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Germination of seeds of New World Urostigma (Ficus) and of Morus rubra L. (Moraceae)*

by

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Abstract: The New World strangler figs of the subgenus *Urostigma* and possibly most of the epiphytes, stranglers and banyans of the subgenera *Urostigma* and *Ficus* in the Old World have viscid achenes. When these achenes are ingested by birds and bats they are voided without suffering any apparent change in viability or in the viscid coat. Digestion of the viscid coat by soil bacteria prior to germination explains why *Urostigma* seeds in the New World always germinate where there is soil and organic matter as well as humidity (floor of the forest, soil-containing cracks or cavities in tree trunks and rocks).

Urostigma and mulberry *(Morus rubra)* seeds planted experimentally in sterilized soil failed to germinate, but responded favorably when inoculated with untreated soil.

There are two subgenera of *Ficus* in the New World: *Urostigma* (section *Americana)* and *Pharmacosycea* (section *Pharmacosycea*). *Urostigma* is characterized by the epiphytic and strangling habit while *Pharmacosycea* figs are almost always found growing on river banks, near abundant water, or in secondary growth forest. New World *Pharmacosycea* species usually grow as free-standing, nonepiphytic trees. **Corner** (1958) mentioned that the same holds for Old World *Pharmacosycea*. However, *F. crassiuscula* Warb., a species found in the high rain forests of Costa Rica, occasionally grows as an epiphyte.

The two subgenera of New World *Ficus* are easy to distinguish on the basis of two characters: *Urostigma* has geminate receptacles and its achenes are invariably covered by a thick, viscid, jelly-like, transparent coat. *Pharmacosycea,* on the other hand, usually has solitary receptacles and its achenes are shiny, crustaceous, and without the viscid coat.

When fresh *Urostigma* seeds were exposed to dry air, the viscid coat lost water very slowly, and when dry, it contracted and became hard, gluing the seeds together and to the containers. **Bessey** (1908) reported that in both *F. aurea* Nutt. and *F. populnea* Willd. (two strangler figs of Florida) "The ripe achenes have an outer layer of cells that form mucilage in water." He also noted that on drying, this mucilage serves to glue the achenes in place.

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Similar viscous mucilaginous coatings have been reported in several Old World species of *Urostigma* (**King,** 1888), especially in figs with scandent, epiphytic, or strangling habits as well as others which produce aerial roots. The same author mentioned similar seed coats in some members of the Old World subgenus *Ficus* (some species of sections *Sycidium, Neomorphe,* and *Sycocarpus*), some of which are epiphytic types or banyans. Like those of the New World species of *Pharmacosycea,* the seeds of most species of Old World *Ficus* lack a gelatinous coat, and are smooth, tuberculate, rugose, punctate, hairy, etc.

My first deduction about the function of the viscid substance of New World *Urostigma* achenes was that it had the property of protecting them as they pass through the digestive tracts of animals (however, *Pharmacosycea* achenes also pass through the digestive tracts of bats without suffering any apparent damage). Assuming that the viscid coats of the achenes serve for protection against digestion, I planted fig seeds from animal droppings.

MATERIAL AND METHODS

One hundred seeds were collected on the same day from fresh droppings under a *Urostigma* tree (*Ficus* No. 4)* in Cumaná, Venezuela during 1967. For comparison, fresh seeds from a ripe syconium of the same tree were obtained. The two groups of seeds were planted in sterile petri dishes (Table 1).

TABLE 1

Germination of Urostigma *seeds in vermiculite and untreated soil*

		Number of seeds planted	Source of seeds	Germination
a.	Untreated soil	50	Fresh, ripe syconium	46
b.	Sterile vermiculite	50	Fresh, ripe syconium	0
c.	Untreated soil	50	Animal droppings	41
d.	Sterile vermiculite	50	Animal droppings	0

The seeds planted in the vermiculite (b, d) did not germinate, while those in untreated soil (a, c) germinated readily. Temperature, humidity and light could not have affected the results, because all four dishes were irrigated with the same amount of sterile distilled water and placed in the same incubator (28 C) in the dark. From these results, I concluded that some factor in the soil was probably indispensable for the germination of *Urostigma* seeds.

In the vicinity of Cumaná, during the dry season (1967), *Urostigma* seeds were seen adhering to bare surfaces such as leaves, branches, rocks and cliffs for a long time; these seeds do not germinate as a rule. Their viscid coats swell again when it rains. Small seedlings were found during the wet season growing abundantly under *Urostigma* trees, in cracks in rocks, or in forks of trees where there was some soil or oganic matter and high humidity. Seedlings growing under trees usually died during the dry season. In other parts of Venezuela where rain is abundant, the seedlings which grew on the dark floor of the forest usually died very early because of lack of light. Only seedlings in epiphytic situations as in forks of trees seemed to have a reasonable chance of survival.

* For an explanation of this nomenclature and of voucher material see **Ramírez,** 1974.

To establish the presence of a soil factor necessary for germination of *Urostigma* seeds, fresh seeds were collected from a single receptacle of *Ficus* No. 4, and grown as before, one group in untreated soil, the other in sterilized soil in a sterilized petri dish (Table 2). For both groups sterilized distilled water was used. As shown in Table 2, the results discriminate completely between sterilized and unsterilized soil, even though the seed surfaces were not sterilized.

TABLE 2

Germination of Urostigma *seeds in untreated and sterilized soil*

		Number of seeds planted	Germination
a.	Sterilized soil	100	0
b.	Unsterilized soil	100	100

About four days after the seeds were planted, the viscid coatings of the seeds in unsterilized soil (b) started to disappear. Two days later the seeds looked completely nude and some possessed a small root. Those in sterilized soil showed no change by the sixth day after planting. By day ten all the seeds in the unsterilized soil replicate (b) had germinated, while those in the sterilized soil (a) still had the viscid subtance intact and none had germinated (Fig. 1).

These results suggested that some agent in the unsterilized soil was responsible for the disappearance of the viscid coat and the subsequent germination. With the help of Mr. Robert Branden, a bacteriologist at Cumaná, a bacterium was isolated from the partially digested viscid coat of a seed. After several transfers using conventional laboratory media for bacteria, a pure culture of a grampositive rod bacterium was obtained.

To prove the effect of this bacterim on the germination of *Urostigma,* seeds of a single receptacle of *Ficus* No. 4 were planted in two sterilized petri dishes with wet filter paper instead of soil. Sterilized distilled water was employed and all other conditions were as before (Table 3). The bacterium was introduced in a diluted agar solution into one dish (b).

TABLE 3

Germination of Urostigma *seeds in sterilized medium in the presence or absence of a soil-inhabiting bacterium*

		Number of seeds planted	Destruction of viscid coat	Germination
a.	Sterile filter paper (2 replicates)	100	0	0
b.	Sterile filter paper + bacterium (2 replicates)	100	100	98

These results indicate that the bacterium isolated was responsible for the digestion of the viscid seed coat (Figs. 2, 3), and therefore why *Urostigma* seeds in nature usually germinate only in places where there is some soil or organic matter

and abundant humidity. The seeds are carried to the place of germination in the droppings of birds and bats which ingest the whole receptacles. Seeds lodged in dry places remain there until moistened by the next rain which may carry them to a moist site containing organic matter.

Bessey (1908) performed several experiments on germination of *F. aurea* Nutt. and *F. populnea* Willd. seeds. He used Knop's mineral nutrient solution in one experiment and soil in the others; there is no indication that either was sterilized. Half of the replicates of each experiment were located in the dark. Germination of *Ficus aurea* seeds occurred only in the petri dishes located in the light. When the seeds kept in the dark were moved into the light, germination occurred quite readily. With *F. populnea* seeds some germination occurred under both dark and light conditions. Bessey concluded that germination of the seeds of *F. aurea* is dependent upon light and that light requirements for germination of *F. aurea* evidently explain the close relation to its mode of life and why the epiphytic habit is the only one assumed in the dense hammocks. In the hammocks, he mentioned ". . . only those seeds germinate that have been deposited in the tops of trees where they can obtain sufficient light." Light seemed unnecessary for germination of *Ficus* No. 4.

Because the achenes of the dioecious mulberry *(Morus rubra)* possess a jelly-like coat similar to that of *Urostigma,* an experiment was performed using three groups of seeds from several fruits and fresh Kansas soil. One group of seeds was treated with 10% "Clorox" (sodium hypochlorite) solution to eliminate any biological contamination. Each group was placed in petri dishes and incubated at 28 C in the dark (Table 4).

TABLE 4

Germination of Morus rubra *seeds in sterilized and unsterilized soil*

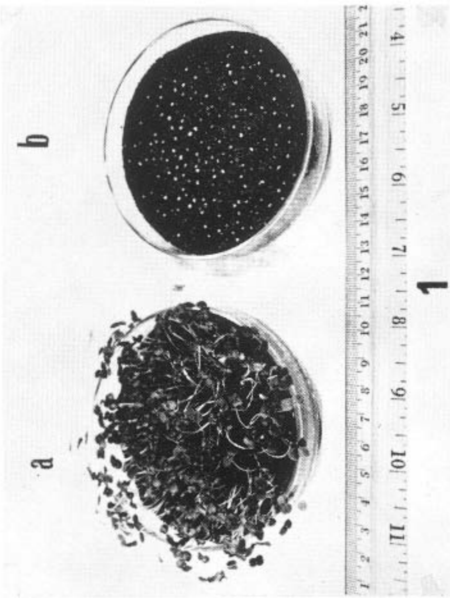
		Nº of seeds	Treated with Clorox 10%	Germination
a.	Unsterilized soil	60		60
b.	Unsterilized soil	60		60
c.	Sterilized soil	60		0

Fig. 1. a, *Urostigma* seedlings growing in unsterilized soil. b, ungerminated seeds in sterile soil. Both photographs taken 20 days after the seeds were planted.

Fig. 2. Ungerminated *Urostigma* seeds in a sterile petri dish, 20 days after planting.

Fig. 3. *Urostigma* seedlings growing in a sterile petri dish in which a soil-inhabiting bacterium was introduced, 20 days after planting.

Fig. 4. a and b. Seedlings of *Morus rubra* growing in unsterilized soil. A, seeds treated with 10% "Clorox" solution. b, untreated seeds. C, seeds planted in sterile soil. Photographs taken 8 days after the seeds were planted.



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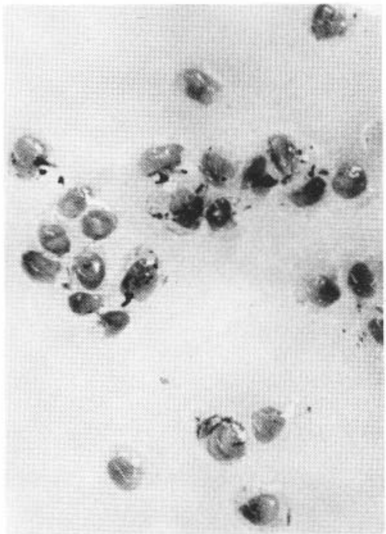

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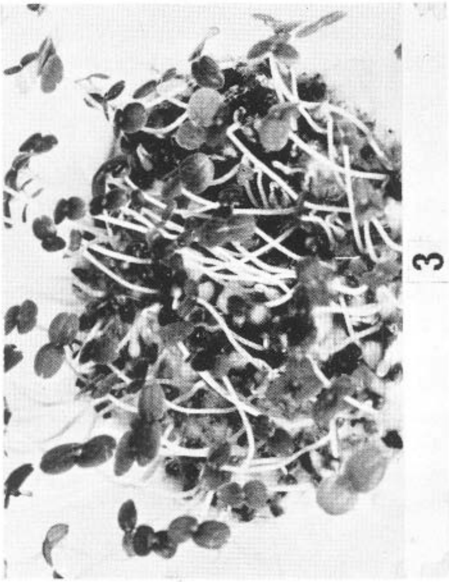

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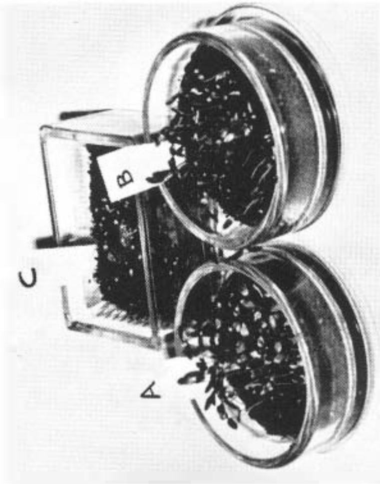

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Germination of all seeds in groups (a) and (b) occurred two days after planting. On the eigth day a small amount of soil from dish (b) was scattered on the seeds of dish (c), two days later the first seeds germinated, three days later 58 seeds had germinated. This last experiment apparently shows that as in *Urostigma, Morus rubra* seeds do not grow in sterilized soil. This finding suggests that the bases for the evolution of the mechanisms found in *Urostigma* for getting seeds to suitable sites exist and are possibly widespread in related groups. Possibly the original function of the viscid coat is to protect the seed from digestion by frugivorous animals, important dispersal agents. It further suggests that the micro-organisms concerned are probably widespread soil forms, probably of various kinds, and not a specific form occurring in the seed coat itself.

RESUMEN

Los higuerones matapalos o estranguladores del subgénero *Urostigma* (sección *Americana*) y posiblemente la mayoría de las especies epífitas y estranguladoras del subgénero *Urostigma* y *Ficus* en el Viejo Mundo poseen aquenios viscosos. Cuando estos aquenios son ingeridos por murciélagos y pájaros, son deyectados sin sufrir ningún cambio aparente en viabilidad o en su capa viscosa. Varios experimentos mostraron que la capa debe ser digerida por bacterias que se encuentran en el suelo para que la germinación pueda ocurrir posteriormente.

Ni los aquenios de *Urostigma* ni los de la morera (*Morus rubra*), que tienen capas viscosas, germinaron en suelo estéril en el laboratorio; al rociar éste con suelo sin tratar, o al inocular la semilla con la bacteria aislada, la germinación fue aproximadamente de 94%.

LITERATURE CITED

Bessey, E. A.
1908. The Florida strangling figs. *Annual Rep. Missouri Bot. Gard.*, 19: 23-33.

Corner, E. J. H.
1958. An introduction to the distribution of *Ficus*. *Reinwardtia*, 4: 15-45.

King, G.
1888. The species of *Ficus* of the Indo-Malayan and Chinese Countries. *Ann. Roy. Bot. Gard. (Calcutta)*, 1: 1-184.

Ramírez B., W.
1970. Taxonomic and biological studies of Neotropical fig wasps (Hymenoptera: Agaonidae). *Kansas Univ.* Sci. Bull., 49: 1-44.