

Cleome ciliata Schum. et Thonn. in Singapore

By ANNE JOHNSON AND TAN KIAP SENG

*Department of Botany,
University of Malaya, Singapore*

AMONG THE many ecological problems awaiting solution in Singapore Island, is the rapid spread of introduced weeds on soil bared by land utilisation. In recent years *Cleome ciliata* Schum. et Thonn. has shown wide distribution, occurring as a weed of wasteland, manure heaps and in exposed situations along the drains of roadsides. This plant of tropical African origin (Hutchinson and Dalziel, 1927) is widely distributed both in tropical Africa and Jamaica. It was first collected in Singapore in 1927 and since then has spread rapidly over Singapore Island and is locally abundant in parts of the Federation of Malaya. In this paper some suggestions will be made as the reasons for its rapid spread and its successful colonisation of exposed sunny land. Other features of ecological interest will also be mentioned.

The Good Colonising Power of *Cleome ciliata* in Singapore

Studies of the autecology of this species showed that particular features of its morphology and life history gave it considerable selective advantage in colonising bare exposed soil in Singapore.

(a) Vegetative development

The root system is a spreading one which consists of lateral roots extending horizontally and forming a circular mat at a depth of 5–10 cm. from the surface. For a well grown plant which sprawls over an area of 120–160 cm. diameter, the root system will form a mat some 60 cm. in diameter. Growing in this particular way, the roots meet with little competition from other species of plants growing in the same habitat. For instance *Phyllanthus niuri*, *Euphorbia hirta*, *Oldenlandia corymbosa* and *Alternanthera speciosa* have tap root systems in which the central main root grows straight down to a depth well below that of the *Cleome ciliata* root zone. Shallowly rooted sedges and grasses do not penetrate below the first 6 cm. of soil. (Fig. 1).

The plant grows erect to a height of 30 cm. and then falls flat on the ground where it continues to grow and flower. Such flat sprawling plants have a good chance of survival in an exposed situation.

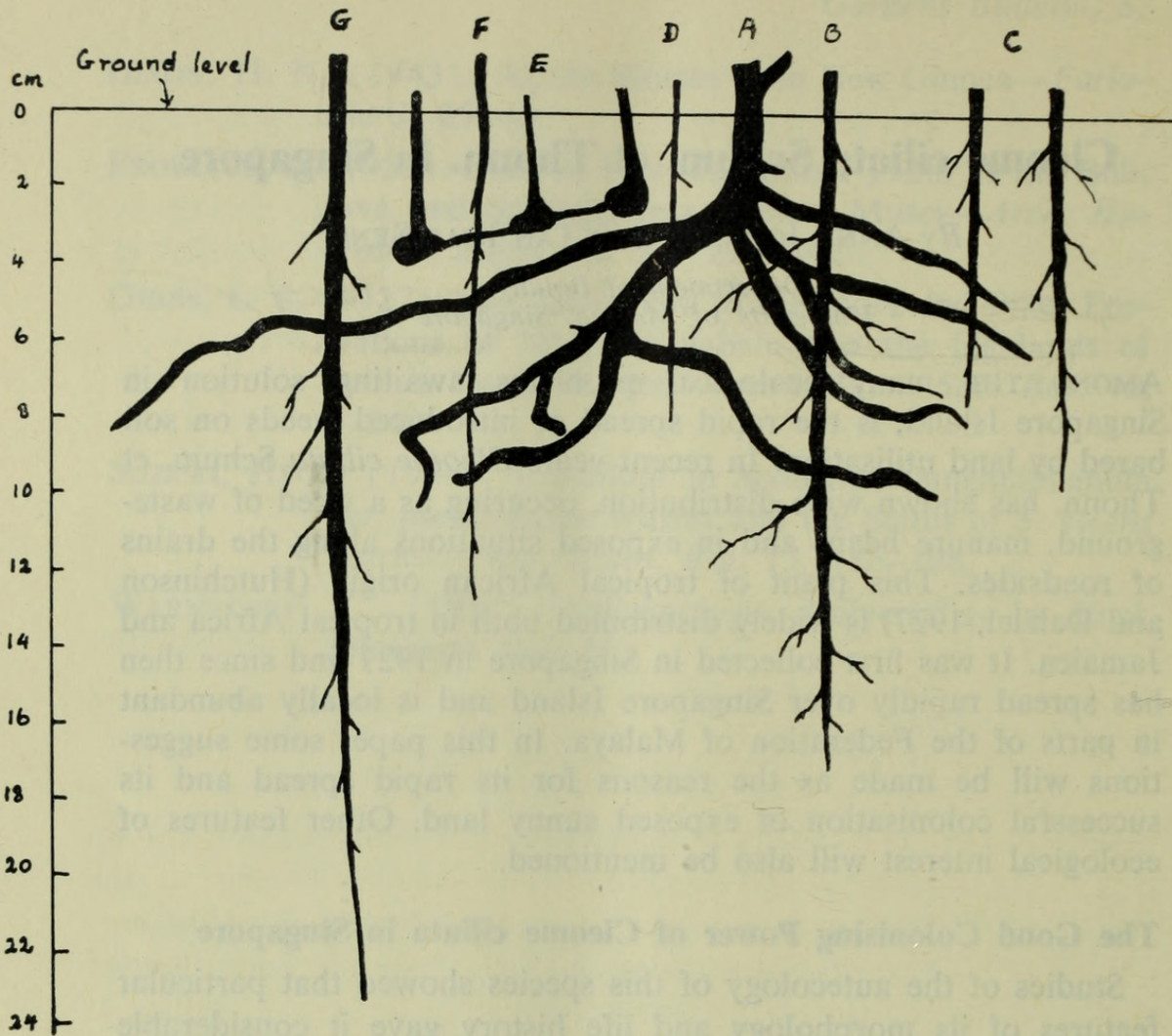


Fig. 1. Root systems of other herbaceous plants growing in association with that of *Cleome ciliata*; (A) *Cleome ciliata*; (B) *Alternanthera triandra*; (C) *Phyllanthus niuri*; (D) *Oldenlandia corymbosa*; (E) *Cyperus* spp.; (F) *Borreria latifolia*; (G) *Euphorbia hirta*.

(b) Reproduction

The flowers are distinctly dimorphous with respect to the ovaries of the mature flower. In the *normal ovary flower*, the mature ovary is almost as long as the filaments of the shortest pair of stamens (8.0–10.0 mm. long), about 1.0 mm. in diameter and bears a pink, papillose, sticky stigma. In the *short ovary flower*, the mature ovary is only 2–3 mm. long and 0.5 mm. in diameter. The stigma is green and undeveloped and no seed is set. (Fig. 2). Both types of ovary occur on the same plant and the ratio of normal ovary flower/short ovary flower varies from 1.1 to 2.0, i.e. there are always more normal ovary flowers than sterile short ovary flowers.

Artificial pollination experiments showed that while the pollen of both types of flowers was viable and successfully fertilised the normal ovary flowers; the short ovary flowers would not set seed either with pollen from flowers of its own type or with pollen from the normal ovary flowers.

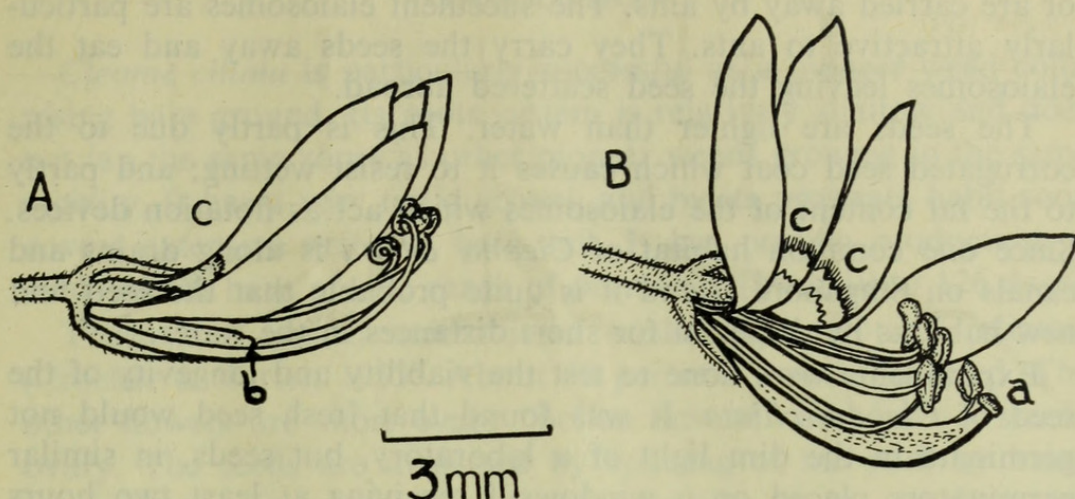


Fig. 2. Flowers of *Cleome ciliata*

A, Short ovary flower with abortive ovules and undeveloped stigma (b).

B, Normal ovary flower with fertile ovules and papillose stigma (a).

In A and B, "honey guides" are indicated (c).

In the field *Apis indica*, a honey bee, is a regular visitor to both types of flowers collecting nectar and pollen. Owing to the proximity of the lower pair of stamens and the stigma of the normal ovary flowers, self-pollination may also take place to a limited extent. The short ovary flowers seem simply to furnish additional supplies of pollen, so that fertilisation of the normal ovary flowers is assured. In the field it was observed that between 50 per cent and 71 per cent flowers set seed and only a few of normal ovary flowers failed to be fertilised.

The seeds are attached along the sutures formed by the two carpels of the fruit and average 50 seeds per pod. They are small and reniform with the embryo curled up with the sharp radicle end touching the cotyledons to form a disc-like structure. The seed coat is thick and transversely corrugated. On either side of the tip of the seed coat are two float-like structures called here "elaiosomes". The elaiosomes which are full of fatty substances, develop from the tips of the outer integuments from special cells differentiated before fertilisation. Three days after fertilisation these cells form a bunch-like structure which enlarge and appear as glistening structure as the mature seed turns from brown to black on ripening.

When the fruit is mature, it splits from below upwards forming two valves. Some seeds are shot out immediately while others are retained and later jerk out by movements of the plant in the wind,

or are carried away by ants. The succulent elaiosomes are particularly attractive to ants. They carry the seeds away and eat the elaiosomes leaving the seed scattered abroad.

The seeds are lighter than water. This is partly due to the corrugated seed coat which causes it to resist wetting; and partly to the fat content of the elaiosomes which act as flotation devices. Since one common habitat of *Cleome ciliata* is along drains and canals on Singapore Island it is quite probable that the seed find new habitats by dispersal for short distances in the water.

Experiments were done to test the viability and longevity of the seed of *Cleome ciliata*. It was found that fresh seed would not germinate in the dim light of a laboratory, but seeds, in similar germinators placed on a windowsill receiving at least two hours direct sunlight a day, germinated with a variable percentage germination according to the seed sample used. Air drying of the seed for 1-7 days does not apparently decrease the percentage germination of samples, but air drying for four months decreases it to 4 per cent.

This apparent marked effect of light is interesting since *Cleome ciliata* is essentially a plant of sunny wastelands and is never found deep in the forest, nor in shady situations. If seeds found their way to such a habitat they would fail to germinate. Removal of elaiosomes does not affect the percentage germination, therefore ant-dispersal is quite feasible.

(c) Establishment of seed

When seed of *Cleome ciliata* are sown thickly in a garden a good percentage germination is obtained, but not all the seedlings will survive. There is a marked effect of crowding resulting in the production of etiolated thin plants, producing flowers somewhat smaller than normal. In one experiment only 58 per cent plants had survived after 52 days.

Such overcrowding by plants of the same species is unlikely to occur in the field due to the diverse methods of seed dispersal which ensures a wide range of destination for seed produced by any one plant. Nevertheless *Cleome ciliata* meets competition from taller life-forms, colonising bare ground in the next stage of the succession. In the field it reacts rapidly showing etiolation of stems, yellowing of leaves, smaller flowers and fewer seeds. If a locality is completely covered with grasses such as *Ischaemum*; or with *Mimosa pudica* or *Cyperus* species *Cleome ciliata* never becomes established. Heavy shade from trees or scrub (e.g. *Adinandra dumosa*/*Wormia suffruticosa* scrub) stops the colonisation by this plant.

DISCUSSION

Cleome ciliata is particularly successful as a pioneer weed colonising bare ground. Its roots system is relatively shallow and does not tap the same zones as other pioneer weeds growing in the same vicinity. It has a very rapid growth and by its prostrate habit soon covers extensive areas of bare soil. It has prolific production of seeds which have a wide range of dormancy (from 10 to 126 days).

These are typical microbiotic seeds of a tropical climate (Crocker & Barton 1953). About 50 per cent flowers set seed. The other flowers are short ovary "pollen flowers" and have a sterile ovary. The seeds are dispersed by splitting of the pod, by being carried away in water currents of floodtide, or by ant-dispersal.

In very exposed situations the stem and adaxial leaf surface developed an erythrite red colour. The flower size was reduced and the number of seeds per fruit decreased. These effects which were not investigated further may well be due to a mineral deficiency.

The tender leaves and shoots are the favourite food of the larvae of a butterfly (*Appis libytheae olferna*). The Capparidaceae are often the food plants of the Pieridae to which family *Appis libytheae olferna* belongs (Corbet & Pendlebury, 1956). Although damage may be done to individual plants, the plants are far too numerous to be exterminated.

SUMMARY

1. *Cleome ciliata* Schum. and Thonn., 1828, a native of Tropical Africa was first collected in Singapore in 1927 and since then has spread throughout the Island and in the Federation of Malaya, growing in open waste-land and by roadsides.
2. The plant produces two types of ovaries:—"normal" ovary which is fertile; and "short" ovary which is abortive. Both types are produced on the same plant. All pollen produced is viable.
3. The seeds bear two, float-like structures, called here "elaiosomes" are not essential for germination of these seeds.
4. The elaiosomes play a double role in seed dispersal. They are partly responsible for the flotation of seeds; and they provide food for ants which scatter the seeds. The elaiosomes are not essential for germination of these seeds.

5. The percentage of germination of seed varies greatly but no germination was observed unless they were exposed to direct sunlight of at least 2 hours duration/day. This effect may be due either to true light sensitivity or to the effect of increased temperature.
6. The morphological development of the plant from germination to fruiting is traced.

ACKNOWLEDGEMENTS

The experiments and observations described in this paper were carried out by the junior author in connection with his course for the degree of B.Sc., with Honours in Botany. For this work the senior author acted as supervisor.

We wish to acknowledge the help and encouragement of Professor H. B. Gilliland, at whose suggestion this work was carried out. We have received the help and co-operation of members of the Departments of Chemistry, Physics, Geography and Zoology who have made our investigation a very interesting one. The Botanic Gardens' staff have given their unfailing assistance and support.

We wish to thank Professor H. G. Baker for his helpful criticism.

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