganj (District of Pabna), Goalundo, Pachuria, Faridpur and Madaripur (District of Faridpur), Náráyanjanj and Narsingdi (District of Dacca), Chándpur and Hájiganj (District of Tippera). At Hájiganj insects were very abundant, but not so at the other places, which I will take first and together. The insect most generally seen was the tree-nesting *Apis dorsata*: it was observed on the flowers in considerable numbers at Serájganj on August 12th, 1904, and again diligently visiting at Madaripur on September 19th, 1904, and at Goalundo on August 30th, 1904. Another insect was a black Apid, seen at Serájganj. The fly *Helophilus*, whose larva is aquatic, we at present believe, was seen at honey at Goalundo on August 30th, 1904. A red Coccinellid was seen eating pollen at Goalundo on the same date, at Pachuria, on August 30th, 1904, and at Chandpur on September 9th, 1906. A *Terias* butterfly was seen at Narayanganj on September 1st, 1904.

At Rámpur Boalia, in the Rájshahi District, Mr. R. S. Finlow, on August 28th, 1906, observed butterflies on the flowers.

The following is a statement of the insects seen on the flowers at Hájiganj, on September 10th, 1906, at a time when the jute fields were under two feet of clear brown jheel water, and there was nothing above the flood except the railway embankment, a raised road and the spaces on which the houses of the village stand, and these last had largely been under water. The day was fine until the evening. Three species of *Xylocopa* were very busy at honey on the flowers,—*X. latipes*, Fabr., *X. æstuans*, Lepel., and another which seems to be *X. fenestrata*, Bingham. *X. latipes* visited at the rate of thirty flowers a minute and *X. æstuans* at the rate of thirty-five. *Apis dorsata* was abundant, sucking honey, and *Apis florea* was represented by a small number of individuals. A black Apid of the size of *Apis dorsata* was present also. Of butterflies three species were flying from flower to flower in the jute fields, a *Terias*, a *Danaïs*, and a white butterfly. A beetle of the Coccinellidæ was eating pollen.

Among the jute tops, *Vespa cincta* was busy hunting small Apids; and innumerable dragon flies were present here as elsewhere, giving an additional contradiction to Lefrance's supposition.

All Visitors of Corchorus capsularis.

	Madaripur.	Goalundo.	Pachuria.	Hajiganj.	Chandpur.	Naryanganj.	Mymensingh.	Jakarnathganj.	Soreaganj.	Farbatipur.	Balajan.	Goalpara.	Burdwan.	Jajpur.	Shishus.	Outsack.
HYMENOPTERA—																
<i>Xylocopa latipes</i> ...				x												
<i>X. æstuans</i> ...				x												
<i>X. fenestrata</i> ...				x												
<i>Apis dorsata</i> ...	x	x		x				x	x							
<i>A. indica</i> ...				x												
<i>A. florea</i> ...				x												
<i>Anthophora</i> , sp. ...												x				
<i>Eumenid</i> ...														x	x	
<i>Elis</i> , sp. ...													x	x		
Other winged <i>Aculeata</i> ...				x				x	x				x	x		
Ants ...																x
LEPIDOPTERA—																
<i>Danais</i> , sp. ...				x			x				x					
<i>Castalius rosimon</i> ...																x
<i>Telchinia violae</i> ...													x			
<i>Terias</i> , sp. ...				x									x			
<i>Lycaena</i> , sp. ...						x					x		x			
A white butterfly ...				x			x				x		x			
<i>Suastus</i> , sp. ...													x			
<i>Parnara</i> ? sp. ...														x		
<i>Microlepidopton</i> ...																x
DIPTERA—																
<i>Helophilus</i> , sp. ...		x						x						x		
<i>Eristalis</i> , sp. ...										x						
COLEOPTERA—																
<i>Coccinellid</i> ...	x	x	x	x				x		x			x			

Corchorus olitorius, Linn.

The floral mechanism of this is exactly like that of *Corchorus capsularis*. The flowers also open at the same time and the anthers discharge pollen in the same manner. If insect visitors be excluded, self-pollination gives rise to a supply of good seed. At midnight the flowers are no longer shapely, and by the next morning the petals are falling. The flowers open by time not by weather, and will expand on the wettest day.

Visitors at Burdwan—

HYMENOPTERA ACULEATA. Apidæ. (1) *Apis florea*, Fabr., sometimes trying to visit before the flowers open. (2) A black Apid. (3) A black and tawny Apid. All sucking honey.

Visitors at Chinsurah on September 16th, 1906—

HYMENOPTERA ACULEATA. Apidæ. (1) *Xylocopa æstuans*, Lepel., two individuals diligently sucking honey. (2) An Apid of the size of *Apis dorsata*, sucking honey. LEPIDOPTERA RHOPALOCERA. (3) *Papilio* sp. (4) A white butterfly frequently at honey. COLIOPTERA. Carabidæ. A small species, frequently feeding on pollen.

It is only in the Hooghly District and within the borders of adjoining districts that this jute is a commoner crop than *C. capsularis*, and I have not given to it the same attention that *C. capsularis* has had. But insects do not avoid the crops: and dragon flies and *Vespa cincta* find plenty of prey in them as in plots of *Corchorus capsularis*.

65. *Notes on the Pollination of Flowers in India. Note No. 3—The Mechanism of six flowers of the North-West Himalaya.*—By I. H. BURKILL.

The following are wayside notes made in marching through the hills and valleys north and west of Simla, in May—the hottest and driest month of the year, when the shade temperature at the lower levels passed daily far above blood heat.

ADHATODA VASICA, Nees.

The conspicuous flowers of *Adhatoda Vasica* are in spikes, but they open only a few at a time. They are large, white and honied. The plant grows as a small bush in waste lands and on the borders of fields very plentifully below 4,000 ft., and flowers from December to June.

The tube of the corolla is 12 mm. long and curved a little: near its base the lumen is constricted by four indentations from outside, a pair above and a pair below (rather diagrammatically represented in fig. 12); the dorsal pair are a little above the ventral pair as indicated in fig. 11. At this point there is a weal of hairs obstructing a free passage down to the honey: the sides of the tube are strengthened by the adherent filaments of the two stamens. There is a large humped platform for insects to alight on.

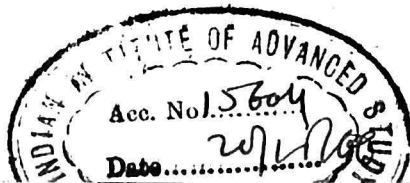
The flowers open in the evening by the falling away of the lower from the upper lip—an act which leaves the upper lip hooded over the green anthers. These green anthers are in contact at the opening of the flower, and the stigma just peeps over the top of them. A little after the opening of the flower the tip of the hood turns up a very little, making room for the stigma to lift itself from contact with the anther-lobes. The anthers dehisce downward, on the lower side exposing their pollen for the backs of visiting bees to rub it off. It is 4 mm. from the anthers to the top of the hump of the platform.

As the flower ages the stamens diverge and the empty anthers are no longer covered by the hood; they become 10 mm. apart or more. While this is happening, the upper part of the style curves so as to bring the stigma exactly where the anthers were. The flower is then in the female stage.

Two species of *Bombus* were seen on the flowers—*B. haemorrhoidalis*, Sm., and another species, here called *Bombus B.*, at 1,600 ft., and *Xylocopa aestuans*, Lepel., at 2,000 ft., all sucking honey. Flowers that are not visited do not set any seed, and they are 90 to more than 99 per cent. of those produced in the rather dreary parts of the Sutlej valley, where, in May, these observations were made.

DICLIPTERA BUPLEUROIDES, Nees.

The flowers of *Dicliptera bupleuroides* are numerous enough to make the plant quite conspicuous on the road-sides and



dry half bush-clad slopes that it inhabits. It is an excessively common plant in the Simla Hills from the plains to 7,000 ft.: it is generally much stunted. The flowers are purple (magenta), very rarely white, and they are honied.

The tube of the corolla is 7—9 mm. long and twisted through half a circle, so that the morphologically upper lip with the stigma and anthers is below, and the morphologically lower lip is above. The upper lip having no function as a hood has become flat and is converted into a fairly broad landing stage: while the lower (ultimately upper) lip serves as a standand, having dark dots near its base. The twisting of the tube takes place in the half-grown flower and always towards the same side. Except that the twisting practically obliterates the lumen of the very thin-walled tube, there is no obstruction in the way to the honey. The outside of the corolla is hairy and below the twist is more or less protected against biting and robbing insects by the bracts (see fig. 6). The rectangular mouth of the tube is seen in fig. 8.

The flowers open at dawn and fall on the same day between 4 P.M. and midnight.

Insects visiting the flowers settle on the stamens and style, touching the anthers and stigma, which are 2 mm. apart, with the underside of their bodies. An *Anthophora* was seen on the flowers at Suket, 4,000 ft., and *Apis indica* was seen on the flowers in Simia at 7,000 ft., both sucking honey, the latter diligently. A wasp was found at Suket to bite through the corolla tube for the honey.

MORINA PERSICA, Linn.

The flowers are, in whorls, on a very conspicuous spike, white, honied, and sweetly but not strongly scented. The plant grows in the open on dry hill-sides at altitudes of 6,000 to 9,000 ft., flowering in May when the grass is short, and it has not many competitors. The following observations were made on May 21st, 22nd, and 23rd, 1906, on the hills both north and south of the valley of the Sutlej above Suni, not far from Simla.

The tube of the flower is 40—45 mm. long and contains honey in fair quantity: no obstruction of hairs or difficulty is offered in the lumen to the passage of an insect's proboscis, if only long enough. But a platform to settle on is not provided. The outside of the tube is somewhat glandular-hairy; and a hard calyx protects its lowest 5—6 mm. against the biters of corollas. Nevertheless, though rarely, *Bombus hæmorrhoidalis* bites the corolla, and steals the honey: the holes which it makes I have seen utilised afterwards by a small Apid.

The flower opens just before sun-down, and is then pure white: the stamens have already dehisced and the stigma is sticky with sweet juice. In the opening of the flower the lower three petals begin to separate from the upper two, and the lowest petal of all falls: a quarter of an hour later the lateral members of the lower trio turn outwards and downwards: then the upper

lobes spread exposing the stigma and two contiguous stamens : after about forty-five minutes from the appearance of the first crack in the bud the flower is fully expanded as drawn in fig. 1.

Fertilisation is affected by Sphingidae, which leave abundant signs of their visits in plumes adhering to the stigma. After a fine night, I found that almost every flower had been visited by them. Once at sundown I saw *Bombus hæmorrhoidalis* in vain trying to reach the honey from the throat of the flower. I saw no butterflies going to the flowers by day, though I watched for them.

On the second day, some fourteen hours after they open, the flowers become flushed with rose-purple on the corolla-lobes : and before the sun sets and the next night's flowers open, they wither.

Kerner, in his *Pflanzenleben*, ii., p. 349, translated as the *Natural History of Plants*, makes several statements regarding *Morina persica* in Europe that point to differences between the Indian plant and the European plant. The time of opening and withering is the same, but he figures the corolla lobes as projecting forward, and says that anthers do not dehisce in the bud but half an hour after the flower opens. Afterwards, he says, the stigma curls round onto the anthers.

SALVIA LANATA, Roxb.

The flowers are, in whorls, on a conspicuous spike, deep lilac and honied. The plant grows in the open on dry hill-sides at altitudes of 5,000 to 8,000 ft., and the spikes stand out of the short burnt-up turf of May. The following observations were made over a wide stretch of country both west and north of Simla.

The tube is 11—12 mm. long, widening much vertically : it contains honey in fair quantity, the way to which is blocked by the sterile half anthers, as in *Salvia pratensis* ; a tooth on the sterile end is just seen at the entrance to the throat in a side view of the flower (see fig. 4). There is no obstruction within the tube beyond the sterile half anthers. The outside of the corolla is somewhat glandular-hairy, and the gamosepalous calyx is very glandular and for a length of 7 mm. protects the corolla-tube. Nevertheless, the corolla-tube is frequently bitten through, generally on the 'right-hand side, most probably by *Bombus hæmorrhoidalis*.

The flower opens in the early morning. The stigma projects from the hood as drawn : and the anthers are protected by the hood as indicated in fig. 4. A single stamen is drawn in fig. 5. There is a horizontal platform made by the lower lip, for bees to alight on : it is 7 mm. long. A bumble bee, alighting on the platform, touches with its back the projecting stigma, and then pushing with its head against the sterile anther lobes, brings the fertile anther-lobes down upon its back, just as in other *Salvias*.

A *Bombus* which I have not yet determined and may call *Bombus A*, was seen at 7,000 ft. on the flowers, going diligently from one to another.

SCUTELLARIA LINEARIS, Benth.

The flowers are in spikes and are conspicuous, but are not raised above the short grass of the dry slopes where the plant flowers in April and May. They are rose-pink with a yellow patch on the landing-stage of the lower lip, and are abundantly honied. They open in the early morning.

Observations were made on the flowers north and west of Simla, on both sides of the Sutlej valley.

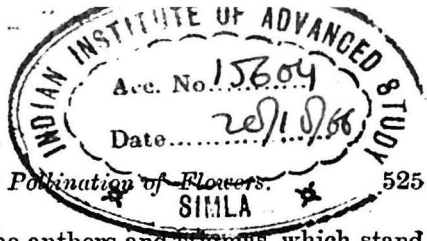
The tube is 11—15 mm. long, rather narrow in the lower half, and slightly curved at the very base: in the upper half it broadens into the two lips. The lips are pressed very close together so that the tube is closed. There is no other obstruction to the tongues of insects, beyond the compression of the lips. The flower is intended for the visits of *Bombi*, which are strong enough to open the lips and adept enough to know how to get the honey. With their feet on the well-marked landing stage they have to raise with their heads the upper lip, a process which is contrived by pressing against the curious palatal plates (marked *p.* in fig. 10): on raising the hood the stigmata and anthers become exposed and the hood again returns over them when the lifting pressure is removed. These palatal plates are invaginations of the hood behind the lobe which is seen at the base of the upper lip in fig. 9.

The outside of the corolla is covered by fine hairs: the calyx hardly protects the tube at all at the base. *Bombus hæmorrhoidalis* bites every flower that it visits. It settles on the lower lip as if to suck honey in the proper way, then rapidly turns head downwards on the right-hand side of the flower and bites the tube just above the calyx: it busies itself with this work from dawn to dusk; and almost every flower examined had been robbed thus.

TEUCRIUM ROYLEANUM, Benth.

The flowers are in whorls, on a moderately conspicuous spike, white with a very faint green tinge, and are honied. The plant grows in hedges and under trees, flowering in May. The following observations were made at Bilaspur on the Sutlej, 1,600 ft. above sea-level on May 12th and 13th, and at Suket, further north, on May 16th, 1906.

The tube of the flower is 8—9 mm. long and slightly curved: the bases of the filaments divide its lumen as in fig. 3, into a part which contains the style and a part which contains the honey. The lower lip forms a horizontal landing stage—a sort of spoon wherein insects may alight: the handle of the spoon has two pairs of teeth on it for compelling the insect-visitors to approach



the mouth of the tube under the anthers and stigmas, which stand exposed over the landing stage. The distal teeth diverge, but are not horizontal as is the case in some European species of the genus: the nearer teeth are vertical and parallel as in *Teucrium Chamædrys*. The outside of the corolla is not hairy: the gamosepalous calyx protects the lower half of it from the biters of corollas.

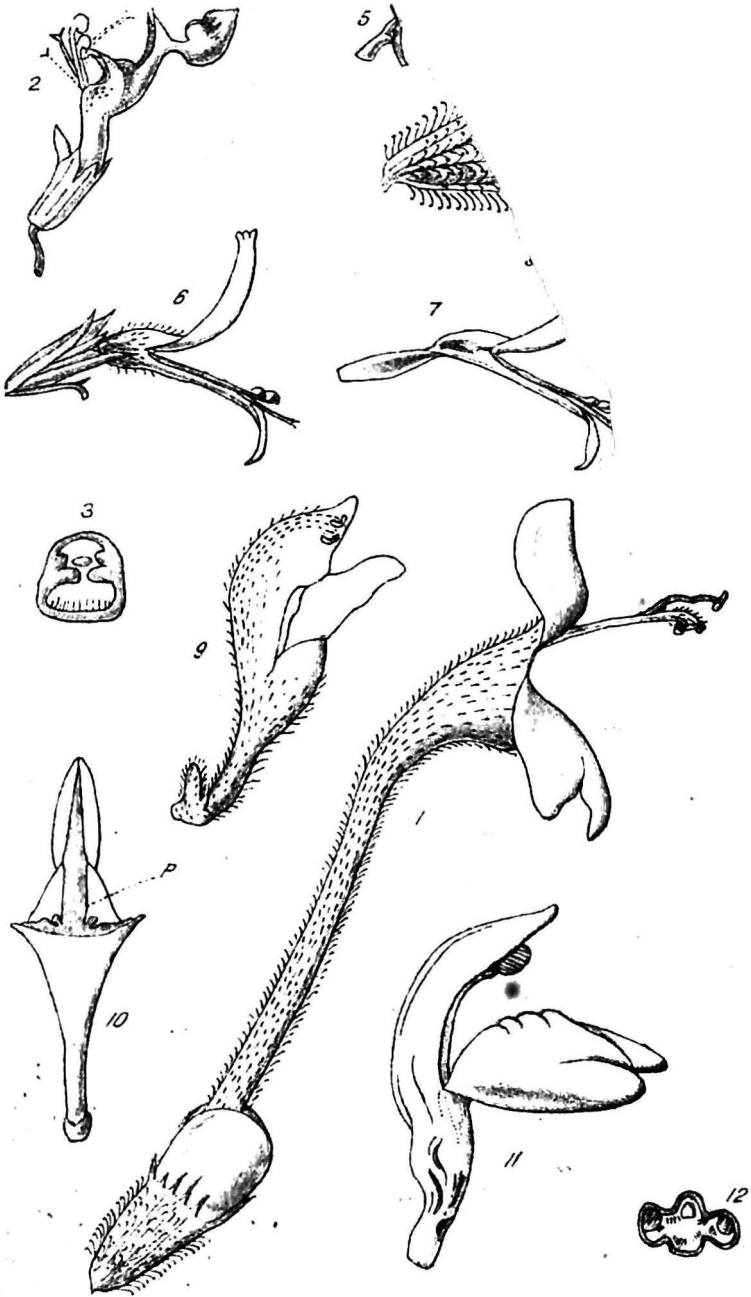
The flower is proterandrous, and when it has just opened the stigma is behind the stamens: it moves forward during flowering as indicated in fig. 2.

The flower is visited by an *Anthophora*: and this bee settles on the spoon with its head thrust between the divergent teeth and up to the parallel processes. A glance at fig. 2 will show how, in so visiting the flower, it touches the anthers when the flower is young and the stigmas first when it is old. The longer filaments of the two pairs of stamens elongate a very little during flowering and just carry their anthers to a point beyond that indicated in the figure. The stalk of the flower is less rigid than the stalk of the alighting platform, and bends a little under the weight of a suitable insect-visitor.

EXPLANATION OF THE PLATE.

All the flowers are represented exactly twice their natural size, and at the angles which they take in life.

- Fig. 1. Flower of *Morina persica*.
- Fig. 2. Flower of *Teucrium royleanum*; the early and the late positions of the style are dotted in.
- Fig. 3. Section through the tube of *Teucrium royleanum* near the base to show the way in which the honied part of the tube is made small and the distribution of hairs in it.
- Fig. 4. Flower of *Salvia lanata*, with the position of the stamens dotted in: s. is the tooth on the sterile anther-lobe.
- Fig. 5. A stamen of *Salvia lanata* in the position that a bee makes it to take.
- Fig. 6. Flower of *Dicliptera bupleuroides* with its bracts.
- Fig. 7. Corolla and style of *Dicliptera bupleuroides* to shew the twist of the tube.
- Fig. 8. Corolla of *Dicliptera bupleuroides* seen from the front and from slightly below.
- Fig. 9. Flower of *Scutellaria linearis*, with the position of the stamens dotted in: the narrow lobe at the base of the upper lip hides the invaginations that make the palatal plates.
- Fig. 10. Tube and hood of *Scutellaria linearis* seen from below, the lower lip having been cut away: p. the palatal plates.
- Fig. 11. Flower of *Adhatoda Vasica* just after opening.
- Fig. 12. Diagrammatic section through the tube of *Adhatoda Vasica* at the invaginations near its base.



SIMLA HILLS FLOWERS, ALL $\times 2$