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of the
UNITED STATES DEPARTMENT OF AGRICULTURE
MAYAGUEZ, PUERTO RICO

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INSECTICIDAL PROPERTIES OF SOME PLANTS GROWING IN PUERTO RICO

By

HAROLD K. PLANK, *Entomologist*

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MAYAGUEZ, PUERTO RICO

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[1] In cooperation with the Government of Puerto Rico.

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CONTENTS

INTRODUCTION

A survey was made of plants growing in Puerto Rico to discover those that might be used to relieve local shortages of insecticides or become possible commercial sources of such materials. This survey included plants thought to possess insecticidal value but did not include *Derris* and *Lonchocarpus* or those plants definitely known to be poisonous to persons handling them. The most promising of the species established by Moore for preliminary tests by the Bureau of Entomology and Plant Quarantine were also examined (*17, p. 68*).[1] Some of these species were later reported on by Sievers, Archer, Moore, and McGovran (*21*). The information obtained and reported herein is believed to be sufficiently extensive to indicate the potential insecticidal value of the species covered.

METHODS

All plant material was air-dried in the shade at room temperature. In addition, most of it was oven-dried during damp weather for about 12 hours at 45° to 50° C. to make it sufficiently crisp for milling. This material was then ground through a 0.02-inch screen of a Wiley mill

[1] Italic numbers in parentheses refer to Literature Cited, p. 16.

or a small hammer mill. The resulting fine powders or dusts were applied in the laboratory under conditions most favorable to reveal toxicity if present. The tests followed closely those employed by Swingle in exploring the insecticidal properties of new compounds (*22*). The following local economic species of insects belonging to four orders were used in the stages of development indicated.

Lepidoptera, half-grown larvae—
1. *Brenthia pavonacella* Clem.
2. *Diaphania hyalinata* (L.) (melonworm)
3. *Hymenia recurvalis* (F.) (Hawaiian beet webworm)
4. *Laphygma frugiperda* (A. & S.) (fall armyworm)
5. *Pachyzancla bipunctalis* (F.) (southern beet webworm)
6. *Plutella maculipennis* (Curt.) (diamondback moth)

Coleoptera, adults—
7. *Andrector ruficornis* (Oliv.)
8. *Diabrotica bivittata* (F.)
9. *Sitophilus oryza* (L.) (rice weevil)

Hemiptera, adults—
10. *Dysdercus andreae* (L.) (cotton stainer)
11. *Dysdercus sanguinarius* Stal (cotton stainer)

Orthoptera, last-stage nymphs—
12. *Periplaneta americana* (L.) (American cockroach)
13. *Periplaneta australasiae* (F.) (Australian cockroach)

All but the cockroaches and melonworms were field-collected as needed. Both species of cockroaches were easily reared in quantity. However, well over half of the egg cases of the American cockroach failed to produce nymphs because of parasitization by a small wasp, *Tetrastichus hagenowi* Ratz. In addition, this species required about 350 days to develop to the adult stage. The Australian cockroach was free of parasites and developed in only 150 days. For these reasons the latter species was used in most of the tests. An attempt was made to use field-collected melonworms, but parasitization of about 10 to 25 percent seriously interfered with the tests. An ample supply of parasite-free larvae was maintained at all times without difficulty under laboratory conditions. Most materials were tested against at least one representative of each of three insect orders. Those materials showing the most promise were further tested against a larger number of species.

For feeding tests, sections of host leaves about 3 inches in diameter were heavily dusted by rolling in the material to be tested or were liberally sprayed with a water suspension (8 pounds in 100 gallons) and dried before placing in pairs in 3.5-inch petri dishes. Additional tests by contact were made of promising materials by direct application to the test insects before caging on untreated food.

The cockroaches and cotton stainers were treated by rolling the specimens of each replicate in 0.1 gram of the dust in ½-pint jars. This was done by turning the jar on a diagonal axis until the insects were thoroughly covered, which usually required not more than six to eight turns. The insects were then left with the dust, but without food and water, in the same jars in which they were treated, ventilation being provided by loosely fitting lids. Untreated controls were handled similarly, except, of course, that no dust was placed in the jars. Mortality in these untreated controls usually was nil and did not exceed 8 to 12 percent.

Beginning immediately after treatment, the cockroaches were observed to clean their appendages with their mouth parts and not to discard the dust removed. Shafer (*20, pp. 52–55*) found that such material entered the crop of the insect. Thus the dust under test had opportunity to act against cockroaches as a stomach poison as well as a contact poison. For testing against the rice weevil 0.1 gram of material was thoroughly mixed with 10 grams of corn.

Each treatment, including the untreated control, was replicated 5 times with 5 insects per replicate, excepting that with the rice weevil 10 adults were used per replication. All cages were kept at room temperature, which ranged approximately between 70° and 85° F. Counts of living and dead and an estimate of the extent of feeding were made at the end of 2 days. Additional counts were made of the cockroaches at the end of 2 weeks after treatment. The percentage reduction in the number of living insects in the treated cages below that in the controls was taken as the percentage toxicity of the material under test. Those materials showing 40 percent or less toxicity to a given insect stage were regarded as inert or weakly toxic, those showing from 41 to 85 percent toxicity as moderately to appreciably toxic, and those over 85 percent as highly toxic.

For comparison, the reaction of a few of the test insects to some standard insecticides and diluents tested under the same conditions as the plant materials is shown in table 1.

SYSTEMATIC DISTRIBUTION OF PLANTS TESTED

Up to 9 different parts were tested from 48 species of plants that belonged to 23 families. The systematic distribution of these species is shown in table 2.

One or more parts of 22 species in 13 families were moderately to highly toxic to 1 or more test insects, and all parts examined of 26 species in 15 families were inert or weakly toxic. The largest number of plants tested in any one family belonged to the Fabaceae. Of the 11 species tested in this family, 6 were toxic and 5 were inert or nearly so. Four species were tested in each of the Clusiaceae and Mimosaceae, but only 1 in the former family and 2 in the latter were toxic. Of the 3 species of Euphorbiaceae and 2 of Polygonaceae tested, only 1 species in each family showed any toxicity.

DISCUSSION OF RESULTS

PLANTS OF MODERATE TO HIGH TOXICITY

Results of laboratory tests of the plants that showed moderate to high toxicity to one or more species of test insects are summarized by families in table 3, and the most important discussed as follows:

CANELLACEAE
(Canella-Bark Family)

Canella winterana (wild cinnamon, "canela").—This plant is said to be used locally for stunning fish. The bark was appreciably toxic to adults of *Andrector* when dusted on bean leaves, but inert as a contact insecticide.

TABLE 1.—*Results of laboratory tests of some standard insecticides and diluents applied as dusts for comparison with similar tests of plant materials*

[All materials tested by feeding unless otherwise stated]

Material and method used	Toxicity to—					
	Diaphania hyalinata	*Plutella maculipennis*	*Andrector ruficornis*	*Dysdercus sanguinarus*	*Periplaneta australasiae* in— 2 days	*Periplaneta australasiae* in— 2 weeks
Barium silicofluoride, 10 percent, in pyrophyllite:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
By feeding	[1] 100a		100a			
By contact	100a			58	4	100
Calcium arsenate, 90 percent, in pyrophyllite	100a		100a		96	100
Cryolite, natural, 50 percent, in pyrophyllite:						
By feeding	100a		100a			
By contact	100a			65	0	0
Derris-talc, 0.5 percent rotenone:						
By feeding [2]	80a	[3] 82a	[3] 8c			
By contact [2] [4]	100a			100	9	17
Hydrated lime [5]	58a	8c	36a	[3] 16	8	21
Lead arsenate, 10 percent, in pyrophyllite	92a		100a		48	100
Pyrethrum flowers:						
By feeding	100a		100a			
By contact	100a		100a	100	100	100
Pyrophyllite	0c		8c	32	0	0
Sodium fluoride, 50 percent, in flour [6]				90	100	100
Sodium silicofluoride, 20 percent, in flour:						
By feeding	100b		92a			
By contact	[3] 100b			16	8	100
Sulfur, dusting grade [5]	8c	8d	12c	0	0	0
Talc [5]	25b	0c	8b	26	8	5

[1] Letter following percentage toxicity indicates estimated extent of feeding: a=none, b=little or trace, c=moderate, and d=normal feeding comparable with that on untreated host plants in open.

[2] 100-percent toxic to *Diabrotica bivittata.*

[3] Weighted average of 2 tests.

[4] 17-percent toxic to *Periplaneta americana* in 2 days.

[5] Inert to *Diabrotica bivittata* with nearly normal feeding.

[6] 100-percent toxic to *Periplaneta americana* in 2 days.

TABLE 2.—*Systematic distribution of Puerto Rican plants examined for insecticidal properties*

Family	Species tested: Total	Species tested: Moderately to highly toxic to 1 or more test insects	Family	Species tested: Total	Species tested: Moderately to highly toxic to 1 or more test insects
	Number	*Number*		*Number*	*Number*
Araceae	2	0	Meliaceae	1	0
Asclepiadaceae	1	1	Mimosaceae	4	2
Asteraceae	1	0	Myrtaceae	1	0
Caesalpiniaceae	3	3	Phytolaccaceae	1	0
Canellaceae	1	1	Piperaceae	1	1
Cyperaceae	1	0	Polygonaceae	2	1
Clusiaceae	4	1	Rubiaceae	1	1
Commelinaceae	1	0	Sapindaceae	1	0
Euphorbiaceae	3	1	Simarubaceae	2	2
Fabaceae	11	6	Solanaceae	3	0
Lamiaceae	1	1	Theophrastaceae	1	1
Loganiaceae	1	0			
			Total	48	22

TABLE 3.—*Results of laboratory tests of plants one or more parts of which showed moderate or greater toxicity to one or more test insects*

[All parts fed as fine powders unless otherwise stated]

Family, species, part tested, and method used	Toxicity to—: *Diaphania hyalinata*	*Laphygma frugiperda*	*Plutella maculipennis*	*Andrector ruficornis*	*Dysdercus sanguinarius*	*Periplaneta australasiae* in— 2 days	*Periplaneta australasiae* in— 2 weeks
Asclepiadaceae							
Calotropis procera (Ait.) R. Br.:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Flowers	[1] 24b	----	----	0c	27	0	0
Fruits	24b	----	----	0c	5	13	14
Leaves	19a	----	----	0d	0	0	0
Bark	14c	----	----	0c	9	0	0
Wood	19c	----	----	0d	8	8	28
Roots	43a	----	16b	0c	----	----	----
Roots, by contact	60c	----	----	----	16	12	32

See footnotes at end of table.

TABLE 3.—*Results of laboratory tests of plants one or more parts of which showed moderate or greater toxicity to one or more test insects*—Continued

[All parts fed as fine powders unless otherwise stated]

Family, species, part tested, and method used	Toxicity to—						
	Diaphania hyalinata	*Laphygma frugiperda*	*Plutella maculipennis*	*Andrector ruficornis*	*Dysdercus sanguinarius*	*Periplaneta australasiae* in— 2 days	*Periplaneta australasiae* in— 2 weeks
Caesalpiniaceae							
Cassia alata L., P. I. No. 106487:	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
Immature fruits	46a	------	0c	0c	------	------	------
Immature fruits, by contact	46c	------	------	------	7	0	4
Ripe fruits	58b	------	0b	0d	------	------	------
Ripe fruits, by contact	0d	------	------	------	0	0	4
Leaflets	21c	------	0c	0c	7	0	8
Petioles	0c	------	0c	0d	14	0	4
Bark	0c	------	0c	0c	0	0	0
Wood	0d	------	4c	0d	0	0	4
Cassia nodosa Hamilt.:							
Seeds [2]	8a	0c	------	------	------	------	------
Leaflets	14b	4d	0c	0c	------	------	------
Petioles	38b	0d	8d	0d	------	------	------
Bark	29b	0d	------	0c	------	------	------
Roots	42b	------	60a	0d	------	------	------
Roots, by contact	17d	------	------	------	7	4	13
Cassia spectabilis L., P. I. No. 87506:							
Leaves	42b	------	0c	0d	------	------	------
Leaves, by contact	13d	------	------	------	0	0	0
Petioles	8b	------	4c	0b	0	0	0
Bark	0b	------	4c	0d	7	0	0
Wood	8b	------	0c	0c	0	0	0
Canellaceae							
Canella winterana (L.) Gaertn.:							
Bark	22a	5d	4d	64a	------	------	------
Bark, by contact	------	------	------	0d	0	0	0
Wood	13b	0d	0c	0c	0	0	4
Clusiaceae							
Mammea americana L.:							
Flowers	72b	------	4d	8c	------	------	------
Flowers, by contact	40c	------	------	------	8	0	0
Leaves [3]	75b	59b	35b	0c	------	------	------
Leaves, by contact	------	------	4c	------	[5] 0	------	------
Immature fruits [3, 4]	21b	0d	28b	0d	[5] 0	------	------
Half-ripe fruits, infusion	[5] 100a	------	------	[5] 4b	------	------	------
Half-ripe fruits, infusion, by contact	[5] 90b	------	------	[5] 100a	57	------	------
Seed hulls [2, 3, 4, 6]	4c	4d	0c	0c	------	------	------
Mature seeds [3, 7]	[8] 91a	[9] 91a	[10] 94a	[8] 86a	------	------	------
Mature seeds, by contact [4, 7]	100a	88b	48c	100a	[10] 14	24	50

See footnotes at end of table.

TABLE 3.—*Results of laboratory tests of plants one or more parts of which showed moderate or greater toxicity to one or more test insects*—Continued

[All parts fed as fine powders unless otherwise stated]

Family, species, part tested, and method used	Toxicity to—						
	Diaphania hyalinata	*Laphygma frugiperda*	*Plutella maculipennis*	*Andrector ruficornis*	*Dysdercus sanguinarius*	*Periplaneta australasiae* in— 2 days	*Periplaneta australasiae* in— 2 weeks
Clusiaceae—Continued	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Mammea americana L.—Con.							
Bark of twigs [2 3 6]	54b	16c	56b	4c	------	------	------
Bark of twigs, by contact [4]	------	------	16c	------	[5] 0	------	------
Bark of limbs	36b	------	------	0c	0	0	0
Wood of limbs	4c	------	------	4c	0	0	4
Roots	71a	------	96a	56a	------	------	------
Roots, by contact	48c	------	------	8c	0	0	8
Euphorbiaceae							
Phyllanthus acuminatus Vahl., P. I. No. 106936:							
Leaves	25b	------	------	0c	12	0	4
Bark	29b	------	8d	20a	------	------	------
Bark, by contact	8d	------	------	32a	47	0	0
Wood	17b	------	------	0b	27	0	4
Roots	42a	------	0c	4b	------	------	------
Roots, by contact	42d	------	------	------	13	0	4
Fabaceae							
Aeschynomene sensitiva Sw.:							
Seeds in pods [3 4]	82b	0d	0b	4d	0	------	------
Calopogonium coeruleum (Benth.) Hemsl.:							
Pods [4]	35a	21c	25a	4d	0	------	------
Seeds [4]	26a	63b	38b	0c	5	------	------
Pachyrhizus erosus Urban, local var.:							
Ripe fruits	76a	------	------	0d	------	------	------
Ripe fruits, by contact	67b	------	------	------	84	12	17
Leaves	56a	------	------	0c	------	------	------
Leaves, by contact	42b	------	------	------	32	0	0
Stems	16b	------	------	0d	26	0	4
Roots	24b	------	------	0d	47	12	4
Pachyrhizus erosus, var. A, M. No. 6717, P. I. No. 88365:							
Pods	4c	0d	4d	0d	------	------	------
Seeds+50% pods [3 4]	80a	42b	72a	0d	[5] 0	------	------
Pachyrhizus erosus, var. A, M. No. 7185, C 43–23:							
Pods	4c	0d	0c	0d	------	------	------
Seeds+50% pods [3 4]	84a	40b	57c	0c	[5] 0	------	------
Pachyrhizus erosus, var. A, M. No. 7186, C 43–22:							
Pods	0c	0c	------	0c	------	------	------
Seeds+50% pods [3 4]	[5] 90a	56a	46b	0d	[5] 7	------	------

See footnotes at end of table.

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TABLE 3.—*Results of laboratory tests of plants one or more parts of which showed moderate or greater toxicity to one or more test insects*—Continued

[All parts fed as fine powders unless otherwise stated]

Family, species, part tested, and method used	Toxicity to—						
	Diaphania hyalinata	*Laphygma frugiperda*	*Plutella maculipennis*	*Andrector ruficornis*	*Dysdercus sanguinarius*	*Periplaneta australasiae* in—2 days	*Periplaneta australasiae* in—2 weeks
Fabaceae—Continued							
Pachyrhizus erosus, var. A, M. No. 7187, C 43–10:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Pods [4]	43b	0c	4c	4c	0	------	------
Seeds+50% pods [3 4]	95a	48b	21c	0c	5	------	------
Pachyrhizus erosus, var. A, M. No. 7208:							
Pods [4]	5b	0c	------	0c	------	------	------
Seeds+50% pods [3 4]	[5] 60b	76a	70b	0c	0	------	------
Pachyrhizus erosus, var. C, M. No. 7188, C 43–21:							
Pods [4]	8c	4d	------	4c	------	------	------
Seeds+50% pods [3 4]	[5] 78a	60b	63b	4c	14	------	------
Pachyrhizus palmatilobus (Moc. & Sessé) Benth. & Hook., var. A, M. No. 7201:							
Pods [4]	0c	0d	------	0d	------	------	------
Seeds+50% pods [3]	[5] 65a	80b	13c	4c	------	------	------
Seeds+50% pods, by contact [4]	75b	------	------	------	19	------	------
Piscidia acuminata (Blake) I. M. Johnst., P. I. No. 106018:							
Leaves	68b	------	60a	0d	------	------	------
Leaves, by contact	25d	------	------	------	4	0	0
Bark	36c	------	------	0d	0	0	4
Wood	4c	------	------	0d	0	0	13
Roots	75a	------	76a	0d	------	------	------
Roots, by contact	[5] 98a	------	------	------	12	0	0
P. piscipula (L.) Sarg., P. I. No. 107831:							
Leaves	72b	------	16b	0d	------	------	------
Leaves, by contact	17d	------	------	------	4	4	8
Bark	52b	------	68a	0d	------	------	------
Bark, by contact	96a	------	------	------	24	0	4
Wood	52b	------	68a	0d	------	------	------
Wood, by contact	88b	------	------	------	8	4	4
Roots	100a	------	80a	0d	------	------	------
Roots, by contact	100a	------	------	------	52	0	0
Lamiaceae							
Leonotis nepetaefolia (L.) R. Br.:							
Ripening seed heads	[5] 68c	------	8d	36b	------	------	------
Ripening seed heads, by contact	25c	------	------	0d	21	0	0
Leaves	[5] 55b	------	0c	0c	------	------	------

See footnotes at end of table.

TABLE 3.—*Results of laboratory tests of plants one or more parts of which showed moderate or greater toxicity to one or more test insects*—Continued

[All parts fed as fine powders unless otherwise stated]

Family, species, part tested, and method used	Toxicity to—						
	Diaphania hyalinata	*Laphygma frugiperda*	*Plutella maculipennis*	*Andrector ruficornis*	*Dysdercus sanguinarius*	*Periplaneta australasiae* in— 2 days	*Periplaneta australasiae* in— 2 weeks
Lamiaceae—Continued							
Leonotis nepetaefolia (L.) R. Br.—Continued	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
Leaves, by contact	13c	------	------	------	0	0	0
Woody stems	0d	------	------	0d	5	0	0
Roots	4d	------	------	0d	16	0	4
Mimosaceae							
Albizzia lebbeck (L.) Benth.:							
Pods	0d	------	------	0c	27	0	0
Seeds	20c	------	------	4c	36	4	0
Leaflets	15d	------	------	0c	32	8	0
Petioles	10d	------	------	0c	46	0	0
Bark	35d	------	------	0d	9	8	0
Wood	0d	------	------	0c	[5] 12	[5] 0	[5] 0
Roots	25c	------	------	8b	0	0	0
A. stipulata (Roxb.) Boiv., M. No. 2738:							
Seeds	52a	------	16b	4c	------	------	------
Seeds, by contact	100a	------	------	------	69	0	28
Leaflets	28b	------	12b	4d	46	0	0
Petioles	44b	------	16b	0d	------	------	------
Petioles, by contact	50c	------	------	------	0	0	0
Bark	4c	------	------	0d	8	0	0
Wood	16c	------	------	0c	23	4	8
Roots	0d	------	------	0d	0	0	0
Piperaceae							
Piper betle L., M. No. 4703:							
Leaves	50b	------	------	12b	------	------	------
Leaves, by contact	0d	------	------	------	5	0	0
Stems	0c	------	------	4c	26	0	8
Roots	29c	------	------	56b	------	------	------
Roots, by contact	------	------	------	0d	26	0	0
Polygonaceae							
Triplaris surinamensis Cham., P. I. No. 108263:							
Leaves	11c	------	0c	0d	------	------	------
Leaves, by contact	8d	------	------	------	44	0	0
Bark	0d	------	------	4d	35	0	0
Wood	0c	------	------	0d	30	0	0
Roots	11c	------	------	0c	0	4	0

See footnotes at end of table.

TABLE 3.—*Results of laboratory tests of plants one or more parts of which showed moderate or greater toxicity to one or more test insects*—Continued

[All parts fed as fine powders unless otherwise stated]

Family, species, part tested, and method used	Toxicity to—						
	Diaphania hyalinata	*Laphygma frugiperda*	*Plutella maculipennis*	*Andrector ruficornis*	*Dysdercus sanguinarius*	*Periplaneta australasiae* in—	
						2 days	2 weeks
Rubiaceae	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
Cinchona ledgeriana Moens:							
Leaves	9c	------	------	4d	0	4	0
Bark	[9] 58b	------	[5] 32b	[5] 2b	------	------	------
Bark, by contact	[5] 2d	------	------	------	[5] 0	[5] 0	[5] 0
Wood	50c	------	36c	8c	------	------	------
Wood, by contact	4d	------	------	------	0	0	0
Roots	[5] 59b	------	40b	0c	------	------	------
Roots, by contact	8d	------	------	------	0	8	0
Simarubaceae							
Balanites aegyptiaca (L.) Delile:							
Pulp of ripe fruits	60a	------	36b	4b	------	------	------
Pulp of ripe fruits, by contact	64b	------	------	------	0	0	0
Seeds	16c	------	------	0d	4	0	0
Leaves	25d	------	------	4d	0	0	0
Bark	38b	------	------	4c	0	0	8
Twigs	4d	------	------	0c	0	0	0
Spines	8c	------	------	0c	0	0	0
Wood	4d	------	------	4d	0	0	0
Roots	28b	------	------	0b	0	8	4
Quassia amara L., P. I. No. 107001:							
Leaves	0b	------	------	8b	0	8	12
Bark	38b	------	------	12d	12	4	8
Wood	4c	------	------	12a	0	0	8
Roots	50b	------	44b	32a	------	------	------
Roots, by contact	96b	------	------	40a	18	4	16
Theophrastaceae							
Jacquinia aristata Jacq., M. No. 2702:							
Leaves	0c	------	------	0d	35	0	0
Bark	32b	------	------	0d	29	0	0
Wood	16c	------	------	4d	12	0	0
Roots	53a	------	88a	8b	------	------	------
Roots, by contact	92b	------	------	------	29	0	0

[1] Letter following percentage toxicity indicates estimated extent of feeding: a=none, b=little or trace, c=moderate, and d=normal feeding comparable with that on untreated host plants in open.

[2] Inert to *Brenthia pavonacella* with moderate feeding.

[3] Inert to *Sitophilus oryza*.

[4] Inert or weakly toxic to *Periplaneta americana*.

[5] Weighted average of 2 tests.

[6] Inert to *Pachyzancla bipunctalis* with moderate feeding.

[7] 100-percent toxic to *Diabrotica bivittata* with no feeding.

[8] Weighted average of 7 tests.

[9] Weighted average of 4 tests.

[10] Weighted average of 3 tests.

CLUSIACEAE
(Balsam Tree Family)

Mammea americana (mamey, "mamey de Santo Domingo").—This indigenous West Indian tree exhibited greater insecticidal potentialities than any other plant examined. Six of the nine parts tested were at least appreciably or highly toxic to one or more test insects, either as a stomach poison or by contact or both. Parts, such as the half-ripe fruits, mature seeds, and roots, that contained an abundance of greenish-yellow, gummy sap were highly toxic to many different insects, including cockroaches. Contrary to most writers, there is little of this toxic material in the bark. The active principle in the mature seeds, the most toxic part of the plant, was found to be mameyin, a type of substance somewhat similar in composition and effect to pyrethrins, which comprised 0.19 percent of the weight of the seed (*8; 9*). In limited field trials the powdered seeds compared favorably with nicotine sulfate in the control of certain truck-crop insects and, extracted in kerosene, were toxic to some household insects (*12, p. 738; 13, pp. 23–24; 16*).

One of the earliest uses of mamey in the West Indies has been in the control of insects, particularly chigos ("niguas") and other fleas attacking man and domestic animals (*4. v. 2, pp. 82, 83*). As shown in table 3, an infusion of the half-ripe fruits at 1 pound in 1 gallon of water was highly toxic to *Diaphania* larvae both as a stomach poison and as a contact poison; it also gave 100-percent control of *Andrector* adults by contact. In a separate test, this infusion and the dry powdered seeds produced complete mortality of the fleas *Ctenocephalides felis* (Bouché) and *Pulex irritans* L. in ½ hour. Applied to dogs infested with these species of fleas and the brown dog tick (*Rhipicephalus sanguineus* Latr.), both materials acted faster than a 1-percent suspension of DDT in water and the control was as effective, though not quite so permanent (*14, p. 16; 15*). The leaves, which were moderately to appreciably toxic in laboratory tests, have been successfully used for many years locally as a wrapping around the trunk of newly set garden plants to prevent the attack of insects at or just below the ground. The leaves, half-ripe fruits, and seeds thus offer cheap and readily available means of controlling certain crop and animal pests in the Tropics.

Large numbers of mamey trees grow in Puerto Rico and they can probably be found in about equal abundance throughout most of their range elsewhere in the West Indies and in northern South America. However, for commercial insecticides manufacture the amount of seeds available would probably be small under present conditions, as most of the fruit is used for food and the seeds discarded. Exposed in the open, the seeds will become infested with small beetles, the scolytid *Poecilips* sp.[2] and *Caulophilus latinasus* (Say) (broad-nosed grain weevil), and with larvae of the phycitid *Myelois notatalis* (Walkr.) (*12*); they may also become black and moldy. Such infestation has lowered toxicity, but the attack of molds has not. When thoroughly dry the seeds can be stored in sealed containers almost indefinitely, and even the water infusion will keep for several months, without any apparent loss in toxicity.

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[2] Determined by W. H. Anderson, Bureau of Entomology and Plant Quarantine.

EUPHORBIACEAE
(Spurge Family)

Phyllanthus acuminatus.—Only the bark and roots of this plant were at all toxic to any of the insects tried. This species apparently holds no more promise than any of the others of the same family reported by McIndoo (*10, pp. 75–82*).

FABACEAE
(Pea Family)

Some of the species tested in this family were highly toxic to certain insects, but none appeared to equal *Mammea americana* in range of effectiveness.

Aeschynomene sensitiva (swamp grass, "hierba de cienega").—The seeds of this common weed were found by Jones (*7, p. 14*) to contain rotenone-type compounds equivalent to 0.08 percent of rotenone and the pods the equivalent of 0.18 percent. However, the seeds plus their corresponding pods were appreciably toxic only to the larvae of *Diaphania hyalinata.*

Pachyrhizus erosus and *P. palmatilobus* (yam bean, "habilla," or "jicama de agua" (Mexico)).—These plants are widely cultivated in tthe Tropics for their edible fleshy roots; in some countries their seeds have been employed as a fish poison and insecticide (*6*). Norton isolated rotenone from seeds that came from Mexico (*11*). A number of varieties and closely related species were established at the station at Mayaguez for comparative studies (*3, p. 14*), and the seeds of some of them were given laboratory toxicity tests. Most of the varieties tested came originally from Mexico, one came from Nicaragua, one from Cameroun, West Africa, and one was a local variety. With small variations among fruits, plants, and strains, the content of rotenone plus rotenoids in the seeds ranged from 0.25 to 0.72 percent (*7, pp. 13–14*). More recent work has shown that these toxicants and others are contained in a resin which comprises up to 3.4 percent of the weight of the seeds (*5, p. 61*). It will be noted in table 3 that the ripe fruits of the local variety were appreciably toxic to *Diaphania* larvae and to *Dysdercus* adults. The leaves were only moderately toxic to *Diaphania.* The dust made from the ripe fruits used contained 62.1 percent of pods by weight.

The seeds of the introduced varieties were so high in oil content that an equal part of corresponding pods had to be added to facilitate grinding. With the possible exception of M. Nos. 7186 and 7187, these 50–50 dusts all appeared to be of about equal toxicity. It is important to note that, as with 0.5-percent rotenone dust (table 1) and *Aeschynomene sensitiva*, previously mentioned as containing rotenone, none of the species and varieties of *Pachyrhizus* were toxic to the local bean leaf beetle, *Andrector ruficornis.*

Piscidia acuminata.—The roots were the most generally toxic part of this close relative of the Jamaica dogwood.

Piscidia piscipula (Jamaica fi h poison, "ventura").—This plant, established from Ecuador, showed considerable toxicity to three of five species of test insects. The roots were the most toxic part examined, although the bark and wood of the branches also give high kills either as stomach poisons or by contact. Both the root bark and the root wood are known to contain rotenone (*19*). Ineffectiveness of this and the foregoing species of *Piscidia* against adults of *Andrector ruficornis* is similar to that of previously mentioned rotenone-bearing plants. Scarcity of material prevented further work with these two plants, but the results obtained would appear to warrant more extensive trials.

LAMIACEAE
(Mint Family)

Leonotis nepetaefolia (lion's-ear, "molinillo").—The powdered seeds of this pasture weed are said by Grosourdy to be effective against lice and the insects infesting wounds (*4, v. 1, pp. 105–106*). Only the ripening seed heads and leaves were found in the present survey to have any marked toxicity and then only to one species of test insect. Asenjo (*2, p. 93*) found 28 percent of oil in the seed and traces of an alkaloidlike substance in this and various other parts of this plant.

MIMOSACEAE
(Mimosa Family)

Albizzia lebbeck (yellow acacia, "lengua de mujer") and *A. stipulata.*—None of the many parts of the first of these trees was more than mildly toxic. However, the seeds of the latter species, established from Ceylon, were appreciably to highly toxic to *Diaphania* larvae and *Dysdercus* adults.

POLYGONACEAE
(Buckwheat Family)

Triplaris surinamensis.—The leaves of this fish-poison tree, native to Dutch Guiana, seemed to affect only *Dysdercus* adults and then only to a moderate extent.

RUBIACEAE
(Madder Family)

Cinchona ledgeriana (Peruvian bark, "quina roja").—The bark, wood, and roots from trees in the station plantings at Mariacao and Toro Negro were moderately toxic to *Diaphania* larvae when tested as stomach poisons, but were practically inert and permitted normal feeding when applied by contact.

SIMARUBACEAE
(Ailanthus or Quassia Family)

Balanites aegyptiaca (desert date).—The fruits and bark of species of *Balanites* have been used in Nigeria and India as fish poisons and insecticides (*18, p. 4*). At high dilutions in water all parts of *B. aegyptiaca*, established from Africa, were toxic to the snail, *Austrolorbis glaboratus* Say, the only known alternate host in Puerto Rico of the liver fluke, *Schistosoma mansoni* Sambon, that infests man and certain other animals (*13, pp. 24–25*). However, the pulp of the ripe fruits of this plant was the only part found to be appreciably toxic to insects.

Quassia amara (Surinam quassia, "cuasia").—All parts but one of this well-known insecticidal plant when used as fine powders had little effect on the insects against which they were tried. The roots, however, were highly toxic to *Diaphania* larvae by contact and moderately to weakly toxic to other test insects.

THEOPHRASTACEAE

Jacquinia aristata.—The roots of this fish-poison plant, established from the Amazon Basin, were highly toxic to two species of test insects and permitted little or no feeding.

INERT OR WEAKLY TOXIC PLANTS

Plants found to have little or no toxicity are listed in table 4 with the insects against which the different parts were tested.

TABLE 4.—*Plants all tested parts of which were inert or weakly toxic to the insects against which they were used*

Family and species	Parts tested	Insects used [1]
Araceae:		
Caladium sp	Leaves, petioles, crown+roots.	2, 6, 8, 10, 13.
Diffenbachia seguin (Jacq.) Schott.	Leaves, stems	2, 7, 10, 13.
Asteraceae:		
Clibadium erosum (Sw.) DC.	Flowers+fruits, leaves, bark, wood.	2, 7, 10, 13.
Cyperaceae:		
Cyperus rotundus L	Seedless flower heads, leaves, tubers.	2, 7, 11, 13.
Clusiaceae:		
Calophyllum antillanum Britton.	Seed hulls	2, 4, 6, 7.
	Seed kernels+80% hulls, leaves, bark, wood.	2, 4, 6, 7, 9.
	Roots	2, 7, 11, 13.
C. inophyllum L	Seed hulls, seed kernels+80% hulls.	2, 4, 6, 8, 11, 12.
	Leaves, bark, wood, roots	2, 7, 11, 13.
Clusia rosea Jacq	do	2, 7, 11, 13.
Comelinaceae:		
Commelina elegans H.B.K.	Leaves+stems	2, 7, 11, 13.
Euphorbiaceae:		
Aleurites trisperma Blanco.	Hulls, kernels+50% hulls, leaves, bark, wood.	2, 6, 8, 10, 13.
Euphorbia heterophylla L.	Whole plant with roots	2, 7, 11, 13.
Fabaceae:		
Abrus precatorius L	Seeds, leaves, stems, roots	2, 7, 11, 13.
Erythrina sp., P. I. No. 109849.	Leaves, petioles, bark, wood	2, 6, 8, 10, 13.
Erythrina variegata orientale (L.) Merr., M. No. 2663.	Seeds in pods, roots	2, 7, 11, 13.
Gliricidia sepium (Jacq.) Steud.	Immature fruits, ripe fruits	2, 4, 6, 7, 9, 11, 12.
	Leaves, petioles	1, 2, 3, 4.
	Bark	1, 2, 4, 5, 6.
Indigofera endecaphylla Jacq.	Seeds, leaves, stems	1, 2, 4.

[1] Numbers refer to species of test insects listed on p. 2.

TABLE 4.—*Plants all tested parts of which were inert or weakly toxic to the insects against which they were used*—Continued

Family and species	Parts tested	Insects used [1]
Loganiaceae:		
Antonia ovata Pohl., P. I. No. 106371.	Leaves, bark, wood	2, 7, 11, 13.
Meliaceae:		
Carapa guianensis Aubl.	Seeds+35% petioles, roots.	2, 7, 11, 13.
	Leaves, petioles, bark, wood.	2, 4, 6, 8, 11, 12.
Mimosaceae:		
Entada polystachya (L.) DC.	Leaflets, petioles, stems	2, 4, 6.
	Roots	2, 7, 11, 13.
Enterolobium cyclocarpum (Jacq.) Griseb.	Leaflets, petioles, bark, wood.	2, 4, 6.
Myrtaceae:		
Eucalyptus sp., M. No. 2145.	Leaves, bark, wood, roots	2, 7, 11, 13.
Phytolaccaceae:		
Petiveria alliaca L.	Fruits, leaves, stems, roots	2, 7, 11, 13.
Polygonaceae:		
Ruprechtia sp., P. I. No. 109868.	Leaves, bark, wood, roots	2, 7, 11, 13.
Sapindaceae:		
Sapindus sp., P. I. No. 107834.	Leaves, bark, wood, roots	2, 7, 11, 13.
Solanaceae:		
Solanum ciliatum Lam.	Immature fruits	2, 6, 7, 11, 13.
	Leaves	2, 6, 8, 11, 13.
	Ripe fruits	2, 6, 7, 8, 11, 12, 13.
	Stems	2, 6, 8, 10, 11, 13.
S. mammosum L.	Ripe fruits, leaves, stems, roots.	2, 7, 11, 13.
S. nigrum L.	Ripe fruits	2, 7, 10, 13.
	Leaves, small branches	2, 7, 10, 11, 13.
	Woody stems	2, 7, 11, 13.

[1] Numbers refer to species of test insects listed on p. 2.

Those plants in table 4 that are followed by accession numbers ("P. I. No." or "M. No.") were reputed to be used as fish poisons or insecticides in the countries from which they were established. Some of the remainder belonged to families, such as Asteraceae, Clusiaceae, Fabaceae, which contain species having such properties. Other plants, like *Diffenbachia seguin* and *Abrus precatorius*, were known to be poisonous when eaten by man or animals, and still others, like *Caladium* spp., *Cyperus rotundus*, *Commelina elegans*, and *Euphorbia heterophylla*, were common weeds rarely attacked by insects.

In this weakly toxic group of plants it is important to note that a contact insecticide "effective against grasshoppers and other insects" (*1, p. 351*) is reported to be made in Costa Rica from *Cyperus rotundus*, the locally common nutgrass or "coqui." Although said to be useful in the control of cockroaches, the fruit and other tested parts of *Solanum mammosum* (love-apple, "berenjena de cucarachas") had no effect on cockroaches and were, at most, only weakly toxic to other insects.

Apparently, the fact that a given plant is poisonous to fish, man, or other animals, rarely infested by insects, or related systematically to plants possessing insecticidal properties, is no definite criterion that it also possesses important insecticidal properties.

SUMMARY

Results are given of laboratory "screening" tests of up to 9 different parts of 48 species of plants in 23 families. Three or more local economic representatives of 4 orders were used as test insects. One or more parts of 22 species of plants in 13 families showed moderate to high toxicity, and all tested parts of 26 species in 15 families were inert or weakly toxic. Six out of 11 species of Fabaceae, the largest family tested, and 1 out of 4 species of Clusiaceae, the next largest, were found to be toxic. Systematic position, or the fact that a given plant was poisonous to other animals or was a common weed rarely attacked by insects, was not a positive indication of insecticidal properties.

The half-ripe fruits, mature seeds, and leaves of *Mammea americana* (mamey) and the seeds of some introductions of *Pachyrhizus erosus* (yam bean) showed definite insecticidal value. Mamey, with a minimum of elaboration, offers an effective and economical means of control of some insects by small farmers and others having access to fresh material. Yam bean seed, which contains rotenone and other toxic compounds, can be more widely grown, but it was very oily and required more preparation than mamey and, in these tests, was not so effective against the same species of insects. The roots of two species of *Piscidia* also showed insecticidal possibilities, but need more extensive tests before they can be definitely evaluated.

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