

PENETRATION OF THE HOST PLANT TISSUES BY THE STYLETS OF THE
COCCOID *ICERYA SEYCHELLARUM* (COCCOIDEA: MARGAROIDEA) ON

ALDABRA ATOLL

by S. Blackmore¹

ABSTRACT

The path of penetration of stylets of *Icerya seychellarum* through tissues of *Euphorbia pyrifolia* Lam., *Avicennia marina* (Forssk.) Vierh., *Scaevola taccada* (Gaertn.) Roxb., and *Casuarina equisetifolia* L. was studied microscopically. Most stylets were seen to end in the phloem, others in the cortex, xylem or pith. Unlike other members of the Coccoidea *I. seychellarum* frequently penetrates thick walled cells such as sclerenchyma and xylem. This suggests that the anatomy of host plants, and the distribution of thickened tissues in particular, is not a restricting factor in host plant specificity.

INTRODUCTION

Stylet penetration has been studied in coccoids which act as vectors for virus diseases of economic plants, notably the potato (Smith, 1926), apple (Glass, 1944), and cocoa (Entwistle & Longworth, 1963). Most coccoids feed on the phloem of their hosts but a few are cortex feeders. Penetration is intracellular or, less commonly, within the cell walls (Entwistle & Longworth, 1963). Smith (1926) described the penetration of xylem vessels by *Dactylopius longispinus* but otherwise penetration of thickened tissues has not been observed.

This study was intended to establish whether *I. seychellarum* conforms to the known pattern, if any tissue damage is caused by the stylets and whether host plant anatomy might influence host plant specificity of the coccoid. The biology of *I. seychellarum* on Aldabra Atoll has been studied by Renvoize (1975) and recently by Hill and Newbery (publications in preparation). *I. seychellarum* infests a wide range of plants. More than half of the one hundred and eighty flowering plant species on Aldabra Atoll have been reported as hosts. Renvoize listed about thirty species which were subject to heavy infestations,

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including all the examples discussed in this paper. In the granitic islands of the Seychelles the coccoid is a pest of Citrus crops.

MATERIALS AND METHODS

The host plants studied were *Euphorbia pyrifolia* Lam., *Avicennia marina* (Forssk.) Vierh., *Scaevola taccada* (Gaertn.) Roxb. and *Casuarina equisetifolia* L. In each case a minimum of thirty stylets were studied *in situ* in sections of stems or leaves and petioles. The plant material was fixed in Formalin-acetic-alcohol, sectioned by hand or by microtome, stained in safranin and light green and mounted. Hand cut sections were particularly useful since with careful examination the stylets were visible in the plant before it was cut. The sections were examined microscopically and the length, width and path of the stylets and the salivary sheath they secreted were recorded.

RESULTS

A number of general points were noted; these are summarized in Table 1 and discussed below.

1. Leaves and petioles were usually penetrated from below. Penetration of the upper surface was only frequent in *Ficus nautarum* and *Thespesia populnea*. The stylets usually entered the leaf to one side of the midrib.
2. The mean length of stylets was approximately 800 μ m which is shorter than the 988 μ m reported in *Pseudococcus njalensis* by Posnette & Robertson (1950). The mean length of stylet inserted into the plant was 520 μ m.
3. Stylets were usually seen to end in the phloem but were also found in the cortex, xylem, laticifers and pith.
4. Penetration was intracellular except in thickened cells where it was intercellular. When the stylet first encountered such tissues it was often withdrawn and re-inserted in a different position. If the stylet did not locate a path through less resistant tissues it was usually eventually successful in penetrating the thickened cells intercellularly.
5. Stylets usually penetrated in a transverse plane and were often found in their entirety on one or two serial sections. Entwistle & Longworth (1963) found that the plane of penetration in other coccoids was related to the orientation of the insect and the stylet was rarely to be found in so few adjacent sections.
6. There was no evidence of tissue damage other than to the cells penetrated. Small groups of callus cells were occasionally found in *Scaevola taccada*.

Table 1. Summary of stylet penetration data for four host plants.

	Euphorbia		Scaevola		Avicennia		Casuarina	
	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf
Mean length Stylet sheath, μm	424	504	750	509	675	548	450	305
Mean number branches in sheath	1.6	0.5	2.5	1.2	3.3	3.2	1.75	0.8
% stylets ending in phloem	84	75	64	67	65	46	83	75
% stylets penetrating thickened tissues	20	23	25	13	87	83	95	85

Specific results are as follows:

Euphorbia pyrifolia

The leaves have little thickened tissue except a band of collenchyma along the midrib. Stylets enter to one side of this and frequently penetrated to the phloem without being withdrawn and relocated. Often several vascular bundles were penetrated in succession. The stems have a well developed cork which was sometimes penetrated intercellularly. Several stylets were seen to enter the stem through lenticels. Many ended in, or passed through, the abundant laticifers of the cortex. It is possible that the latex is an additional food source.

Scaevola taccada

Leaf penetration was similar to that in *Euphorbia*. The stem has more sclerenchyma around the vascular tissues which may account for the greater number of reinsertions of the stylet and resulting branching of the salivary sheath.

Avicennia marina

The undersides of the leaves have a dense cover of simple trichomes. The stylets pass between these and secrete a salivary sheath extending slightly out beyond the trichomes. The vascular tissues are completely

surrounded by sclerenchyma and reinsertion of the stylets is more frequent. The stems have large cortical air spaces. Some stylets passed through the spaces but an equal number followed a sinuous course through the surrounding cells. Additional cambia within the xylem produce small groups of phloem within the xylem. About 20% of stylets penetrated through to these inner phloem cells.

Casuarina equisetifolia

The leaves or, strictly, phyllodes have angular, ridged surfaces covered by a thick cuticle beneath which a layer of sclerenchyma overlays the chlorophyllous tissues. Between the ridges the cuticle is thin and the sclerenchyma absent and stylets entering here did not encounter so much mechanical tissue. Equal numbers of stylets entered through and between the ridges. Those passing through the sclerenchyma produced branched salivary sheaths, the others did not.

CONCLUSIONS

I. seychellarum differs from most coccoids in the ability of its stylets to penetrate thickened tissues. The ability of the stylets to locate the phloem, even if this requires passage through thickened cells, implies that the stylets are to some extent sensory.

Host plants of the coccoid on Aldabra Atoll range from fleshy leaved plants such as *Euphorbia pyrifolia* to others with heavily thickened stems such as *Casuarina equisetifolia*. The ability of the insect to feed on plants with such varied anatomy suggests that host anatomy is unlikely to be a limiting factor in the selection of hosts.

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REFERENCES

- Entwistle, P.F. and Longworth, J.F. 1963. The Relationships Between Cacao Viruses and their Vectors: the Feeding Behaviour of Three Mealybug (Homoptera:Pseudococcidae) Species. *Ann. Appl. Biol.* 52: 387-391.
- Glass, E.H. 1944. Feeding Habits of Two Mealybugs, *Pseudococcus comstockii* Kuw. and *Phenacoccus colemani* Ehrh. *Tech. Bull. Va agric. Exp. Sta.* 95: 16 pp.

Posnette, A.F. and Robertson, N.F. 1950. Virus Diseases of Cacao in West Africa, VI. Vector Investigations. *Ann. Appl. Biol.* 37: 363.

Renvoize, S. 1975. *Icerya seychellarum* on Aldabra. Unpublished Royal Society Aldabra Research Committee Report, ALD/21(75).

Smith, K.M. 1926. A Comparative Study of the Feeding Methods of Certain Hemiptera and the Resulting Effects upon Plant Tissues with Special Reference to the Potato Plant. *Ann. Appl. Biol.* 13: 109-139.

The meteorological conditions during the period of the study were typical for Aldabra. The data presented in the accompanying table indicate the climate to be uniformly warm and humid. Extreme temperatures ranged from 20.1°C. to 32.0°C. (60°F. to 89°F.), relative humidity from 64% to 100%, and monthly rainfall from 117.1 mm to 186.5 mm (4.61 in. to 7.34 in.). Generally, the daily low temperatures occurred just prior to sunrise and the high during early afternoon. Daily relative humidity varied from a low of 64% to a high of 100% at the time of sunrise. (Because a daily relative humidity measurement was recorded at 8:00 p.m. rather than at sunrise, the extreme high and average high relative humidity percentages were probably somewhat higher than indicated in the table.) With a few exceptions, daily rainfall was in the form of brief, regular showers of moderate intensity. The total annual rainfall would have been approximately 1813 or 1865 mm.

As is typical for this area of the Pacific, the greatest seasonal climatic variation is reflected in wind velocity and direction rather than in temperature, relative humidity and precipitation patterns. Maximum wind speeds prevailed during the study period. Some months were characterized by low velocity variable winds and other months by higher velocity winds blowing from a particular direction. Wind direction was recorded at 10-minute intervals and the bearing of the wind was recorded at 15-minute intervals.

Influential winds during the meteorological study were the trade winds, which were generally from the east or east-northeast. The data presented in the accompanying table indicate the climate to be uniformly warm and humid. Extreme temperatures ranged from 20.1°C. to 32.0°C. (60°F. to 89°F.), relative humidity from 64% to 100%, and monthly rainfall from 117.1 mm to 186.5 mm (4.61 in. to 7.34 in.). Generally, the daily low temperatures occurred just prior to sunrise and the high during early afternoon. Daily relative humidity varied from a low of 64% to a high of 100% at the time of sunrise. (Because a daily relative humidity measurement was recorded at 8:00 p.m. rather than at sunrise, the extreme high and average high relative humidity percentages were probably somewhat higher than indicated in the table.) With a few exceptions, daily rainfall was in the form of brief, regular showers of moderate intensity. The total annual rainfall would have been approximately 1813 or 1865 mm.

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