Pollination of Hevea in Malaya

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Observations on the insects visiting flowers of Hevea were made in three successive years and their possible role as pollinators noted. Those entering flowers are listed.

Hevea brasiliensis in Malaya produces flowers twice a year—during a main flowering season from February to June, and a subsidiary one from August to October. Though flowers are produced in abundance, the number of fruits produced is small. MAAS (1919) estimated that even in a good flowering season not more than 3 per cent of the female flowers developed into fruit. In a seed garden in Malaya, the percentages of female flowers that later bore mature fruits in the years 1958, 1959 and 1960 were observed to be only 0.3, 1.6 and 0.5 respectively, but higher figures were obtained in 1959 following hand pollination at the Experiment Station of the Rubber Research Institute of Malaya (ROSS, 1961). The degree of success at harvest depended on the time of hand pollination; averaging the results of all crosses, pollinations in the first period give 8.4% mature fruits as compared with 4.6% from later pollinations. Where unselected seed is required for planting, to be budded later, a poor yield of seed is of little consequence because of the large area available for collection. In a seed garden, on the other hand, a low production of seed in the main planting season is a serious matter. The results of hand pollinations suggest that the production of a seed garden might be improved if the degree of natural pollination could be increased. For this reason the mechanism of natural pollination is worthy of study.

Although the size of the pollen grain is not large (about 44 μ in diameter), pollen does not appear to be carried by wind. Inflorescences enclosed in insect-proof bags did not set seed (MAAS, 1919; MORRIS, 1929; MUZIK, 1948). Vaseline-coated slides placed near inflorescences failed to collect pollen (MUZIK, 1948). The author failed to collect any on slides in a Hirst volumetric spore trap that was run for three days within fifty feet of heavily flowering trees on the R.R.I.M. Experiment Station; nor was any detected in centrifuged leaf washings of the upper surface of one hundred leaves taken at random from just below the inflorescences at four different localities.

The structure of the flowers, their colour and fragrance, the stickiness of the pollen grain and of the stigmatic surface and the presence of a nectary, point to insects as being the most likely agents of pollination. In Malaya, MORRIS (1929) recorded many types of insects—bees, flies, bugs, caterpillars, beetles, weevils and ants—as having been seen on or around inflorescences, but he did not produce evidence of their ability to carry pollen from male to female flowers. He had seen bees of at least three species frequently entering male flowers to collect pollen, and a small fly and two minute beetles inside female flowers.

The first methodical study of insect visitors to *Hevea* flowers, and the first demonstration that they effect pollination, were made by WARMKE (1951) in Puerto Rico. By placing a sticky material on the tips of petals and by means of adhesive cards wrapped round the inflorescences in loose cylinders he caught a large number of insects, mostly thrips and small flies. Of the latter a majority were Ceratopogonid midges of the genera *Dasyhelea, Atrichopogon* and *Forcipomyia,* whose antennal and body hairs were found sticking on the stigmas. Continuing his observations in Brazil, the same author (WARMKE, 1952)

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again found abundant Ceratopogonid midges visiting male and female flowers for about 1 to 1½ hours after sunrise and for the same period before sunset. He had no doubt that they were largely responsible for pollination.

OBSERVATIONS IN MALAYA

Inflorescences with freshly opened flowers were kept under observation during the months of March and April 1953, April 1954 and April, May and June 1955 on the R.R.I.M. Experiment Station. In 1953, low flowering branches were chosen for convenience of observation, but the collection was poor, heavy infection of the inflorescences with *Oidium heveae* resulting in premature flower fall. In the following years a ladder or tower was used, bringing the observer within reach of inflorescences at a height of 25 feet. Observations were made at different times of the day, but mostly during the two hours after sunrise and two hours before sunset, for about 26 hours in 1953, 18 hours in 1954 and 21 hours in 1955. A considerable collection of insects was made, even though it involved waiting for a long time, without disturbing the flowers, before an insect could be seen to approach.

To trap the insects, the following method was used, based on that of POSNETTE (1944) who collected insects from cocoa flowers in Trinidad. When an insect was seen to enter a flower, a 7 × 1 in. specimen tube was lowered over it, the cork being used to prevent the insect's escape. The flower was released after the insect had come out into the tube.

Most of the insect visitors to the flowers were thrips, midges of the families Ceratopogonidae, Chironomidae and Cecidomyiidae, or Scatopsid flies, but no group could be said to be numerous. The thrips could be collected in the mornings and evenings; the midges mainly in the evenings. Small numbers of other flies—Drosophilidae, Calliphoridae, Psychodidae, Sciaridae, Phoridae, Muscidae and Chloropidae—were also collected. Parasitic Hymenoptera of the families Braconidae, Encyrtidae, Eulophidae, Ceraphronidae and Cynipidae also visited the flowers. It is possible that many of them are parasites of Lymantriid (*Euproctis subnotata* Walk.), Noctuid (*Oruza vacillans* Walk.) and Geometrid (*Hemithea costipunctata* Moore and *Chloroclystis sp.*) caterpillars frequently seen feeding on the flowers and tender leaves. Bees (*Trigona spp.*), ants (*Tapinoma spp.*), Mirid bugs (*Lygus sp.*) and the fungivorous beetles *Thea bistigmosa* (Muls) (*Coccinellidae*) and *Anisomeristes sp.* (*Corylophidae*) were frequently found on the inflorescences. Strong wind, cloudy weather and rain reduced the number of visitors. The Diptera, Thysanoptera and the parasitic Hymenoptera which visited the flowers are listed in *Table 1.*

Thrips were the commonest insects in the flowers, moving in and out of them, or getting stuck to the black spots of coagulated latex often found on the petals, believed to result from insect injury. Four species — *Taeniothrips* (*Rhopalandrothrips*) *minor* (Bagnall), *Thrips hawaiiensis* (Morgan) and *Thrips florum* (Schmutz)—comprised most of the thrips visitors. Many had pollen sticking to their wings.

The Ceratopogonidae were the most numerous of the midges that visited the flowers. In the 1953 collection the family was represented by a few specimens of *Forcipomyia* sp. collected only from male flowers, but in 1954 a good collection of individuals of this genus and of *Dasyhelea* sp. was made from both male and female flowers. In the 1955 collection, the Ceratopogonidae and Scatopsidae (mostly unidentified) were almost equally numerous. Altogether, over the three years, Ceratopogonidae were seen to enter male or female flowers thirty-two times, the Scatopsidae fourteen times, Cecidomyiidae twelve times and Chironomidae six times.

The midges generally fly round the inflorescence for a while before alighting on an open flower; after some hesitation they move down into the corolla tube with their dorsal side towards the stigma or anthers. They move around the ovary or staminal column, stopping frequently, apparently to feed. They

TABLE 1. INSECT VISITORS TO HEVEA FLOWERS ON THE RUBBER RESEARCH INSTITUTE EXPERIMENT STATION DURING 1953, 1954 AND 1955

Order and family	Identification	Number of times observed	Remarks
DIPTERA :			
Calliphoridae	*Idiella divisa* Walk.	2	Insert mouth parts into open flowers.
Cecidomyiidae	Genus undetermined	12	Enter male and female flowers; pollen on body, legs and antennae.
Ceratopogonidae	*Dasyhelea sp.*	11	Enter male and female flowers; pollen on body, legs and antennae.
	Forcipomyia spp.	16	Enter male and female flowers; pollen on body, legs and antennae.
	Genus undetermined	5	Enter male and female flowers; pollen on body, legs and antennae.
Chironomidae	*Metriocnemus sp.*	2	One entering male and the other entering female flower.
	Orthocladius sp.	2	One inside male flower and the other stuck to stigma of female flower.
	Smittia sp.	2	Both inside female flowers; pollen on antennae.
Chloropidae	*Oscinella sp.*	3	Two entering male flowers and one entering female flower; pollen on head and wings.
Drosophilidae	*Drosophila sp.*	4	Enter male and female flowers.
Ephydridae	*Hecamedoides sp.*	1	Enters male flower.
Muscidae	*Atherigona sp.*	1	Enters male flower.
Phoridae	*Megaselia sp.*	3	Enter male flowers.
Psychodidae	*Psychoda sp.*	2	Enter female flowers, pollen on mouth parts.
Scatopsidae	*Scatopse sp.*	2	Enter male flowers.
	Genus undetermined	12	Enter male and female flowers; some with pollen on body and wings.
Sciardae	*Bradysia sp.*	1	Enters male flower.
Unidentified Nematocera		6	Caught within male and female flowers; some with pollen on antennae.
HYMENOPTERA :			
Braconidae	*Apanteles hemitheae* Wilkn.	1	Inside female flower.
Ceraphronidae	*Aphanogmus sp.*	2	Inside male flowers.
Cynipidae	*Chrestosema sp.*	1	Inside male flower.
	Ganaspis sp.	1	Stuck to petal of female flower.
	Nedinoptera sp.	1	Inside male flower.
	Pseudeucoila sp.	2	One inside male and the other inside female flower.
	Rhoptromeris sp.	2	Inside male flowers.
	Trybliographa sp.	2	Stuck to petal of male flowers.
Encyrtidae	Genus undetermined	1	Inside female flower.
Eulophidae	Genus undetermined	3	Inside male and female flowers.
	Syntomosphyrum obscuriceps Ferr.	1	Inside male flower.
	Tetrastichus sp.	1	Inside female flower.
THYSANOPTERA :			
Thripidae	*Taeniothrips (Rhopalandrothrips) minor* Bagnall	many	Inside male and female flowers and stuck to latex on petals.
	Taeniothrips (Lefroyothrips) sp.	2	One inside female flower and the other stuck to petal of male flower.
	Taeniothrips spp.	2	Inside female flower and stuck to male flower.
	Thrips hawaiiensis Morgan	many	Inside male and female flowers and stuck to latex on petals.
	Thrips florum Schmutz	many	Inside male and female flowers and stuck to latex on petals.
	Thrips pallipes Moulton	1	Inside male flower.
	Thrips spp.	2	Inside male and female flowers.

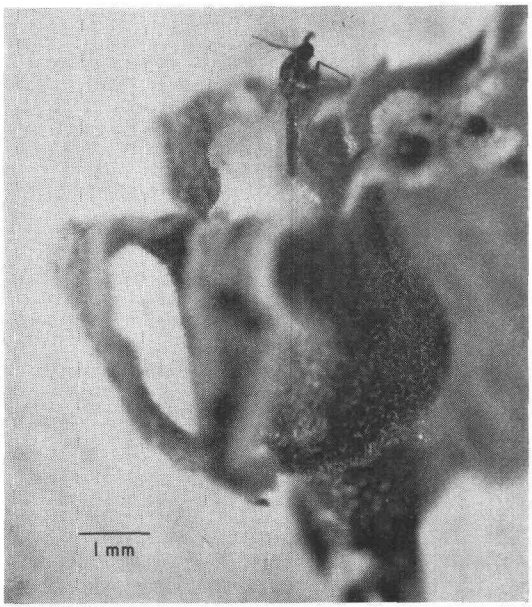

Figure 1. A dead midge (Orthocladius sp.) stuck to the stigma and petals of female flower.

may spend anything from two to five minutes within the flower. Many emerged with pollen sticking to them—particularly those that have brush-like antennae. Dead insects were sometimes seen stuck to the petals or stigma (*Figure 1*).

In 1955, one hundred and fifty female flowers that had opened the previous day were collected from seven different localities and their stigmas examined: insect hairs, apparently the antennal and body hairs of the midges, were seen on the stigmas of 8 out of 20, 5 out of 15, 5 out of 12, 2 out of 12, 7 out of 50, 3 out of 18 and nil out of 23 flowers. (*Figure 2*). Bunches of short bristles resembling those on the wings of thrips were also occasionally noticed on the stigmas.

DISCUSSION

Only the midges, thrips and the parasitic Hymenoptera, which have been seen to visit both male and female flowers, need to be considered as possible pollinators. The other insects merely rest on the inflorescence or on unopened flowers, feed on the flowers or collect pollen.

The Ceratopogonidae, and to a lesser extent the Chironomidae, Cecidomyiidae and Scatopsidae, emerge as the most important pollinating agents. Their minute size and clothing of long hairs, and their capacity for sustained flight, make them ideally suited to this function. They have been seen to visit both male and female flowers, and often to have pollen attached to them.

The thrips, though more numerous, can be expected to play a smaller role, as they are not active fliers. However, they may transfer pollen between flowers on neighbouring inflorescences, or on neighbouring trees. The role of parasitic Hymenoptera is uncertain. They are much less hairy; further, their presence is dependent upon the presence of their hosts.

CONCLUSIONS

Warmke's observations on the role of Ceratopogonid midges in the pollination of *Hevea* in Puerto Rico and Brazil can be said to apply broadly in Malaya. But, whereas in Brazil

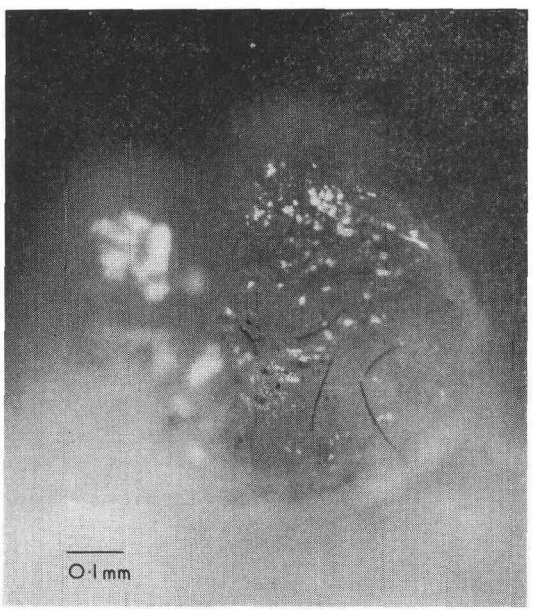

Figure 2. Insect hairs adhering to the surface of one lobe of the stigma.

they were 'so numerous that half a dozen may be observed at one time around a single inflorescence', in Malaya their visits are infrequent.

ACKNOWLEDGEMENTS

Grateful acknowledgement is made to the Director and the staff of the Commonwealth Institute of Entomology, London for identification of the insects collected, and to Dr A. Newsam for his assistance in preparing the paper for publication.

Pathological Division
Rubber Research Institute of Malaya
Kuala Lumpur *June 1961*

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