UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

DIVISION OF INSECTICIDE INVESTIGATIONS

LONCHOCARPUS (BARBASCO, CUBE, AND TIMBO)--
A REVIEW OF RECENT LITERATURE

By

R. C. ROARK

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United States Department of Agriculture
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INTRODUCTION

In March, 1936, the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture issued mimeographed publication No. E-367, entitled, "Lonchocarpus species (Barbasco, Cube, Haiari, Nekoo, and Timbo) Used as Insecticides", in which all available information on the subject was reviewed. The purpose of this paper is to summarize information on Lonchocarpus that has become available since March 1936, or that was overlooked in the compilation E-367.

Lonchocarpus has become the principal source of rotenone used in the United States. In 1936 this country imported 704,120 pounds crude cube, timbo or barbasco root, 1,124,936 pounds powdered timbo root, and 510,337 pounds crude derris root.

Although the literature on insecticides contains many more references to derris than to Lonchocarpus, the latter is receiving an increasing share of attention. Insects controlled by the one are in most cases also controlled by the other, and entomologists are beginning to speak of rotenone dusts and sprays without specifying whether made from derris or Lonchocarpus.

The reader interested in the rotenone-bearing plants will find additional information on this subject in the publication E-402, "Tephrosia as an Insecticide--A Review of the Literature", issued February, 1937. The information concerning derris is now being compiled, and it is hoped that eventually all the information on rotenone and related insecticides, whether occurring in Derris, Lonchocarpus, Tephrosia, Mundulea, or other genera, will be assembled in one publication.

COMMON NAMES

Martius (270) in 1843 recorded that in Brazil Paullinia pinnata L. was called timbo and timbo-sipo.

The Lima Geographic Society (261) in 1894 published a paper entitled, "El barbasco (cubi o cumu)". This gave information on several kinds of barbasco which are mostly species of Tephrosia. Lonchocarpus is not mentioned.

The following common names for species of Lonchocarpus have been noted:

Common names of Lonchocarpus species

<u>Species</u>	<u>Common name</u>	<u>Where used</u>	<u>Reference</u>
atropurpureus Benth.	jobe	Venezuela	Pittier, 329,330
blackii (F. Muell.)	bloody bark	Not specified	Gerth, 164
	Queensland lance-pod	"	"

<u>Species</u>	<u>Common name</u>	<u>Where used</u>	<u>Reference</u>
blainii C. Wright	guama cinarron	Cuba	Roig, 359
	guama hodiendo	"	"
	guama hodiendo hembra	"	"
	guama de San Bartolome	"	"
bussei Harns	agoio	Congo	Staner and Boutique, 395
	mbale ol. bararuai	East Africa " "	Bally, 14 "
chrysophyllus Kleinh.	black haiari	British Guiana	Krukoff and Smith, 255
			Martyn and Follett- Smith, 271
	nekoe	Surinam	Krukoff and Smith, 255
			Pulle, 337
	wake-ro-koda	British Guiana	Krukoff and Smith, 255
	wakorokoda	"	"
crucisrubicrae Pittier	wakuru-kuda	"	"
	nemudito tocorito	Venezuela "	Pittier, , 330
cyanescens (Schum. & Thonn.) Benth.	ochi	Nigeria	Kew, 240
	olu	"	Kew, 240; Maloney, 285
	gara	"	Kew, 240
	gera	"	"
	indigo	Not specified	Gerth, 164
	negopassa	Nigeria	Kew, 240
	negoparsa	"	"
	nialo	"	"
	West African indigo	"	Kew, 240; Maloney, 285; Gerth, 164

<u>Species</u>	<u>Common name</u>	<u>Where used</u>	<u>Reference</u>
	Yoruba indigo	Nigeria	Kew, 240; Gerth, 164; Hooker 196
densiflorus Benth.	bastard haiari	British Guiana	Martyn and Follett- Smith, 271
	haiari	"	"
densiflorus moritzianus Benth.	majono	Venezuela	Pittier, 329, 330
dipteroneurus Pittier	grifo	"	"
doningensis (Pers.) DC.	guana	Cuba	Roig, 359
	guana de majagua	"	"
	guana de sogá	"	"
oriocalyx Harms	nevaro	East Africa	Bally, 14
fendleri Benth.	nehono	Venezuela	Pittier, 330
	majono	"	Pittier, 329, 330
floribundus Benth.	tinbo	Brazil	Krukoff and Smith, 255
	tinborana	"	"
	tinbo venenoso	"	Fagundes, 136
	tinbo venenoso do Para	"	LeCointe, 258
	wiriri nekuru	Surinam	Krukoff and Smith, 255
hintoni Sandwith	aricuahuc	Mexico	Kew, 241
	cajurica	"	"
	palo de Aro	"	"
	zopilacuague	"	"
katangensis de Wild.	tjuija	Congo	de Wilde- man, 469
latifolius (Willd.) H.B.K.	acurutu	Venezuela	Pittier, 329, 330
	bitch wood	Not specified	Gerth, 164
	fuerte-ventura	Puerto Rico	Pittier, 330
	guana candelon	Cuba	Roig, 359

<u>Species</u>	<u>Common name</u>	<u>Where used</u>	<u>Reference</u>
	guana de costa	Cuba	Roig, 359
	guana hodiendo	"	Roig, 359
	palo hodiendo	Puerto Rico	Pittier, 330; Stahl, 393
	savonette jaune	Not specified	Gerth, 164
laxiflorus Guill. and Perr.	homohono	Nigeria	Kew, 240; Sin, 377
	nowaleh	"	Kew, 240; Grant & Oliver, 172
	panda	"	Kew, 240; Sin, 377
longipes Urb. & Elm.	guana de costa	Cuba	Roig, 359
martynii A. C. Smith	a-ya	British Guiana	Krukoff and Smith, 255
	white haiari	"	"
mirandinus Pittier	grifo	Venezuela	Pittier, 330
mossambicensis Sin.	chicush	Portuguese East Africa	Sin, 377
	chicuswa	"	"
	mpangeli	"	"
	pangira	"	"
nicou (Aubl.) DC.	barbasco	Peru	Fagundes, 136
	conapi	Peru	"
	cube	"	"
	haiari	Guianas	"
	haiari	Brit. Guiana	Martyn and Follett- Smith, 271
	inecou	Not specified	Ernst, 132
	nicou	Guianas	Fagundes, 136
	pacai	Peru	"
	tinbo	Brazil	Fagundes, 136
	tinbo legitimo	Brazil	McCointe, 258
	tinbo macaquinho	"	"
	white haiari	Brit. Guiana	Martyn and Follette- Smith, 271
pictus Pittier	tecorito	Venezuela	Pittier, 329
punctatus H.E.K.	aco	"	Pittier, 329, 330

<u>Species</u>	<u>Common name</u>	<u>Where used</u>	<u>Reference</u>
rariflorus Mart.	black haiari	Brit. Guiana	Martyn and Follett-Smith, 271
	cururu	Brazil	Krukoff and Smith, 255
	faia-faia	Brit. Guiana	Krukoff and Smith, 255
	faia-fai(a) noroko	"	Martyn and Follette-Smith, 271
	noroko	"	Krukoff and Smith, 255
	timbo andrello	Brazil	"
	timbo cururu	"	"
roseus DC.	cacahuananchi	Jalisco, Mexico	Duges, 121
rubiginosus Benth.	Saint-Martin rouge	Not specified	Gerth, 164
rufescens Benth.	bois enivrant	"	"
	liane a enivrer les poissons	"	"
	liane a nivre	"	"
	nicou	Guiana	Lindley, 262
	nicou	Not specified	Gerth, 164
	real hiarree	"	"
	robinier nicou	"	"
	vischgiftliane	"	"
sericeus (Poir.) H.B.K.	apapo	Nigeria	Kew, 240
	box lonchocarpus	Not specified	Gerth, 164
	buchsenlonchocarpus	"	"
	guama bobo	Cuba	Roig, 359
	ipapo	Nigeria	Kew, 240
	lonchocarpe a boites	Not specified	Gerth, 164
	mutala-merha	Nigeria	Kew, 240;
			deWildeman, 469
	ossani	"	Kew, 240;
			Moloney, 285; Paris Exposition, 315
	yoruba	"	Kew, 240

<u>Species</u>	<u>Common name</u>	<u>Where used</u>	<u>Reference</u>
sylvestris A. C. Smith	barbasco del monte	Peru	Krukoff and Smith, 255
	sacha barbasco	"	"
	timbo	Brazil	"
	timborana	"	"
	timoata	"	"
tomentosus Tul.	baura	Colombia	Cortes, 91
urucu Killip and Smith	barbasco	Brazil	Gleason, 166
	timbo assu	"	Krukoff and Smith, 255
	timbo carajura	"	"
	timbo carajura	"	LeCointe, 258
	timbo uassu	"	Krukoff and Smith, 255
	timbo urucu	"	"
	timbo urucu	"	Fagundes, 136
	timbo urucu	"	LeCointe, 258
	timbo vermelho	"	Silva, 374
	timbo vermelho	"	Krukoff and Smith, 255
	timbo vermelho	"	LeCointe, 258
utilis A. C. Smith	barbasco	Peru	Krukoff and Smith, 255
	barbasco	Ecuador	"
	conapi	Peru	"
	cube	"	"
	cube de alnidon	"	"
	pacai	"	"
	timbo	Brazil	Krukoff and Smith, 255
	timbo legitimo	"	"
	timbo macaquino	"	"
	timbo urubu	"	"
	timbo verdadeiro	"	"
	tinu	Ecuador	"
	tinu-anbi	"	"
violaceus (Jacq.) H.B.K.	acurutu	Venezuela	Ernst, 130
	bai-ario	Not specified	Gerth, 164
	geno geno	Antilles	Stahl, 393
	Margarita	Venezuela	Ernst, 130
	nekoe	Not specified	Gerth, 164
	stinkhout	Not specified	"
	tiengihoedoe	"	"
	tingi hoedoe	"	"

<u>Species</u>	<u>Common name</u>	<u>Where used</u>	<u>Reference</u>
L. sp.	guano negro	Cuba	Roig, 359
	haiari	Guianas	Roth, 360
	heri	Guianas	Roth, 360
	Inekhou	French Guiana	"
	nakko	Guianas	Barreno, 16;
	nekko	Surinam	Roth, 360
	nekoe	"	Sack, 363
	oeman nekoe	"	Krukoff and Smith, 255
	reddi nekoe	"	"
	red haiari	Brit. Guiana	"
	stinkholz	Surinam	Kappler, 233
	stinkhout	"	Sack, 363
	tinbo branco	Brazil	Krukoff and Smith, 255
	tinbo de massa	"	"
	tinbo legitimo	"	"
	tinbo nanso	"	"
	tinbo pao	"	"
	tinbo pau (de massa)	"	LeCointe, 258
	tinbo verdadeiro	"	Krukoff and Smith, 255
	yurabo indigo	"	Cantley, 64

Botanical identity of plants listed alphabetically according to common name.

<u>Common name</u>	<u>Species of Lonchocarpus</u>
aco	L. punctatus H.B.K.
acurutu	L. latifolius (Willd.) H.B.K.
acurutu	L. violaceus (Jacq.) H.B.K.
agoio	L. busseii Harms.
apapo	L. sericeus (Poir.) H.B.K.
aricua hue	L. hintoni Sandwith
a-ya	L. martynii A. C. Smith
bai-arie	L. violaceus (Jacq.) H.B.K.
barbasco	L. nicou (Aubl.) DC.
barbasco	L. urucu Killip and Smith
barbasco	L. utilis A. C. Smith
barbasco del monte	L. sylvestris A. C. Smith
bastard haiari	L. densiflorus Benth.
baura	L. tomentosus Tul.
bitch wood	L. latifolius (Willd.) H.B.K.
black haiari	L. chrysophyllus Kleinh.
black haiari	L. rariflorus Mart.
bloody bark	L. blackii (F. Muell.) Benth.
bois enivrant	L. rufescens Benth.
box lonchocarpus	L. sericeus (Poir.) H.B.K.
buchsenlonchocarpus	L. sericeus (Poir.) H.B.K.
cacahuananchi	L. roseus DC.
cajurica	L. hintoni Sandwith
chicush	L. mossembicensis Sim
chicuswa	L. mossembicensis Sim
conapi	L. nicou (Aubl.) DC.
conapi	L. utilis A. C. Smith
cube	L. nicou (Aubl.) DC.
cube	L. utilis A. C. Smith
cube de almidon	L. utilis A. C. Smith
cururu	L. rariflorus Mart.
echi	L. cyanescens (Schum. & Thonn.) Benth.
elu	L. cyanescens (Schum. & Thonn.) Benth.
faia-faia	L. rariflorus Mart.
faia-fai (a) noroko	L. rariflorus Mart.
fuerte-ventura	L. latifolius (Willd.) H.B.K.
gara	L. cyanescens (Schum. & Thonn.) Benth.
geno geno	L. violaceus H.B.K.
gera	L. cyanescens (Schum. & Thonn.) Benth.
grifo	L. dipteroneurus Pittier
grifo	L. mirandinus Pittier
guama	L. domingensis (Pers.) DC.
guama bobo	L. sericeus (Poir.) H.B.K.
guama candelon	L. latifolius (Willd.) H.B.K.
guama cimarron L.	L. blainii C. Wright
guama de costa	L. latifolius (Willd.) H.B.K.
guama de costa	L. longipes Urb. & Ekm.
guama hediondo	L. blainii C. Wright

Common name

Species of Lonchocarpus

guama hediondo	<i>L. latifolius</i> (Willd.) H.B.K.
guama hediondo hembra	<i>L. blainii</i> C. Wright
guama de majagua	<i>L. domingensis</i> (Pers.) DC.
guama negro	<i>L. sp.</i>
guama de San Bartolome	<i>L. blainii</i> C. Wright
guama de sogá	<i>L. domingensis</i> (Pers.) DC.
guano negro	<i>L. sp.</i>
haiari	<i>L. densiflorus</i> Benth.
haiari	<i>L. nicou</i> (Aubl.) DC.
haiari	<i>L. sp.</i>
heri	<i>L. sp.</i>
homohomo	<i>L. laxiflorus</i> Guill. and Perr.
indigo	<i>L. cyanescens</i> (Schum. & Thonn.) Benth.
inecou	<i>L. nicou</i> (Aubl.) DC.
inckou	<i>L. sp.</i>
ipapo	<i>L. sericeus</i> (Poir.) H.B.K.
jebe	<i>L. aprepurpureus</i> Benth.
liane a enivrer les poissons	<i>L. rufescens</i> Benth.
liane a nivre	<i>L. rufescens</i> Benth.
lonchocarpe a boites	<i>L. sericeus</i> (Poir.) H.B.K.
mahomo	<i>L. fendleri</i> Benth.
majomo	<i>L. densiflorus maritzianus</i> Benth.
majomo	<i>L. fendleri</i> Benth.
Margarita	<i>L. violaceus</i> (Jacq.) H.B.K.
mbale	<i>L. bussei</i> Harms.
nenudito	<i>L. crucisrubicrae</i> Pittier
mowaleh	<i>L. laxiflorus</i> Guill. and Perr.
mpangeli	<i>L. mossambicensis</i> Sin
mutala-menha	<i>L. sericeus</i> (Poir.) H.B.K.
nuvare	<i>L. criocalyx</i> Harms
nako	<i>L. sp.</i>
negepassa	<i>L. cyanescens</i> (Schum. & Thonn.) Benth.
nekko	<i>L. sp.</i>
nekoc	<i>L. chrysophyllus</i> Kleinh.
nekoc	<i>L. sp.</i>
nekoc	<i>L. violaceus</i> (Jacq.) H.B.K.
ngeparsa	<i>L. cyanescens</i> (Schum. & Thonn.) Benth.
niale	<i>L. cyanescens</i> (Schum. & Thonn.) Benth.
nicou	<i>L. nicou</i> (Aubl.) DC.
nicou	<i>L. rufescens</i> Benth.
noroko	<i>L. rariflorus</i> Mart.
oenan nekoc	<i>L. sp.</i>
ol bararuai	<i>L. bussei</i> Harms
ossani	<i>L. sericeus</i> (Poir.) H.B.K.
pacai	<i>L. nicou</i> (Aubl.) DC.
pacai	<i>L. utilis</i> A. C. Smith
palo de Aro	<i>L. hintoni</i> Sandwith
palo hediondo	<i>L. latifolius</i> (Willd.) H.B.K.
panda	<i>L. laxiflorus</i> Guill. and Perr.

Common name

Species of Lonchocarpus

pangira	<i>L. mossambicensis</i> Sim
Queensland lance-pod	<i>L. blackii</i> (F. Muell.) Benth.
real hiarree	<i>L. rufescens</i> Benth.
reddi nekoo	<i>L. sp.</i>
red haiari	<i>L. sp.</i>
robinier nicou	<i>L. rufescens</i> Benth.
sacha barbasco	<i>L. sylvestris</i> A. C. Smith
Saint-Martin rouge	<i>L. rubiginosus</i> Benth.
savonette Jaune	<i>L. latifolius</i> (Willd.) H.B.K.
stinkholz	<i>L. sp.</i>
stinkhout	<i>L. sp.</i>
stinkhout	<i>L. violaceus</i> (Jacq.) H.B.K.
tiengihoedoe	<i>L. violaceus</i> (Jacq.) H.B.K.
tinbo	<i>L. floribundus</i> Benth.
tinbo	<i>L. nicou</i> (Aubl.) DC.
tinbo	<i>L. sylvestris</i> A. C. Smith
tinbo	<i>L. utilis</i> A. C. Smith
tinbo anarello	<i>L. rariflorus</i> Mart.
tinbo assu	<i>L. urucu</i> Killip and Smith
tinbo branco	<i>L. sp.</i>
tinbo carajura	<i>L. urucu</i> Killip and Smith
tinbo cururu	<i>L. rariflorus</i> Mart.
tinbo de massa	<i>L. sp.</i>
tinbo legitimo	<i>L. nicou</i> (Aubl.) DC.
tinbo legitimo	<i>L. utilis</i> A. C. Smith
tinbo legitimo	<i>L. sp.</i>
tinbo macaquino	<i>L. utilis</i> A. C. Smith
tinbo macaquino	<i>L. nicou</i> (Aubl.) DC.
tinbo manso	<i>L. sp.</i>
tinbo pao	<i>L. sp.</i>
tinbo pau (de massa)	<i>L. sp.</i>
tinborana	<i>L. floribundus</i> Benth.
tinborana	<i>L. sylvestris</i> A. C. Smith
tinbo uassu	<i>L. urucu</i> Killip and Smith
tinbo urubu	<i>L. utilis</i> A. C. Smith
tinbo urucu	<i>L. urucu</i> Killip and Smith
tinbo venenoso	<i>L. floribundus</i> Benth.
tinbo venenoso do Para	<i>L. floribundus</i> Benth.
tinbo verdadeiro	<i>L. utilis</i> A. C. Smith
tinbo verdadeiro	<i>L. sp.</i>
tinbo vermelbo	<i>L. urucu</i> Killip and Smith
tinoata	<i>L. sylvestris</i> A. C. Smith
timu	<i>L. utilis</i> A. C. Smith
timu-ambi	<i>L. utilis</i> A. C. Smith
tingi hoedoe	<i>L. violaceus</i> H.B.K.
tjuija	<i>L. katangensis</i> de Willd.
tocorito	<i>L. crucisrubrae</i> Pittier
tocorito	<i>L. pictus</i> Pittier
vischgiftliaan	<i>L. rufescens</i> Benth.

Common name

Species of Lonchocarpus

Wake-ro-koda
wakorokoda
wakuru-kuda
West African indigo
white haiari
white haiari
wiriri nekuru
yoruba
yurabo indigo
yoruba indigo
zopilacague

L. chrysophyllus Kleinh.
L. chrysophyllus Kleinh.
L. chrysophyllus Kleinh.
L. cyanescens (Schum. & Thonn.) Benth.
L. nartynii A. C. Smith
L. nicou (Aubl.) DC.
L. floribundus Benth.
L. sericeus (Poir.) H.B.K.
L. sp.
L. cyanescens (Schum. & Thonn.) Benth.
L. hintoni Sandwith

REFERENCES TO THE BOTANY OF LONCHOCARPUS

Willdenow, in the fourth edition of Linne's (263) *Species Plantarum*, published in 1801, described Robinia scandens Willd. , Lonchocarpus nicou) from Guiana.

Guillamin, Perrottet and Richard (179) in 1833 described Lonchocarpus formosianus DC. and L. laxiflorus Guill. and Perr. from Senegambia, Africa.

Information concerning the genus Lonchocarpus H.B.K. was given by Endlicher (127) in 1840, and by Meisner (280) in 1843.

Miquel (284) in 1844 described Lonchocarpus hedyosmus and L. pterocarpus [Derris pterocarpus (DC.) Killip] from Surinam.

Mueller (288) in 1861 described Milletia blackii, which according to Bentham and Mueller (*Flora Australiensis* 2: 272. 1864) is Lonchocarpus blackii Benth.

Harvey and Sonder (189) in 1862 described plants of the Cape Colony, Africa, region, including Lonchocarpus philenoptera Benth. This is stated to be a native also of Mozambique and Abyssinia.

Grant and Oliver (172) in 1872 described Lonchocarpus laxiflorus Guill. and Perr., and L. violaceus H.B.K. from eastern Africa.

Holmes (195) in 1875 reported on a specimen of timbo collected in the province of Rio, Brazil, by Cyriax and Farries and presented to the Museum of the Pharmaceutical Society, London. It was not identified botanically. The taste was not bitter. When chewed the root caused only a slight but persistent tingling of the tongue.

Lindley (262) in 1876 described Lonchocarpus as an extensive genus of leguminous plants, of which the greater number are tropical American, seven tropical African, and one Australian. Some are small trees, seldom exceeding 30 or 40 feet in height, and others tall climbing shrubs with woody stems. They have alternate pinnate leaves, except in a solitary species from Southern Mexico, in which they are reduced to a single leaflet; and their pea-like flowers are in racemes and either purple reddish or white, but never yellow. The genus is solely distinguished from its congeners by its pods, the structure of its flowers not differing from that of *Piscidia* and other allied genera. The pod is flat, much longer than broad, varying from a thin paperlike to a hard woody consistency, and without wings along the edges, the seed-bearing edge being merely thickened or flattened.

Duges (121) in 1881 recorded "Cacahuananchi" as a common name applied in Jalisco, Mexico, to Lonchocarpus roseus.

Ernst (130) in 1881, in a description of the most important families of plants found in Venezuela, included Lonchocarpus violaceus as an example of a plant belonging to the tribe Dalbergieae.

Vatke (448) in 1881 described Lonchocarpus? inconstans Vatke from Madagascar.

Baker (12) in 1887 described L. paullinioides as a new species from Madagascar.

Moloney (285) in 1887 described Lonchocarpus sericeus H.B.K. as an erect tree 30 to 40 feet high, very common on the sea-shore of Upper Guinea and Lower Guinea. The wood is close-grained and durable. L. cyanescens Benth. is a woody climber, 20 to 30 feet long.

Hooker (196) in 1887-1888 published drawings of Lonchocarpus cyanescens Benth. from West tropical Africa.

Baker (13) in 1889 described L. polystachus as a new species from Madagascar.

Bolus (33) in 1889 described Lonchocarpus speciosus Bolus as a very distinct new species from South Africa. This has large and handsome bright blue flowers.

Tenison-Woods (401) in 1889 wrote of fish-poison plants used in Malaysia. In speaking of one of these, Pongamia volubilis Zoll. and Mor., he says, "it is a climbing plant very much like Derris: in fact it is only separated from that genus and Lonchocarpus by the peculiarity of its pods."

Sacleux (364) in 1891 included L. laxiflorus Guill. and Perr. in a list of plants of Zanzibar and other African countries.

Engler (128) in 1895 wrote that Lonchocarpus laxiflorus Guill. and Perr. is widely distributed throughout tropical Africa.

Durand and de Wildeman (122) in 1897 gave information concerning the following Congo species: Lonchocarpus eetveldeanus Micheli, L. dewevrei Micheli, L. comosus Micheli, and L. barteri Benth.

Cortes (91) in 1898 published information on Lonchocarpus atropurpureus, L. guatemalensis Benth., L. latifolius H.B.K., L. longifolius, L. macrophyllus H.B.K., L. sepium DC., L. sericeus H.B.K., L. tomentosus Tul., L. velutinus Benth. and L. violaceus H.B.K. growing in Colombia.

Chevalier (73) in 1902 described, with drawings, Lonchocarpus cyanescens Benth. growing in French Sudan.

Grandidier (171) in 1902 published information on the synonymy, botanical characteristics and occurrence in Madagascar of Lonchocarpus iethyotomus H. Baillon, Lonchocarpus inconstans Vatke, Lonchocarpus paullinioides Baker, and Lonchocarpus polystachus Baker, and stated that this genus scarcely differs from Milletia and in the absence of mature fruits the allocation of a species to one or the other of these genera is rather arbitrary.

Niederlein (303) in a description of the plant resources of the French colonies published in 1902 listed Lonchocarpus latifolius H.B.K. as occurring in Martinique, L. rubiginosus Benth. in Guadeloupe, French Guiana and elsewhere and other species of Lonchocarpus in the same countries. L. nicou is listed from French Guiana under "medicinal plants."

Micheli (281) in 1903 described, with drawings, Lonchocarpus eriocarinalis as a new species. L. eriophyllus Benth., L. guatemalensis Benth., and L. violaceus H.B.K. are listed as Mexican species.

de Wildeman (469) in 1905 published descriptions of useful or interesting plants found in the Congo, including Lonchocarpus Dewevrei Micheli, L. sericeus H.B.K. and L. Katanvensis de Wild.

Harms (188) in 1906 described Bolusanthus Harms as a new genus. He also made the transfer Bolusanthus speciosus (Bolus) Harms (= Lonchocarpus speciosus Bolus) from South Africa.

Pulle (337) in 1906 included Lonchocarpus sericeus H.B.K. and Dorris guyanensis Benth. in a list of Surinam plants.

Sin (377) in 1909 described, with drawings, Lonchocarpus laxiflorus Guill. and Perr. and L. nossambicensis Sin from Portuguese East Africa.

Engler and Drude (129) in 1910 published a drawing of Lonchocarpus cyanescens Benth. from West Africa.

The Kew Royal Botanic Gardens (240) in 1911 published information on the botany, vernacular names and uses of Lonchocarpus cyanescens Benth., L. laxiflorus Guill. and Perr. and L. sericeus H.B.K. These are all found in Nigeria.

Pittier (328) in 1923 described Lonchocarpus pius Pittier as a new species found in Venezuela.

Ducke (119) in 1925 published botanical information concerning Lonchocarpus angulatus Ducke, L. nicou (Aubl.) DC., L. paniculatus Ducke, and L. rariflorus Benth. growing in the Amazon region of Brazil.

Pittier (329) in 1926 published a manual of Venezuelan plants. Included are: L. atropuroreus Benth., L. densiflorus moritzianus Benth., L. dipteroneurus Pittier, L. fendleri Benth., L. latifolius (Willd.) H.B.K., L. pictus and L. punctatus H.B.K.

Pittier (350) in 1928 described the following species of Lonchocarpus growing in Venezuela: L. atropurpureus Benth., L. crucis-rubrae Pittier, L. densiflorus Benth., L. dipteroneurus Pittier, L. fenderi Benth., L. guaricensis Pittier, L. larensis Pittier, L. latifolius (Willd.) H.B.K., L. lutescens Pittier, L. macrocarpus Benth., L. mirandinus Pittier, L. negrensis Benth., L. nitidulus Benth., L. pictus Pittier, L. punctatus H.B.K., L. sericeus H.B.K., L. stenopteris Pittier, L. stenurus Pittier, L. stramineus Pittier, and L. violaceus (Jacq.) H.B.K.

In Gleason's (166) account of botanical explorations in the region of Mt. Duida, Venezuela, A. C. Smith has a description of Lonchocarpus urucu Killip and Smith. It is called barbasco and used to poison fish. The species is so far known only from Gurupa, in the state of Para, but is to be expected along tributaries of the Amazon and Negro.

Pulle (338) in 1933 discussed the botany of Lonchocarpus chrysophyllus Kleinh. and L. hodysonus Miq.

According to Klein (244) Robinia nicou = Lonchocarpus rufescens.

Silva (375) in 1935 published an illustration of Timbo vermelho (= Lonchocarpus urucu).

Martyn and Follett-Smith (271) in 1936 recorded that the following species of Lonchocarpus used as fish poisons have been reported from British Guiana: L. nicou (Aubl.) DC., L. densiflorus Benth. and L. rariflorus Mart.

Stahl (393) in 1936 published information on the botany, synonymy and distribution in the Antilles of L. latifolius H.B.K. and L. violaceus H.B.K.

The Kew Royal Botanic Gardens (241) in 1936 described Lonchocarpus hintoni Sandwith as a new species from Mexico. It is a 30-foot tree with blue or pink flowers.

Krnkoff and Smith (255) in 1937 reported a study of ten species of South American rotenone-yielding plants including three new species (Lonchocarpus sylvestris, L. Martynii, and L. utilis), with special reference to native names, distribution, economic importance, and specimens examined. Descriptions and comparisons of foliage are sufficiently complete to permit the identification of sterile material. Notes of use to field workers have been incorporated. The species concerned, for the most part, belong to the leguminous genus Lonchocarpus, Series Fasciculati. Other species described are L. floribundus Benth., L. rariflorus Mart., L. urucu Killip and Smith, L. chrysophyllus Kleinh., and three unknown species of Lonchocarpus. Derris amazonica Killip (L. negrensis Benth.) is also described.

A leguminous plant collected in Amazonas and Mato Grosso, Brazil, contained an average of 0.6 percent rotenone in the root. This plant known locally as Timbo vermelho and Timbo melancia, does not belong to Lonchocarpus, Derris, Tephrosia or Ormocarpum. The bulk of cube or barbasco roots exported

from Peru come from L. utilis A. C. Smith and not L. nicou (Aubl.) DC., which is found in the Guianas. The bulk of roots and powder exported from Para and Manaus is the product of L. urucu.

Panshin (314) in 1937 published a description of the wood anatomy of the rotenone-yielding plants collected by Krukoff and Smith in South America. His conclusions:

"A critical analysis of data indicates a striking similarity in so far as the structure of xylem of the species described in this paper is concerned. The anatomical variations recorded were mostly those of size and frequency of different types of wood elements. However, these variations were in many cases no greater than those found in the sections of stem and root taken from different parts of the same plant. Since the number of specimens available from different plants of each species was in some cases small, it is impossible at this writing to ascertain whether the variations in size and number of xylem elements are sufficiently constant to provide a reliable means of separation for these closely allied species. The difference in color of root wood in some cases appear to be constant enough to be of aid in the field identification of these plants."

Staner and Boutique (395) in 1937 summarized information on the botany, geographical distribution and use as medicine of the Belgian Congo species of Lonchocarpus bussei Harms., L. cyanescens Benth. and L. sericeus H.B.K. taken largely from de Graer, Holland and Bally.

Chevalier and Chevalier (78) in 1937 described the anatomy of a root of Lonchocarpus nicou from Peru and also of a root of timbo from the State of Para, Brazil.

CULTIVATION OF LONCHOCARPUS

Africa.--Preuss (336) described the effects of a tornado on the night of March 20-21, 1902, on the botanical garden at Victoria, Cameroons, Africa. Lonchocarpus sericeus resisted the storm and is being considered as a protective tree for plantings of rubber Strophanthus, etc.

Brazil.--Ducke (119) in 1925 stated that L. nicou is cultivated in Gurupa, Brazil, under the name "timbo urucu". Nabuco de Araujo, Jr., (292) in 1936 reported on the growing of timbo in Brazil. In the Amazon Basin the cultivation of timbo is being actively encouraged for the production of insecticidal products. All the household insecticides marketed in Brazil use the timbo root received from the State of Para. Lonchocarpus species grow abundantly throughout the Amazon region, and Brazil seems destined to become the largest producer of cube or timbo, as it is called in this country. The demand for the roots seems to be so great that several firms and individuals have recently started a campaign locally to create interest in the cultivation of the species of timbo that will give the largest percentage of rotenone. The species known as macaquinho gives the highest yield. Approximately

25 metric tons of cube or tinbo were shipped from Para during 1934. The average export price on this material in 1934 was about \$480 per metric ton, f.o.b., Belém. Several pulverizer and extraction plants are in operation in the states of Amazonas and Para. The average content of rotenone in the Brazilian tinbo is about 5.5 to 6 percent. Carbon tetrachloride is largely used for the extraction of rotenone from tinbo, and the Brazilian Government has aided several in the importation of this solvent when used for the extraction of rotenone.

An anonymous (5) writer in 1937 referred to the interest in rotenone plants in Brazil and the efforts of the government to foster the growing of tinbo and the extraction of rotenone. Only powdered root containing a minimum of 3.5 percent rotenone can be exported from the state of Para.

British Guiana.--The British Guiana Department of Agriculture (48) in its annual report for 1932 reported that haiari grew better in the open than under shade. The white haiari grows more vigorously than the black. The growth of both types is better on sandy soils than on laterite. Haiari is easily established from cuttings put in the ground after clearing the bush and needs little attention beyond periodic weeding. In its 1933 annual report (49) this department recorded that in only one sample of haiari, a mature root from the forest, did the rotenone content approach 3 percent. The root system of the haiaris is not large and that of the black variety is very poor. Experiments with plants of insecticidal value, black and white haiari (Lonchocarpus spp.) have been continued at the Mosororo Experiment Station. The black and white haiaris planted in the open at the Wauna substation are making better growth than those planted in the shaded areas. In its 1934 report (50) the British Guiana Department of Agriculture again reported that the haiaris grow more vigorously in the open than under shade. The black haiari, which under similar conditions had not at first appeared so vigorous as the white variety, was now almost equal to it in rate of growth. In the North West District of British Guiana no cultivation of poison plants was carried out during 1934, the plants being allowed to grow wild.

Martyn and Fellett-Smith (271) in 1936 reported on the growing of Lonchocarpus in British Guiana. Since 1929 the Department of Agriculture has had the "black" and "white" haiaris of the North West District under cultivation at their experiment stations in that district. At Mosororo the plants were grown both under shade and in the open on laterite soil, and at the Wauna substation under similar conditions of light and shade but on a sandy soil. The shaded areas in both cases consisted of secondary forest in which the undergrowth and smaller trees had been cut down. The plants grow easily from stem cuttings, and it has become apparent that growth on the sandy soil is more vigorous than on laterite, and that much better growth is made in the open. At first the black haiari grew rather more slowly than the white, but this difference was not noticeable after the first three years or so. The plants in the open were assisted by periodic weeding for the first 3 to 4 years of their development, after which they maintained themselves. The value of limestone as a fertilizer for the haiaris is being studied. White haiari roots aged 7 years were analyzed for rotenone with the following results:

Percentage of rotenone
Air-dry basis Oven-dry bases

Sample A	1.6	1.7
Sample B	1.0	1.0

Barrett (17) in 1936, in describing the vegetative propagation of dorris, expressed the opinion that prolonged intensive cultivation of Dorris and Lonchocarpus might result in an increase up to 16 percent of the "alkaloids" [rotenone?] in the roots.

Colombia.--Neathery (299), Assistant Trade Commissioner at Bogota, Colombia, reported on January 19, 1937, on the active interest in exploitation of barbasco in Colombia. Several varieties of barbasco known to exist in various regions of Colombia and which have heretofore been used almost exclusively as a fish poison by native fishermen, are being studied by officials of the Ministry of Agriculture and Commerce in Bogota in an effort to determine the rotenone contents of some of the most abundant plants. It is understood, also, that an expedition into the Amazon region will be made in the near future to ascertain the potential supply and chemical content of plants which are reported to abound in that section of the republic. Senor Luis Uribe Aguirre, reported to be associated with Lawrence C. Seville of New York, will lead the investigation. The Ministry of Agriculture and Commerce has received samples of barbasco from Tumaco, Leticia, and other municipalities of the Amazon territory, the Department of Boyaca, and the Meta region. An analysis of the Tumaco specimen, according to statements made recently, reveals a minimum and maximum rotenone content of 2.93 and 5.27 percent, respectively. While barbasco exports have been insignificant in the past, an increase in the volume may be expected if present investigations result in the discovery of a high rotenone content of existing stands.

Malaya.--The Federated Malay States Department of Agriculture (140) in 1933 introduced black and white haiari from British Guiana at Serdang, F. M. S. Cantley (64), in a list of the principal economic plants contained in the forest experimental nurseries, Straits Settlements, in 1886, included Lonchocarpus sp. (Yurabo indigo) from the West Indies.

In its annual report for 1935 (141) the Federated Malay States Department of Agriculture stated that plants of haiari root were propagated by layering. Analyses of these haiaris from Serdang, aged about 25 months, were as follows:

	Percent on a moisture-free basis	
	Ether extract	Rotenone
Black haiari	7.9	3.0
White haiari	7.7	0.8

Georgi (160) has also referred to the low rotenone and ether extract content of these haiaris grown at Serdang. Analyses will be made again when the plants are 4 years old.

The Koloniaal Instituut (250) of Amsterdam in 1933 quoted the above analyses.

Milsum and Georzi (283) in 1937 reported on dorris cultivation in Malaya. They wrote:

"While at present the extent to which toxicity is an inherent character is uncertain, there are indications that the proportions both of rotenone and of other extract remain constant within limits for successive generations. Should a much closer relationship be found to exist, the value of clonal material will be of the greatest importance since it will permit of the export of a standard product. This will enable dorris to withstand competition from other vegetable insecticides possessing toxic principles of a similar nature, notably cube root (Lonchocarpus spp.) from South America."

Peru.--Page (313), chief of the Agronomic Station of Loreto, Peru, in August 1935 published an account of the growing of barbasco in that province. Huasco barbasco (Lonchocarpus nioqui) is richer in rotenone than the species known as sachá barbasco, lagarto barbasco, tirano barbasco, etc., in most cases containing from 5 to 15 percent of this constituent.

A region that is less humid and less hot than that along the rivers is favorable to a high rotenone content in barbasco. In the Agronomic Station it has been observed that the huasca barbasco plants which are planted in rotation with yucca plants behave much better than those planted free in the open without any plants to shade them. The farmers in the neighborhood who cultivate barbasco on their land agree that it is necessary to protect the plants against bright sunlight especially in the first months of growth.

The natives of the region use various ways of planting huasca barbasco; some plant two pieces of roots at a distance of one to two meters and others place various pieces, sometimes up to eight or ten, in one row with greater distances up to four meters between each row.

Barbasco roots, when pulled up, contain moisture according to the time of harvesting and the nature of the soil. The root taken from a single plant, 1-1/2 years old, growing in the region of San Juan weighed one kilo at the moment of extraction from the soil (plants at this age commonly produce in this region more than 4 kilos of root per plant), and 575 grams after the roots had been stored for about 15 days in the open air but in a shady place. These roots were harvested and dried during April-May, which is a very rainy period. The experiment was repeated in August when there was dry weather, with roots of another plant growing at the same place and of the same age. When the roots were pulled up they weighed 1.8 kilograms and after 15 days 1.54 kilograms. The traders usually make a deduction of 20 to 30 percent in the price to cover loss in weight when they purchase fresh barbasco.

In order to avoid this unsatisfactory condition between sellers and buyers it is advisable that each producer of barbasco sell his product only in a dry state. For the drying process, a kind of stove would not be out of place, and it may also suffice to dry them in the sun.

Only the variety huasca barbasco should be offered for sale, because if mixed with other similar roots the content of the active principle lowers the price. A well organized propaganda in favor of the Peruvian barbasco should be started in foreign countries.

Page is of the opinion that huasca barbasco, on account of its high content of rotenone and other valuable substances, will have a great future and will displace other similar products competing with it, that are of inferior quality, such as derris and barbasco of different countries.

It is advisable to recommend official intervention of the Agriculture Department that a farmer never store his barbasco and pile it up before it is absolutely dry. If this is not done the chances are that the product will deteriorate, mold, and take on a disagreeable musty odor. Furthermore, when barbasco is in such condition it is easily attacked by fungi and also by insect larvae.

Exteriorly the roots of huasca barbasco, as those of other varieties, resemble in color the soil in which they grow. Thus if a root grew in a clay sod it seems to have a yellowish color no matter what the variety may be. If it was cultivated in a sandy soil it appears to be of a light color almost white. On drying later, it takes on a clearer color in almost all cases. If a section of huasca barbasco root is observed under a microscope, it will be noted that ligneous vessels in the center and of the rind are always of a finer texture and are closer together than in the other varieties. In these the rind also appears to be darker in general, or spotted. These differences are more conspicuous in the roots of plants more than 2 years old.

A sample of huasca barbasco coming from Parana Pura, in the neighborhood of Yurimaguas, which was analyzed by Mr. Massey in his private laboratory, showed a content of 13 percent rotenone.

Dennis (113) in 1935 delivered an address on cube at the Lima, Peru, High School, which was published in two articles in the West Coast Leader.

"My interest in Cube Barbasco dates from 1917, when, for the first time, I saw it used for fishing purposes in the Mantaro River, near Huancayo...From that day on I commenced my studies and research work in order to determine whether the Barbasco had any commercial value. I believed that an extract from the root would kill ants and other parasites or land-insects attacking the crops. Lacking a laboratory and other facilities for experimenting, I finally decided to send a few roots to a chemical concern in the United States, manufacturers of a well-known insecticide preparation. They replied, advising me that they had at their service a Peruvian Chemist, to whom they had referred the matter and who had informed them that he was quite familiar with this particular plant, the root

of which, he added, was of no commercial value. I wrote to another factory in my country and got no reply.

"The following year a scientific expedition from the University of Indiana, U. S. A., came to Peru, for the purpose of studying fish-life in the sierra or mountain region. The leader of this expedition, Dr. Eigennan, called on me in Huancayo, and I then made known to him my ideas on Cube Barbasco and their possible commercial use. He purchased a quantity of Cube in Huancayo, for use in his fish-collecting. On his return to the States, after a trip in the interior, Dr. Eigennan handed over to Dr. McIndoo a former pupil of his a few of the roots left over. McIndoo at that time was an entomologist employed by the Washington Government. Dr. McIndoo immediately recognized the merit of cube as an insecticide and requested me to furnish him with a further supply of roots wherewith to effect his experiments."

Dennis argued that cube is superior to Gerris and Brazilian timbo. The price of fresh root at Iquitos in 1935 ranged from 30 to 80 centavos per kilo. In the third year a crop may be harvested which will yield at least four tons for each hectare sown, which rate of production, at the price of 30 centavos a kilo will give a profit of S/.1,200 (Peruvian soles). As far as land is concerned, cube barbasco can be grown with success in any part of the jungle where it is sufficiently hot and where the rivers do not flood the lands. Barbasco grows equally in sweet lands and bitter ones. A "weevil" penetrates to the heart of the stem's fresh wood and greatly damages the cube.

The question of a trade name is discussed. Huasca in Spanish means to climb. The word cube is used in the Chanchamayo country, also throughout the Satipo, Apurimac, Huenuco and Urubamba districts, and, as its commercial use started with the roots purchased in Huancayo, it was naturally employed by the publicity people who were endeavouring to push the sale of the Peruvian root. Owing to the fact that there are many barbascos, it is of the utmost importance that the product be known under a different name, and owing also to the fact that the term cube has been duly approved by those distributing the propaganda matter and, moreover by the world's scientific literature, it is quite reasonable to believe that the terms cube barbasco or simply cube are the best and most adequate words it has been possible to find.

It is suggested that ovens be set up at Iquitos to dry cube. This could be done in 3 days as compared to 3 weeks at present and even then 14% water remains in the roots because of the damp atmosphere. Cube can not be kept for more than three months in warehouses, without the exporter being subject to a loss of 20% by reason of the weevil pest, and the importer finds himself in the same predicament, plus the loss of a further 14% on account of water.

Young (479), American Consul General at Lima, Peru, on October 26, 1935, reported that there are several types of barbasco, only one of which is desired so far as the export trade is concerned.

Greenup (174), American Commercial Attache at Lima, Peru, on April 7, 1936, reported on the culture and exportation of Peruvian cube or barbasco, and Crilley (101,106), Assistant Commercial Attache at Lima, Peru, on October 20, 1936, reported that the Peruvian Government had investigated cube root standards. These reports are based on an article published in "La Vida Agricola" and on the report by Page.

Clark (83), Assistant Trade Commissioner at Lima, Peru, on October 7, 1937, called attention to these articles and also a later one by Dennis.

The Kolonial Instituut (250) of Amsterdam in 1936 published the results of some of its work on insecticides of the derris type. Three samples of barbasco root from Peru were examined with the following results:

	I	II	III	Good Derris root
Ether extract	16.7%	21.0%	5.3%	15 to 20%
Rotenone	6.1%	11.0%	traces	5 to 8%

The quality of the first two samples is regarded as good or very good; that of the third sample, which consisted entirely of pieces of root bark, as very unfavourable. On the whole, the quality of the barbasco root requisitioned from America seems to have been regarded favorably. With many parcels, however, there is the objection that the difference in the landed weight and that at the time of shipment from South America is about 20 to 40 percent, a fact which points to a very faulty drying of the product. The evaporation in parcels of derris root during the voyage from India to Europe or America is rarely more than a few percent. Biological tests made with barbasco root have not led to definite conclusions, but it is considered that with equal rotenone content preference must be given to derris root over barbasco, a distinction that should be due to the great effectiveness of the secondary substances of derris which, next to rotenone, occur in the ether extract.

United States.--Floyd L. Cooper (90), an experimental nurseryman of Huntington Park, Calif., wrote Roark on September 15, 1936, that cuttings of Lonchocarpus nicou received from British Guiana had been grown successfully in southern California. The cuttings were potted November 28, 1935, and transferred to the ground June 7, 1936. On September 14, 1936, the plants had grown to a height of 4 to 5 feet.

The United States Department of Agriculture, Puerto Rico Experiment Station (428), in 1937 published the results of the Durham test which was used in a preliminary way on many of the introduced fish-poison plants propagated at this station. The reagents for the test were applied directly to freshly cut tissues of 29 introductions and 18 indigenous species of fish-poison plants. Of the 47 kinds of plants tested, 8 species were positive to the test, including the roots of Lonchocarpus nicou.

On the basis of the above results and of the growth response of the plants to local environment, only Derris elliptica and Tephrosia toxicaria have shown promise of becoming commercially important in Puerto Rico. Most of the plants of Lonchocarpus nicou have not been established long enough to permit appraisal of their probable worth.

PESTS ATTACKING LONCHOCARPUS

In 1934 Wille (470) recorded Rhizopertha dominica F. attacking cube root (Lonchocarpus sp.) in Peru. In 1937 Wille et al. (471) and in 1938 Jones (223, 224) recorded Dinoderus bifoveolatus Woll. as a pest of cube root.

USE OF LONCHOCARPUS AS A FISH POISON

As early as 1665 the use of fish poisoning plants by the natives of the Antilles was recorded by de Rochefort (358). He wrote of the use by the Caribes of a certain wood which is cut into pieces, beaten up, and thrown into fish pools.

Barrère (16) in 1743 wrote an interesting account of fish poisoning by the natives of French Guiana who used inekou (= Lonchocarpus) as one of the plants for this purpose.

Gumilla (180) in 1791 described the catching of fish on the Orinoco River by means of cuna (Tephrosia) and barbasco.

Stedman (396) in 1796 wrote of his travels in Surinam during 1772 to 1777. The natives there catch fish by inclosing the entry of small creeks or shoal water with a paling, shooting them with their trident arrows, or poisoning the water by throwing in it the roots of hiaree, in Surinam called tringee-woodo or konamee, by which the fish become stupefied, and are taken by hand, while they float on the surface of the water.

Hilhouse (192) in 1832 in writing of the Indians living in the Interior of British Guiana described their method of catching fish by stopping creeks at high water, and infusing the hai-arry, or the gonami, in the shallows, the intoxicating qualities of which cause the fish to rise and float insensibly on the surface.

Hilhouse (193) in 1834 further described fishing with hai-arry. The root, which is of slow growth, is, when full grown, three inches in diameter; it contains a white gummy milk, which when expressed is a most powerful narcotic, and is commonly used by the Indians in poisoning the water to take the fish. They beat it with heavy sticks till it is in shreds like coarse hemp; they then fill a coorial with water, and immerse the hai-arry in it; the water becomes immediately of a milky whiteness, and when fully saturated, they take the coorial to the spot they have selected, and throwing over the infusion, in about twenty minutes every fish within its influence rises to the surface, and is either taken by the hand or shot with arrows. A solid cubic foot of the root will poison an acre of water even in the falls, where the current is so strong. The fish are not deteriorated in quality, nor do they taint more rapidly when thus killed, than by being netted or otherwise taken.

St. Clair (392) in 1834 mentioned nake or heri (a bush) and nebe (a vine), the roots of which are used to stupefy fish by the Indians of the Guianas.

Bernau (28) in 1847 described the use of quanami leaves [Tenilrosia toxicaria] and hai-arry root as fish poisons by the natives of British Guiana. The roots are pounded; the juice of the root is washed into canoes nearly full of water; then the poison is thrown in all directions.

Kappler (232) in 1854 described the use of Stinkolz (Lonchocarpus) conami and Gunapalu (family Euphorbiaceae) for catching fish in Surinam.

Brett (46) in 1868, in an account of the Indian tribes of Guiana, wrote that the Acauiois supply the coast tribes with considerable quantities of the haiarri root, which is used in poisoning fish. These roots are usually cut in pieces of about two feet in length, and tied up in small bundles which have a powerful and disagreeable scent.

Lindley (262) in 1876 referred to the use by the Indians of South America of the leaves and young branches of several species of Lonchocarpus for intoxicating fish. One species used in Guiana is nicou (L. rufescens).

Boddam-Whetham (31) in 1879 described the taking of fish by the natives of British Guiana by the use of the juice beaten from the roots of the leguminous creeper hai-ari.

Crevaux (98) in 1883 stated that the natives of French Guiana use the cultivated plants conami and sinapou and the wild plant Lonchocarpus (Robinia) nicou, which is collected in the forests along rivers, for taking small fish.

Kappler (233) in 1887 described fishing in Surinam with the sap of narcotic plants. One of the 3 plants used is Nekko, stated to be Lonchocarpus scandens [Derris scandens]

Ernst (131) in 1887 listed 187 species of plants used as fish poisons. Lonchocarpus species include the following: L. densiflorus Benth., L. floribundus Benth., L. latifolius H. B. K., L. nicou DC., and L. rariflorus Mart. Among doubtful species of Lonchocarpus are tulonimibi and inecu, from the Antilles.

Ernst (132) in 1883 identified the fish-poisoning plant inecu of Breton (Dict. Caraïbe-français, Auxerre 1665, p. 244) as Lonchocarpus nicou DC.

Koch-Grünberg (247) in 1923 wrote that in northwest Brazil the term timbo includes a great number of fish poisons, but Paullinia pinnata is usually meant.

Roth (360), of the Bureau of American Ethnology, in 1924 published a study of the arts, crafts and customs of the Guiana Indians. Timbo is the lingua geral and barbasco the Spanish term for vegetable poisons in general. On the upper Rio Negro these would include species of Paullinia and Serjania. The publications of earlier writers are thoroughly reviewed. The following are certain of the fish poisons that have been identified: Lonchocarpus of various species (e.g. densiflorus, rufescens). It is known as haiari, heri, or nako, as nekko in Surinam, apparently identical with the Robinia nicou, or inekou, of Cayenne. Dance mentions three kinds of haiari bush rope--a white, red, and black.

PHARMACOLOGY OF LONCHOCARPUS

According to a catalog of the products of Gabon in French Equatorial Africa exhibited at the Paris Exposition (315) of 1867 and also according to Moloney (285) in 1887 the bark of Lonchocarpus sericeus H. B. K. has been employed in West Africa for abdominal complaints and as a laxative for children.

Drake and Spies (118) in 1932 reported that an acetone extract of barbasco root of unknown botanical origin from Costa Rica, used at the rate of 1 cc. of extract (representing 0.2 gram plant material) per liter of water, killed goldfish in 184 minutes. A similar extract of derris (rotenone = 1.7 percent) killed in 92 minutes.

Haegle (182) in 1934, in reporting spraying tests with cube and derris against the codling moth at Parma, Idaho, stated that the derris and cube dust became somewhat nauseating to those exposed to the dust or spray for a time.

Ambrose and Haag (7) in 1936 reported a toxicological study of derris. One sample of cube containing 4.7 percent rotenone and 21.4 percent total carbon tetrachloride extractives was also tested and found to be similar to derris in action when fed to rabbits, rats, cavies and dogs. A specimen of derris (9.6 percent rotenone and 28.5 percent total carbon tetrachloride extractives) had a fatal oral toxicity of 600 mg. per kg. of body weight for rabbits, 100 for rats, 75 for cavies and 150 for dogs.

Mathews and Lightbody (273) in 1936 reported on the toxicity of three samples of derris and one of cube to rats. The cube contained 3.8 percent rotenone, and to houseflies its toxicity was equivalent to 8.5 percent rotenone. When fed to rats, an olive oil extract of this cube had a m. l. d. (dose necessary to kill 50 percent of a group of rats) of 300 mg. per kg. body weight. A carbon tetrachloride extract gave a value of 370. Based on toxicity to rats, this cube had an apparent rotenone content of 8.3 percent based on the olive oil extract, or 6.7 percent based on the carbon tetrachloride extract.

Viehoever (449) in 1936 reported on the action of various materials on Daphnia--a transparent crustacean which serves as a biological reagent. "Insecticides, as rotenone, rotenone resin and cube extract containing rotenone, cause the paralysis of the breathing legs. If the rotenone is not oxidized in the upper food canal, then the digestive canal will also be paralyzed--a toxic action which has correspondingly been observed in higher animals, such as cats, rats and rabbits."

The United States Department of Agriculture, Bureau of Chemistry and Soils (415), in its annual report for 1936 reported that diets containing cube or derris root did not interfere with the normal growth of rats when the concentration was below 0.06 percent. Marked retardation occurred with a diet containing 0.12 percent. Experiments with rotenone in comparison with cube and derris root indicated that the growth-inhibitory effects of cube and derris were not produced by their rotenone content.

Haag (181) in 1937 discussed the toxicity of rotenone to humans. The acute oral toxicity of a sample of cube containing 4.7 percent rotenone and 21.4 percent total carbon tetrachloride extractives was determined and the lethal dose (smallest quantity that proved fatal to about 70 percent of the experimental animals), expressed as mg. per kg. of body weight, was found to be: guinea pigs 200; white rats 200; rabbits 1,000.

Göbel (167) in 1937 found that an aqueous solution of timbo extract (30% rotenone) killed Oxyuris vermicularis L. and Ascaris lumbricoides L. at a concentration of 1:5000. Dogs without food were not affected by 250 mg. per kg. of this extract. Three experiments were made on man. Pure rotenone 0.1 gram and timbo extract 0.25 gram when followed by castor oil, glycerin or sweetened water had no injurious effect on human beings when taken on an empty stomach and all intestinal worms (Oxyuris) were killed.

Göbel suggested that rotenone and timbo extract should be effective against Ancylostoma duodenale Dubini; Necator americanus, Stilles solitaires, and also against the infective organisms of yellow fever, malaria, etc., either by mouth or by injection.

Taken shortly after a meal, timbo extract caused a strong indisposition accompanied by a painful anxiety, a state that lasted about 3 hours. The Indians of the Amazonas in order to punish a criminal force him to take timbo. In order to avoid any consequences in man, it is necessary to give rotenone or timbo extract on an empty stomach with castor or mineral oil.

The Journal of the American Medical Association (9) in 1937, in answer to an inquiry, stated that as judged from animal (and to some extent, human) experimentation there is no danger of acute poisoning as a result of ingestion of vegetables sprayed with rotenone, cube or derris. The problem of a possible chronic intoxication following the prolonged use of vegetables treated with derris or rotenone has been studied on animals and, while further work is desirable, results of these observations also lead one to believe that the human health hazard here is also low. Reference is made to the publications of Haag, Ambrose, Mathews and Lightbody.

Bally (14) in 1937 summarized information on native medicinal plants of East Africa. The root of Lonchocarpus bussei Harms is used as a galactagogue and a remedy for gonorrhoea; the root of L. eriocalyx Harms is used to cure eruptions on the skin.

CHEMISTRY OF LONCHOCARPUS

The occurrence of indigo in the leaves of Lonchocarpus cyanescens Benth. has been recorded by several writers. In 1883 Dyer (123) called attention to the plant called West African indigo or Elu in the Yoruba dialect and stated that it had been conjecturally referred to Lonchocarpus by Benth and it may be closely allied to L. cyanescens. The young leaves are pounded into paste in a mortar and made into balls. One ball to 1 gallon of water imparts a fine deep blue to cloth soaked in it 4 days. The dye is fixed with potash. Moloney (285) in 1887 gave the same account. The Kew Royal Botanic Gardens (238) in 1888 reprinted this information and referred to the plant as

Yoruba indigo. Later (239) Kew Gardens reproduced the drawing of this species that is given in Hooker's *Icones Plantarum*. Maguire (266) in 1906 in an account of West African dyeing methods inserted a footnote which stated that one shade of dark blue used at Sierra Leone is, according to Aug. Chevalier, not indigo, but the product of a liana, Lonchocarpus cyanescens. Perkins' (318) work on indigo from Lonchocarpus cyanescens (called the Gara plant in Sierra Leone) was reviewed by the Imperial Institute of Great Britain (215 and 216) in 1907 and 1909. In Great Britain (173), Miscellaneous Colonial Report No. 51, Thompson in 1908 reported that in the Maru forests of the Western Province of southern Nigeria there was noticed Lonchocarpus cyanescens, from the leaves of which the bulk of the indigo used by the natives of the Western Province is extracted.

F. M. Bailey (11) in 1909 described two species of Lonchocarpus growing in Queensland, L. blackii Benth. and L. nesiotes Bail. The former species, called bloodbark, exudes a blood-red juice which on exposure dries to a brownish gum containing arabin 3.8 percent, resin 1.4 percent, tannic acid 74.2 percent, and water 20.6 percent.

The Handelsmuseum of the Koloniaal Instituut of Amsterdam (248) in 1934 reported analyses of 3 samples of nekoe root (L. chrysophyllus Kleinb.). These tested from 1.2 percent to 2.5 percent rotenone, average 2 percent.

Banners (27) in October 1935 submitted (through Concannon) a sample of nekoe from Dutch Guiana to the Division of Insecticide Investigations which was found to be apparently L. nicou. The root contained only 0.8 percent rotenone and 3.5 percent total carbon tetrachloride extractives, and a qualitative test revealed the presence of rotenone in the stem.

Tattersfield (399) in 1936 published a valuable review of recent work on fish poison plants as insecticides.

"Some samples of cube and tinbo have been found with very high rotenone-content, occasional specimens of the former containing as much as 12 percent rotenone and of the latter one as high as 15-16 percent have been reported, but these are exceptional. Commercial samples of cube examined at Rothamsted have usually ranged from 5-6 percent and good samples of Derris elliptica have touched 8-9 percent. There is, however, little or no question that these South American plants are being produced in continually increasing amounts and that in course of time competition with derris is likely to be severe.

"It has been recently established that the White Haiari of British Guiana is Lonchocarpus nicou (Aubl.) DC. and conspecific with cube of Peru, thus there are obviously several strains of this plant which differ somewhat widely in rotenone-content. Haiari plants taken from forests of British Guiana, and from their appearance of many years' growth, analyzed at Rothamsted, showed appreciable amounts of rotenone. Black Haiari roots contained over 3 percent and the stems about 0.8 percent. White Haiari roots gave 1.8

and the stems 0.6 percent of crude rotenone by the carbon tetrachloride method. Cultivated specimens, six years old, of Black Haiari gave 1.4 percent and of White Haiari 0.9 percent rotenone, the stems in both cases containing only traces. A further search for other and richer strains of Lonchocarpus in that colony would appear to be worth while. There is always the possibility, as Killip and Smith point out, that in Peru the cube plant, cultivated for centuries as a fish-poison may represent a selected strain in which the content of toxic principles of the roots is at a maximum."

John Powell and Company (332), in letters dated April 28 and July 6, 1936, presented average analyses of cube and derris recently imported by them.

Material	Total extractives by--			
	Rotenone (percent)	Ether (percent)	CCl ₄ (percent)	Acetone (percent)
Brazilian cube	5.29 (12)*	19.49 (11)	20.95 (8)	23.29 (4)
Peruvian cube	5.29 (7)	16.53 (7)	18.75 (5)	---
Malay derris	5.35 (2)	14.07 (2)	---	---

*The number of samples analyzed appears in the parenthesis.

The Federated Malay States Department of Agriculture (143) in its 1936 report stated that further samples of cube or haiari root (Lonchocarpus spp.) from plants at Serdang aged about 36 months were analysed by the Division of Chemistry, C. D. V. Georgi, Agricultural Chemist. Compared with derris, the results were again disappointing as the following figures, calculated on a moisture-free basis, show. Further, there was no indication of any marked increase in toxic content with age.

Type	Ether Extract	
	2 years old (percent)	3 years old (percent)
Black haiari	7.9	8.9
White haiari	7.7	8.0

Chevalier and Chevalier (78) in 1937 reviewed information on derris and cube. The authors have found up to 6.7 percent rotenone in cube. Peruvian cube imported into France in 1936 was more uniform in composition than derris. Rotenone was not below 4 percent and usually was 5 to 6 percent; total extract varied from 15 to 19 percent.

Georgi (161) in 1937 published additional analyses of black haiari (Lonchocarpus chrysophyllus Kleinh.) and white haiari (L. Martynii A. C. Smith) introduced from British Guiana and grown in Malaya.

The average yield of air-dry root from plants of varying age was:

Age of Plants

	2 years	4 years
<u>L. chrysophyllum</u>	no plants	7 ounces
<u>L. Martynii</u>	32.55 ounces	37.35 ounces
<u>D. elliptica</u> Changi No. 3		

The rotenone content of the fine roots of L. chrysophyllum was 3 per cent for the 2-year old plants and 4.3 per cent for 4-year old plants. The total ether extracts on these samples were 7.9 and 8.8 per cent respectively. L. Martynii, 4 years old, contained only 0.8 percent rotenone in the fine roots but 1.1 percent in the coarse roots. Derris elliptica Changi No. 3 contained an average of 9 per cent rotenone and 27 per cent other extract. All these figures are on a moisture-free basis.

Gooden and Smith (168) in 1937 investigated the principal optical and physical properties of the carbon tetrachloride solvate of rotenone, which is formed in the analysis of derris and cube. The principal results of the optical determinations are: $\alpha=1.563$; $\beta=1.612$; $\gamma=1.631$; optical character, negative; elongation, commonly negative; system, orthorhombic. The density at 30° is 1.40 g. per cc. The dissociation pressure in the range 60° to 90° is expressed by the equation $\log P \text{ mm.} = 9.308 - (2313/TK)$. The "decomposition temperature" is consequently 87°, and the heat of dissociation-vaporization 69 calories per gram of carbon tetrachloride.

According to Krukoff and Smith (255) the rotenone content of certain South American plants is as follows:

Average content (on an air-dry basis of 12 percent moisture) of--

	Rotenone (percent)	Extractives (Percent)
<u>Lonchocarpus chrysophyllum</u> Kleinh.	2.1	9.4
<u>L. floribundus</u> Benth.	poor	---
<u>L. Martynii</u> A. C. Smith	2.3	10.1
<u>L. rariflorus</u> Mart.	trace	7
<u>L. sylvestris</u> A. C. Smith	none	----
<u>L. urucu</u> Killip and Smith	4.4	17
<u>L. utilis</u> A. C. Smith	12	25
<u>L. sp.</u> (Tinbo branco)	7	16
<u>Derris amazonica</u> Killip	0.3	2

Jones (223) in 1938 reported a chemical examination of a sample of cube root which when received by the Division of Insect Investigations was found to be infested with Dinoderus bifoveolatus Woll. The whole root and the powder made by the insects were analyzed for rotenone with the following results:

Analysis for rotenone content of two samples of cube root.

Sample		Percent Rotenone
Original sample	Whole root	3.3
	Powder formed by insects	1.4
Specimen sample of original whole root	Whole root	4.1
	Powder formed by insects	2.3

It is seen that the portion of the root through which the insects tunneled, and which was thus reduced to powder by them, was lower in rotenone content than the remainder of the root. That there was no reduction in the total rotenone content of the root as a result of the insect attack was shown by the fact that the net rotenone content of the whole specimen sample, when the relative weights of whole root and powder are taken in account, was about the same as that of the original sample of whole root. Thus in a shipment of cube root infested by these insects it might be expected that there would be no loss in the total rotenone content provided none of the powdered material was lost.

Reference to this publication by Jones is made in the News Letter (224) of the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine.

Cupples (110) in 1938 stated that soaps containing free alkali or which hydrolyze readily with the formation of free alkali cannot be used with pyrethrum, derris, or cube, because the active principles of these plants are easily decomposed into inert compounds in the presence of alkaline solutions.

ASSAY OF LONCHOCARPUS

Pozzi-Escot (333,334) in 1935 described a modification of the carbon tetrachloride method of determining rotenone with special reference to its application to cube.

R. J. Prentiss and Company, Inc., (335) in 1935 argued that for the evaluation of the insecticidal value of dusts less emphasis be placed on rotenone content and more on total ether extractive. No derris or cube powder containing less than 15 percent total ether extractives will give satisfactory results when used in a dust at the usual dilutions.

"The situation on cube is somewhat similar. There are available somewhat limited supplies of what may be described as high rotenone cube, which yield powder containing 5 percent or more rotenone but as a rule only 15 percent or 16 percent total ether extractives.

There are also available apparently large amounts of a different type of cube which has a lower rotenone content, usually 3 percent to just under 5 percent, but with a good amount of ether extractives, from 18 percent to as high as 22 percent. The indications are that this may be about as effective and satisfactory as the first type for use in agricultural dusts but more complete information on it is badly needed."

Hoyer and Leonard (205) in 1936 proposed an "Index of Relative Toxicity" for the evaluation of derris and cube. This figure is the ratio: percent total ether extractives divided by percent rotenone. Examples are given of rotenone-bearing roots whose index of relative toxicity varies from 2.5 to 4.5. The total ether extractives in dusts standardized to a 0.75 percent rotenone content, made by diluting these derris powders with clay, talc or sulphur, ranges from 1.87 percent to 3.38 percent. The authors conclude: (1) "The percentage rotenone alone is not an accurate index of toxicity; (2) Roots having the greatest relative amounts of other extractives are the best; (3) By the use of the Index of Relative Toxicity the value of several roots, regardless of species and source of origin, may be put on the same basis for comparison."

Jones and Smith (230) in 1936 proposed the following formula to express the approximate toxicity of cube as determined by chemical analysis: Toxicity value = percent rotenone + 0.4 (total extractives - rotenone); total extractives may be determined with acetone, benzene or carbon tetrachloride. This formula expresses fairly well the relation between toxicity to houseflies (determined by the Campbell turntable method) and chemical analysis of 5 samples of cube containing from 0.8 to 12.1 percent actual rotenone.

Attention is called in the Bureau of Entomology and Plant Quarantine News Letter (169) for February, 1936, to Goodhue's (Jour. A. O. A. C. 19:118) improvement in the Gross-Smith colorimetric method for rotenone. The method is suitable for the analysis of spray residues of derris and cube.

Robinson (356) in 1936 called attention to the difficulty of estimating the rotenone content of hairis grown in British Guiana by the methods of Jones, Cahn and Born, and of Tattersfield and Martin, and proposed a modification of the carbon tetrachloride method.

Beach (23) in July, 1936, described a method of extracting rotenone from 20-mesh powdered cube root with chloroform at room temperature. Rotenone is determined in an aliquot of the filtrate as the carbon tetrachloride solvate in the usual way.

Bogtrup (25) in 1937 described a method in which 100-mesh cube powder packed tightly in an ordinary funnel is extracted by pouring toluene through it 6 times at room temperature. Rotenone is weighed as the carbon tetrachloride solvate.

Jones (219) in 1936 reported on the optical rotatory power of extracts of derris and cube roots. His conclusions were:

"Values for 'rotenone' equivalent to the combined optical rotatory powers of both acetone and benzene extracts of derris and cube roots gave an approximate measure of the insecticidal effectiveness of these materials to houseflies. Values calculated from the rotation of benzene extracts did not agree with toxicity so well as did the combined values, and in about half the samples results derived from the optical activity of acetone extracts were widely different from the toxicity values.

"Since a method has already been proposed for calculating the approximate toxic value to houseflies of derris and cube roots based on the rotenone and total extractive contents, which is both simpler and less open to question, the use of optical rotatory power cannot be recommended as a means of evaluation.

"From the chemical standpoint the results indicate that optically active constituents other than rotenone and deguelin were probably present in the samples of derris and cube tested. Dextrorotatory materials were undoubtedly present in the samples of derris root containing no rotenone, and possibly in other samples. The use of optical rotation should prove of considerable value in further chemical study of the components of extracts of derris and cube roots."

Ten samples of cube ranging in actual rotenone content from 0.8 to 12.1 percent and in total acetone extract from 14.1 to 25.4 percent were used in these studies.

Spoon (390) et al., of the Koloniaal Instituut of Amsterdam, in 1937 reported a means of distinguishing powders made from Derris and Lonchocarpus by the characters of the starch grains. Besides the shape also the size of the grains is characteristic for both genera. An exact description and figures are given. For 1,063 measured grains of Derris starch the average length is 6.38 microns ± 0.1 ; for 1,197 measured grains of Lonchocarpus starch the average size is 9.80 microns ± 0.2 . A drawing shows the size of the grains. By means of the differences described it is possible to distinguish with certainty between Derris powder and Lonchocarpus powder as well as between dusts for insecticidal purposes, prepared with both roots. It is claimed that mixtures can be examined and the average percentage of Lonchocarpus powder mixed with pure Derris powder detected.

Seaber (370) in 1937 reported analyses of derris, barbasco and timbo for rotenone, using chloroform, carbon tetrachloride, trichloroethylene and ethyl acetate as solvents. In all cases chloroform gave higher results. Seaber suggests that the best method for the determination of rotenone is to extract with cold chloroform (Beach's method), crystallize from carbon tetrachloride, determine the purity of the solvate by polarization, and report the percentage of pure rotenone.

Graham (170), Referee on Insecticides for the Association of Official Agricultural Chemists, in 1937 reported that during 1936 he investigated a number of methods for the determination of rotenone in derris and cube and that their collaborative study would probably be undertaken next year.

Jones (221) in May 1937 published a modified procedure for the crystallization of rotenone-carbon-tetrachloride solvate from extracts of derris and cube roots. Accurate results by this crystallization method were obtained only when the rotenone present was equivalent to at least 4 percent of the root, or in lieu of this, when sufficient rotenone was added, or a sufficiently large sample taken, to bring the amount present during crystallization above this value. A determination of the precision of replicate results on one sample of derris with about this rotenone content showed a standard deviation of ± 0.05 percent. In a study of the accuracy eight extracts, containing known amounts of rotenone in the range of most accurate results, gave average values which in view of the precision were not significantly different from the actual rotenone content. In other words, results for rotenone in the region of 4 percent should only be quoted to about 0.1 percent.

It is probable that the nonrotenone portion of the extract only exerts a retarding action on the crystallization and has little or no actual solvent effect on the rotenone. The so-called Sumatratype derris extracts show no unusual retarding action and no apparent solvent effect, indicating the "hidden" rotenone of Cahn and Bean to be a result of retarded crystallization similar to that found in other extracts of low rotenone content.

The exact procedure of the improved method is as follows:

"The extract from a 25-gram sample of root in a 125-cc. Erlenmeyer flask is evaporated on the steam bath in a current of air until free of solvent. The residue is treated with exactly 25 cc. of carbon tetrachloride, the flask is loosely stoppered, and complete solution is effected by gentle warming. The extract is next cooled in an ice bath for several minutes and then seeded with a few crystals of rotenone-carbon tetrachloride solvate. The flask is then tightly stoppered and swirled until crystallization is apparent. If at this stage only a small amount of crystalline material separates, an accurately weighed quantity of pure rotenone should be added, the mixture warmed to effect complete solution, and crystallization again induced. Sufficient rotenone must be present so that the result, expressed as "pure" rotenone, is at least 1 gram. At the same time a solution of rotenone in carbon tetrachloride containing 0.27 gram per 100 cc. of solution (the solubility at 0° C.) is prepared for use in washing. The extract and the washing solution are then placed in an ice bath capable of maintaining a temperature of 0° C. overnight.

"In the morning (the method is based on a crystallization time of 17 to 18 hours) the extract is filtered rapidly through a weighed Gooch crucible in the bottom of which has been placed a disk of filter paper, the flask being removed from the ice bath only long enough for pouring a small portion of extract into the crucible. The separated crystalline material is rinsed from the flask and washed under suction with sufficient of the ice-cold saturated solution (usually 6 to 10 cc.) to remove the excess mother liquor. Suction is applied for about 5 minutes, and then the material is dried to constant weight at 40° C., which usually requires about 1 hour. This is the weight of crude rotenone-carbon tetrachloride solvate.

"The contents of the crucible are then broken up with a spatula and thoroughly mixed, and a 1-gram sample is placed in a 50-cc. Erlenmeyer flask where it is treated with 10 cc. of alcohol which has been saturated with rotenone at room temperature. The flask is swirled for a few minutes and then tightly stoppered and set aside at the same temperature for 4 hours. The mixture is then filtered at the same temperature through a weighed Gooch crucible with filter-paper disk. The crystals are rinsed from the flask and washed under suction with the solution of alcohol saturated with rotenone at the temperature of the recrystallization. About 5 cc. are usually required for this. Suction is applied for about 3 minutes, and then the material is dried at 105° C. to constant weight, or for about 1 hour. The weight in grams is multiplied by the weight of crude solvate, and to the product is added 0.07 gram, representing the correction for rotenone held in solution in the 25 cc. of carbon tetrachloride used in crystallization. If any pure rotenone was added, its weight must be subtracted from the value obtained. This gives the weight of "pure" rotenone contained in the extract of the 25-gram root sample."

Cassil (66) in 1937 reported that the Gross-Smith-Goodhue (J. A. O. A. C. 19: 118-120. 1936) red-color test for micro amounts of rotenone previously developed in the Division of Insecticide Investigations can be applied to the study of derris or cube residues on cabbage. Chlorophyll and wax from the outside leaves complicated the recovery of the rotenone, but the procedure finally developed overcame the difficulty. It was found that cabbages from a plot that had received a total of 94 pounds of derris dust (9.4 pounds of derris) in six applications, retained, 5 days after the last dusting, 0.006 grain derris per pound, equivalent to 0.8 p.p.m. Five-sixths of this was on the four outer leaves, which normally are discarded before the cabbage is sold to the retail trade.

According to a report of the Handelsmuseum of the Koloniaal Instituut of Amsterdam (252) in 1937, Lonchocarpus powder is only 1/3 to 2/3 as active insecticidally as derris powder. Examination of 19 samples of powder represented to be derris powder showed 10 samples to consist exclusively of derris powder, 3 samples to be mixtures of derris and Lonchocarpus, and 6 samples to consist solely of Lonchocarpus powder. Examination of 7 samples of derris dusting mixture showed that all 7 contained derris powder. This information is also given by Spoon (389).

The United States Department of Agriculture, Food and Drug Administration (425), in its annual report for 1937 stated that more satisfactory methods for determining rotenone in derris and cube, both in the root powder and in mixtures of these powders with sulphur, had been developed.

Jones and Graham (228) in 1938 presented the results of a study of the relative merits of various solvents for the extraction of rotenone from derris and cube. Tests were made with chloroform, benzene, acetone, ethyl acetate, carbon tetrachloride, ethylene dichloride, trichloroethylene and an azeotropic mixture of benzene-alcohol. The moisture content of the samples tested ranged from 4.9 to 8.5 percent. The authors draw the following conclusions from their work:

"In the analysis of finely powdered samples of derris and cube roots a method involving treatment with chloroform at room temperature followed by removal of an aliquot of the filtered extract gives satisfactorily complete extraction of the rotenone.

"Fineness of the sample is an exceedingly important factor in obtaining complete extraction by any method. If coarse samples are ground so that at least 95 per cent passes a 60-mesh sieve, they will usually give satisfactory extraction by the aliquoting procedure.

"Samples containing a high ratio of rotenone to total extractives were found to be more difficult to extract than those with lower percentages of rotenone. When the ratio of rotenone to total extract was about 40 per cent or over, particularly in the case of derris roots, it was necessary to employ extraction at room temperature with successive lots of chloroform in order to obtain satisfactory extraction of the rotenone. This method should also be employed as a check whenever there is doubt as to the completeness of extraction by the aliquoting procedure.

"Cube roots in general are more readily extracted of their rotenone content than are derris roots.

"The moisture content of derris and cube roots as received in this country has not been found to be sufficiently great to interfere with their analysis, and hence preliminary drying of samples seems unnecessary."

Jones and Graham (229) in February 1938 published the procedure recommended by them for the determination of rotenone in derris and cube. This is as follows:

"Weigh 30 grams of the finely powdered root into a 500 cc. glass-stoppered Erlenmeyer flask. Add 300 cc. of CHCl_3 measured at a definite room temperature; place the flask on a shaking machine and fasten the stoppers securely. Agitate vigorously for not less than 4 hours, preferably interrupting the shaking with overnight rest. (As an alternative procedure the flask may be shaken continuously overnight.) Remove the flask from the machine and allow to cool in a refrigerator for at least an hour. Filter the mixture rapidly into a suitable flask, using a fluted paper without suction and keeping the funnel covered with a watch-glass to avoid loss from evaporation. Stopper the flask and adjust the temperature of the filtrate to that of the original CHCl_3 .

"Transfer exactly 200 cc. of this solution to a 500 cc. Pyrex Erlenmeyer flask and distil until only about 25 cc. remains in the flask. Transfer the extract to a 125 cc. Erlenmeyer flask, using CCl_4 to rinse out the 500 cc. flask. Evaporate almost to dryness on the steam bath in a current of air. Then remove the remainder of the solvent under reduced pressure, heating cautiously on the steam bath when necessary to hasten the evaporation. (The suction may be applied directly to the flask.) Dissolve the extract in 15 cc. of hot CCl_4 and again, in a similar manner, remove all the solvent. Repeat

with another 10-15 cc. portion of hot CCl_4 . (This treatment removes all the CHCl_3 from the resins.) The CHCl_3 extract is usually completely soluble in CCl_4 . If small quantities of insoluble material are present, the purification procedure described later will eliminate them. However, if a large quantity of insoluble residue should remain when the extract is dissolved in the first portion of CCl_4 , it should be filtered off and thoroughly washed with further portions of hot solvent, after which the filtered solution plus washings should be treated as described above for the removal of CHCl_3 .

"Add exactly 25 cc. of CCl_4 and heat gently to completely dissolve the extract. Cool the flask in an ice bath for several minutes and seed with a few crystals of rotenone-carbon tetrachloride solvate if necessary. Stopper the flask and swirl until crystallization is apparent. If at this stage only a small quantity of crystalline material separates, add an accurately weighed quantity of pure rotenone, estimated to be sufficient so that the final result, expressed as pure rotenone, is at least 1 gram. Then warm to effect complete solution, and again induce crystallization. At the same time prepare a saturated solution of rotenone in CCl_4 for washing. Place the flasks containing the extract and the washing solution in an ice bath capable of maintaining a temperature of 0°C . and allow to remain overnight.

"After 17-18 hours in the ice bath, rapidly filter the extract through a weighed Gooch crucible fitted with a disk of filter paper, removing the flask from the ice bath only long enough to pour each fraction of extract into the crucible. Rinse the residue of crystalline material from the flask and wash under suction with sufficient of the ice-cold saturated solution (usually 10-12 cc.) to remove the excess mother liquor. Allow the crucible to remain under suction for about 5 minutes and then dry to constant weight at 40°C ., which usually requires about an hour. The weight obtained is the "crude rotenone-carbon tetrachloride solvate."

"Break up the contents of the crucible with a spatula, mix thoroughly, and weigh 1 gram into a 50 cc. Erlenmeyer flask. Add 10 cc. of alcohol that has previously been saturated with rotenone at room temperature, swirl the flask for a few minutes, stopper tightly, and set aside for at least 4 hours, preferably overnight, at the same temperature. Filter on a weighed Gooch crucible fitted with a disk of filter paper. Rinse the crystals from the flask and wash under suction with a solution of ethyl alcohol saturated with rotenone at the temperature of recrystallization (5-10 cc. will usually be required). Allow the crucible to remain under suction for 3-5 minutes and then dry at 105°C . to constant weight, which should be effected in 1 hour.

"Multiply the weight, expressed in grams, by the weight of the crude rotenone-carbon tetrachloride solvate, and to the product add 0.07 gram, which represents the correction for rotenone held in solution in the 25 cc. of CCl_4 used in crystallization. If any pure rotenone has been added, subtract its weight from the value obtained.

This gives the weight of pure rotenone contained in the aliquot of the extract, representing 20 grams of the sample."

Reference to this method of Jones and Graham for the determination of rotenone in cube and derris is made in the News Letter (227) of the Bureau of Entomology and Plant Quarantine.

USE OF LONCHOCARPUS AS AN INSECTICIDE

Probably the earliest published account of the use of cube as an insecticide occurs in an article by Klinge (245) in the February 1910 Boletín de la Dirección de Fomento, Lima, Peru. A translation from the Spanish is as follows:

"At present I am studying and testing out a liquid for the control of ticks on llamas of which I spoke in one of my recent letters. There is a plant here called "CUBE" in the Quechuan dialect which is used for catching fish in dammed up streams by poisoning the water with the root. From tests that I made it results that maceration produces an effective insecticide, which destroys the tick; but I do not know whether it will be toxic to the llamas, if these animals should take it accidentally internally, as would be the case in a dipping process. I am making solutions by crushing and maceration in various proportions, in order to find one, if possible, which kills the tick and is not poisonous to the llamas in quantities larger than one liter, which is the maximum that can be taken during a dipping bath. The work is done in the laboratory of the college and in a peasant house in the neighborhood of the town. This will delay me a few more days."

Delassus, Lepigre, and Pasquier (112) in 1933 wrote that rotenone (from the roots of Derris, Tephrosia, Lonchocarpus, etc.) may be used like pyrethrum insecticides against insects attacking grapevines in Algeria.

The British Guiana Department of Agriculture (48) in 1934 published results of tests of cold water, hot water, and carbon tetrachloride extracts of the bark, stems, and leaves of fresh young shoots of haiari against the red stinging ant, Solenopsis sp. None of the extracts had any effect on the ants. An aqueous extract of haiari gave excellent results against another species of ant, probably Prenolepis sp., infesting coffee trees.

Garman and Turner (158) in March 1934 published information on substitutes for lead arsenate on fruits and vegetables in Connecticut. Rotenone preparations made from cube or derris are promising both as stomach and contact poisons, and are recommended against insects attacking currants, gooseberries, raspberries, strawberries, beans, cabbage, cauliflower, broccoli, celery, and leafy vegetables such as beets, turnips, lettuce, spinach, Swiss chard, New Zealand spinach, etc.

The United States Department of Agriculture, Bureau of Entomology (417), on March 14, 1934, issued a mimeographed memorandum recommending derris or

cube dust containing 0.5 to 1.5 percent rotenone and combined pyrethrum-derris extract as a spray for combating the common cabbage worm, cabbage looper, cabbage webworm, and diamondback moth on cabbage; melon and pickle worm on squash; leaf-feeding insects on lettuce and spinach; and Mexican bean beetle on beans. Satisfactory diluents for the dusts are finely-ground tobacco dust, clay, talc, and sulphur which has proved especially successful on cabbage and squash.

The opinion of one of the large insecticide manufacturers as to the relative merits of derris and cube is of interest. McCormick and Company (274) in 1934, in a full-page advertisement on the properties and uses of derris powder, wrote as follows:

"It is reasonable to assume that, if the rotenone content and total ether extractives are identical in derris and cube, their effectiveness should be identical. However, experience has shown us that the rotenone content and ether extractives in derris are uniformly higher than are these two elements in other rotenone bearing roots. This is probably true because derris is more extensively cultivated than any of the other varieties."

Crosby and Chupp (109) in 1934 recommended 0.5 percent rotenone dusts made from cube or derris mixed with talc or clay for the control of cabbage worms (Pieris rapae L., Autographa brassicae Riley, and Plutella maculipennis Curtis) and the Mexican bean beetle.

Haegeler (182) in 1934 reported that cube powder at the rate of 10 lbs. per 100 gals. applied on a 7-day schedule and also at the rate of 5 lbs. per 100 gals. plus 0.5 percent oil applied on the regular spray schedule proved most unsatisfactory (more worms per 100 apples) in controlling the codling moth at Parma, Idaho. Heavy residues were left on the fruit from the 7-day pyrethrum, derris, and cube treatments, but there was no injury or lack of color apparent. Use of these organic insecticides resulted in the least number of stings per 100 apples.

The Colorado Agricultural Experiment Station (87) reported that in 1934 a satisfactory control of the imported cabbage worm on cabbage and cauliflower was secured with derris or cube dusts carrying 0.5 percent rotenone.

F. L. Campbell (69), at the 1935 Codling Moth Conference, asserted that because derris and cube are so toxic to codling moth larvae in laboratory tests they should be tested further.

R. E. Campbell (62) in 1935 reported that laboratory tests at Alhambra, Calif., against the imported cabbage worm showed cube dust to be slightly more toxic than derris dust with an equivalent rotenone content. Talc was used as a diluent in each case and applications were made with a precision duster at a dosage of 1 gram per plant.

An anonymous (3) writer in 1935 stated that roach powders containing from 5 to 25 percent cube or derris and 95 to 75 percent pyrethrum were on the market.

Childs (79) in 1935 reported cube as well as derris ineffective against the codling moth in Oregon.

Cassidy and Barber (65) reported in 1935 that in plat tests cube was less effective (45.2 percent control) than derris (62.8 percent control) in controlling the following hemipterous cotton insects in Arizona: Euschistus impectiventris Stal, Chlorochroa sayi Stal, Thyanta custator F., Dysdercus mimulus Hussey, and Lygus hesperus Knight.

Feytaud and Lapparent (147) in 1935 reported favorable results against the Colorado potato beetle in France with a terpinolene extract of derris (or cube) emulsified in water. These workers prepared terpinolene extracts of derris and cube by macerating 8 grams of root with 100 grams terpinolene for 3 to 5 days. After being filtered and emulsified, this extract killed larvae of the Colorado potato beetle at a dilution of 1 to 19 with water. A spray of 2 percent of this extract has been used to destroy caterpillars on tobacco, roses, cherries, pears and coquelicot.

A good emulsion is made by mixing 700 grams of the terpinolene extract with 300 grams of sulphated higher fatty alcohol (oleyl, lauryl, cetyl). This is better than sodium resinate. Terpinolene, or essence of pine, is rich in iso-cineol. Emulsions of 8-10 percent strength of the terpinolene extract are being tried as a substitute for anthracene oil.

Later Feytaud and Lapparent (148) reported that in laboratory tests against the Colorado potato beetle it was necessary to use the following quantities of a product containing about 16 percent of the extractives of derris of which 5 percent was rotenone: 100 grams per hectoliter of water for young larvae, 200 grams per hectoliter of water for old larvae, 500 grams per hectoliter of water for adults.

Derris extract in terpinolene is made as follows: 15 grams powdered derris or cube (rotenone = 5 percent) is macerated for 5 days at a temperature not above 30° C. in 100 grams terpinolene, then filtered and kept in a tinted glass flask to escape the action of light. A mixture is made of derris extract in terpinolene, 60 parts; terpineol, 20 parts; sulphated oleyl alcohol, 20 parts.

Preferably the last two ingredients are mixed first and the derris extract then added. For use this mixture is added to water to make a 0.5-percent emulsion. Ammonium sulphoricinate may also be used as an emulsifier. A 0.5-percent emulsion of this applied to fourth-stage potato beetle larvae killed 30 percent in 24 hours, 75 percent in 48 hours, and 100 percent in 4 days.

Howard and Davidson (200) in 1935 advised that derris sprays or dusts were the best insecticides for the control of cabbage worms in Ohio. Derris or cube dust containing 0.05 to 0.1 percent rotenone, applied at the rates of from 20 to 25 pounds per acre, gave good control of the imported cabbage worm. It was indicated that three or four applications may be required to obtain control in some instances. Good results were also obtained by the application

of derris or cube root sprays containing 0.01 percent rotenone. For the control of the cabbage looper it was necessary to use derris or cube dusts containing 0.4 to 0.5 percent of rotenone, or to use derris or cube root sprays containing 0.015 to 0.02 percent of rotenone. Applications were made every 10 to 14 days after the worms appeared in large numbers. There was no significant difference in the degree of control obtained from the use of derris root or cube root dusts or sprays, provided the rotenone contents of the insecticides were practically equivalent. The addition of spreaders or stickers to derris root suspensions in water applied as sprays seemed to increase slightly the control obtained. Very little difference in the degree of control resulted from the use of a number of diluents for derris or cube dusts.

H. H. Richardson (340) in 1935 reported that both derris and cube were effective against the common red spider, on greenhouse plants. Suspensions of powdered cube root (5.3 percent of rotenone and 17.3 percent of total carbon tetrachloride extractives) at the rate of 0.25 percent (rotenone approximately 1:8,000) in combination with 0.25 percent by volume of sulphonated castor oil gave high mortality. Cube killed 97.2 percent of the adults and 96.6 percent of the nymphs as compared to 99.2 and 99.5 percent kill, respectively, for adults and nymphs caused by the same concentration of derris with 0.5 percent sulphonated castor oil.

The South Carolina Agricultural Experiment Station (386) in 1935 tested powdered cube root (rotenone 5 percent) mixed with talc or tobacco powder as a dust and also undiluted as a spray against the Mexican bean beetle. Cube compared favorably with derris of equal rotenone content.

Weigel and Richardson (461) in 1935 reported that the proportion of sulphonated castor oil is an important factor in the effectiveness of derris sprays against red spider. Tests conducted against the red spider mite, Tetranychus telarius L., at Barberton, Ohio, indicated that a spray composed of derris root powder in water, with a rotenone content of approximately 0.0034 percent, which has not proved entirely effective, showed a marked increase in effectiveness when the proportion of sulphonated castor oil was increased from 1:400 to 1:300. With this proportion, kills of 98.4 percent of the adults and 96.4 percent of the nymphs were obtained. It was observed that increasing the rotenone content to 0.0052 percent without increasing the proportion of sulphonated castor oil did not appreciably increase the effectiveness. Similar results were obtained when cube root powder in water, containing approximately 0.0095 percent of rotenone, was used with the sulphonated castor oil.

The Bureau of Entomology and Plant Quarantine (418) in 1935 assembled the results of codling moth investigations during 1934. Gentner at Talent, Oreg., reported that powdered cube root mixed with kaolin, to a rotenone content of 1 percent, at a dosage of 10 lbs. to 100 gals., applied at seven-day intervals (calyx and first cover of lead arsenate) gave much poorer control than lead arsenate on Bartlett pears.

F. L. Thomas (405) in 1935 recommended 1 part derris containing 5 percent rotenone mixed with 9 parts finely ground conditioned sulphur for the control of cabbage worms (Pieris rapae L., Autographa brassicae Riley, and Plutella maculipennis Curtis) and the tomato fruitworm (Heliiothis obsoleta Fab.)

in Texas. The following is said concerning cube: "Cube, another commercial rotenone-bearing plant, is approximately equivalent to derris in its rotenone content."

Hervey, Hockett, and Glasgow (191) in 1935 recommended a dust containing 0.5 percent rotenone made by diluting derris or cube with talc or clay, used at the rate of 30 pounds per acre for the control of the imported cabbage worm, Pieris rapae L., the cabbage looper, Autographa brassicae Riley, and the larvae of the diamond-back moth, Plutella maculipennis Curtis. The Zebra caterpillar, Manestra picta Harr., is very resistant to derris dust. Instead of dust, derris spray at the rate of 100 gallons per acre may be used. This is made by adding 4 lbs. derris powder (4% rotenone) and 4 lbs. skim milk powder to 100 gals. water.

Hervey (190), in discussing the European corn borer, stated that spraying or dusting sweet corn may become feasible where the value of the crop is high. Insecticides showing the most promise include derris or cube, phenothiazine, and nicotine.

Feytaud (146) in 1935 mentioned rotenone powders for combating the Colorado potato beetle in France. The type formula is 5 parts powdered derris or cube (rotenone not less than 5%) and 95 parts talc or kaolin.

The Colorado Agricultural Experiment Station (86) in 1935 reported that pyrethrum- and rotenone-bearing materials are more effective on cabbage worms as dust than as sprays. Dusts of these materials that are effective against cabbage worms do not give satisfactory control of plant lice. The imported cabbage worm is controlled with pyrethrin- and rotenone-bearing dusts of lower strengths than will control the cabbage looper and diamond-back moth. Calcium arsenate dusts gave very poor control of the imported cabbage worm, but paris green dust gave a satisfactory control. Derris and cube dusts were equally effective when used at the same rotenone content, although the cube appeared somewhat more erratic when used during cool weather in the fall.

Rotenone and pyrethrins are known to break down more rapidly in direct sunlight; however, there were no significant differences in the results from morning and evening applications.

The New Jersey Agricultural Experiment Station (302) in 1935 reported that derris and cube roots are practically equal in their toxicity to aphids, provided that they contain about the same amounts of rotenone and total extractives.

Fenton (145) in 1936 compiled information on the use of sulphur in the control of truck crop and cane fruit insects and diseases. Information is included on mixtures of sulphur with derris or cube.

Boyce (37) in 1936 reported finely powdered cube root ineffective against the citrus red mite, Paratetranychus citri McG., and its eggs under field conditions in California.

F. S. Chamberlin (66) in 1936 reported tests made at Quincy, Fla., in 1934 in which he found that derris and cube, diluted with a fine nearly neutral denicotinized tobacco dust to a rotenone content of 0.05 percent, were equally effective (85 percent mortality) when dusted on the tobacco flea beetle, Epitrix parvula Fab., under cage conditions.

Brannon (40) in 1936 reported that best simultaneous control of the Mexican bean beetle and powdery mildew on snap beans at Norfolk, Va., was obtained by adding 2 pounds of wettable sulphur to derris or cube powder suspensions containing about 0.02 percent rotenone or by diluting derris or cube powder with sulphur down to a rotenone content of 0.5 percent.

Brannon (41) in 1936 reported that no significant control of the corn earworm, Holiothis obsoleta Fab., on lima beans on the Eastern Shore of Virginia was obtained with derris-talc dusts containing 0.75 or 1 percent rotenone, and that sprays of powdered derris and cube roots containing 0.025 percent rotenone gave even poorer control.

Farrar (138) in 1936 reported that tests made in Illinois showed that against the aphids Hysteroneura setariae Thomas, Aphis pomi Deg., and A. spiraeicola Patch extracts of pyrethrum, derris, or cube are not so efficient as nicotine when mixed with oil emulsion. The addition of soap will increase the killing power of an oil containing such extracts, but not enough to warrant the added cost of the extracts.

Brannon (42) in 1936 reported that cube dust containing 0.5 percent rotenone was less toxic than cryolite-talc (60:40) dust in field cage tests against the adult sweetpotato leaf beetle, Typophorus viridicyaneus Crotch, at Norfolk, Va.

Fleming and Baker (150) in 1936 reported results of tests of insecticides against the Japanese beetle under controlled laboratory conditions. Cube and timbo with a rotenone content and total extractives equivalent to derris were only half as effective as repellents.

Bronson (52) in 1936 described a ball mill for mixing cube or derris powder with a diluent and with an activator or conditioner. These dusts have proved to be toxic against the pea aphid, Illinoia pisi Kalt., in small experimental tests.

Hammer (186) in 1936 recorded tests made in New York for the control of the gooseberry fruitworm, Zophodia grossulariae Riley, on currants. Powdered derris and cube root containing 5 percent rotenone gave good control when used in sprays. The best results were obtained when two applications were made with either of these materials used at the rate of 2 pounds in 100 gallons of water. The first application was made on May 21 (one day after the calyx spray was begun on McIntosh apples) and a second spray was applied on June 3. Almost as good results were obtained from one application using 4 pounds of derris or cube in 100 gallons of water. This spray was applied on May 29, just as the worms were beginning to web the clusters together.

Derris gave slightly better results than cube when used in sprays. Dust mixtures containing either derris or cube root and having 0.5 percent rotenone gave good control but were slightly inferior to the sprays. There was no apparent difference in toxicity between derris and cube when used as dusts in these tests. Both clay and talc proved satisfactory as diluents.

Howard (198) in 1936 reported tests made at Columbus, Ohio, the previous year with insecticides against the Mexican bean beetle. Satisfactory control was obtained with suspensions of derris root powder and cube root powder in water at dilutions of 0.01, 0.015, 0.02, and 0.025 percent of rotenone. Fairly satisfactory results were obtained with derris sprays containing 0.005 percent of rotenone. The incorporation of various wetting agents, spreaders, and stickers did not improve the efficiency of these spray suspensions. In general, cube proved to be approximately equal in effectiveness to derris when tested at the same dilution of rotenone. Derris dust mixtures and cube dust mixtures containing 0.4, 0.5 and 0.75 percent of rotenone, respectively, with various diluents, all gave satisfactory control. As a result of special tests of various diluents, it was concluded that it was not important to obtain any particular diluent for use with derris or cube dust, provided such diluent is nonalkaline in character. The results indicated that talc-flotation sulphur (50:50), wheat flour, ground [pyrethrum] marc, talc, bentonite, and finely ground dusting sulphur in the order named, with the last two almost equal in effectiveness, were as good as, or slightly superior to, any of the diluents tested. In general, derris dusts appeared to be slightly superior to cube dusts in effectiveness.

Howard, Brannon and Mason (199) in 1936 recommended derris or cube spray as the best control measure for the Mexican bean beetle. Three pounds of powder (containing 4 percent rotenone) per 100 gallons gives a rotenone content of about 0.015 percent. The treatment should be started when beetles are found in the field and should be repeated at intervals of 7 to 10 days. Dusts containing 0.5 percent rotenone may be used at the rate of 20 to 25 pounds to the acre per application. Sprays are recommended in preference to dusts for bean beetle control, since spraying will give better control and longer protection to the plants. In the case of home-mixed dusts, either talc, dusting sulphur, infusorial earth, kaolin (china clay), or other finely ground inert clay, gypsum, diatomaceous earth, wheat flour or tobacco dust may be used as a diluent or carrier, but recent experiments have indicated that talc is the most satisfactory. Dusts containing 0.5 or 0.75 percent rotenone should not be used for making sprays. Begin spraying when the adults are found in the field or when the eggs of the beetle become numerous on the undersides of the leaves. One to three, sometimes four, applications are required, depending on the abundance of the insect.

Howe (204) in 1936 reported tests made at Clarksville, Tenn., against the tobacco flea beetle, Eotrix parvula Fab., which indicated that a cube root dust mixture having a rotenone content of approximately 1.5 percent was the most toxic of the materials tested against the flea beetle on dark-fired tobacco, but that a similar dust mixture containing 2 percent rotenone was most efficient in the tests with Burley tobacco. In general, however,

it appeared that the dust mixture containing 1.5 percent rotenone was so nearly equal to the mixture containing 2 percent rotenone that the former dilution is preferable because of its lower cost. The cube dust mixture proved more effective than a mixture of 50 percent cryolite and 50 percent kaolin, or a mixture composed of 8 percent paris green, 42 percent lead arsenate, and 50 percent kaolin. Results indicated that there was very little difference in the relative toxicity to flea beetles on tobacco plant beds between the two last-mentioned dust mixtures.

Hutson (209) in 1936 published directions for the control of insects with derris and pyrethrum. Hutson states "The term Derris is used for convenience. Present information indicates that cube of equivalent rotenone content is just as satisfactory."

Laake (256), of the Dallas, Tex., station of the Bureau of Entomology and Plant Quarantine, Division of Insects Affecting Man and Animals, in 1936 reported that powdered cube root, rotenone concentrate, and many other materials were ineffective as repellents for stable flies and horn flies.

Edwards (124) in 1936 recommended derris or cube dust containing 0.5 percent rotenone for the control of spittle bugs, Aphrophora permutata Uhl. and Philænus spunarius (Louccohtholmus) L., on strawberries in Oregon. About 150 pounds of dust per acre are needed to secure control.

Ewing (133) in 1936 reported that in cage toxicity tests against the cotton flea hopper, Psallius seriatus Reut, at Port Lavaca, Tex., a mixture of 10 parts pyrethrum, 10 parts cube, and 80 parts sulphur killed 15 percent of the adults and 67 percent of the nymphs. Best control of adults (82 percent) was obtained by sulphur-paris green, 90:10, and best control of nymphs (93.5 percent) was obtained with sulphur-pyrethrum, 60:40.

Smith and Scales (382) reported the following results of cage tests made at Tallulah, La., during 1936:

Treatment	Leafworm	Control (percent)		Boll weevil
		Tarnished plant bug		
		Nymph	Adult	
Cube 40%, sulphur 60%, (rotenone 1.96%)	72	54	49	45
Cube 20%, sulphur 80%, (rotenone 0.98%)	58	--	33	28
Cube 10%, sulphur 90%, (rotenone 0.49%)	31	--	12	6
Cube 10%, pyrethrum 10%, (sulphur 80% (rotenone 0.49%)	63	71	21	9
Cube (rotenone 4.9%)	76	2	50	80

Cube was slightly better than derris against the boll weevil and about equal to derris against the leafworm, while derris was slightly more effective against the tarnished plant bug. Calcium arsenate was more effective than cube against the boll weevil and the leafworm.

Chapman, Hollingsworth and Robertson (71) reported only slight reduction in the pink bollworm infestation in plats heavily dusted with a mixture of 20 percent cube and 80 percent sulphur (1 percent rotenone) at Presidio, Tex., in 1935. Cube (5 percent rotenone) used as a spray, 10 lbs. to 50 gals. of water and 2 lbs. of flour, also gave very little control.

Chapman and Williams (72) reported that a dust of 10 percent cube, 10 percent pyrethrum, and 80 percent sulphur (0.49 percent rotenone) used against the pink bollworm in cage tests in 1936 was not so effective as barium fluosilicate or calcium arsenate.

McKinney (273) in September 1936 reported that the application of dust mixtures containing 1 percent rotenone, derived from derris or cube, with talc as a diluent, proved effective in controlling the western striped cucumber beetle, Diabrotica trivittata Mann., on cantaloupes in the Salt River Valley, Ariz. Treated plots yielded approximately 1.6 times more fruit than did untreated plots grown under comparable conditions, and the protected plants also produced more fruits earlier in the season, when prices were high.

Murphy and Vandenburg (289) in 1936 wrote that most household sprays contain as the insecticidal principle an extract of pyrethrum flowers, an extract of derris or cube root, a solution of an aliphatic thiocyanate, or some combination of these toxic agents.

The New York (Geneva) State Agricultural Experiment Station (304) in its annual report for 1935 (published in 1936) stated that when stomach insecticides are needed for the control of the imported currant worm on currants a rotenone spray or dust may be used. Studies made in 1934 show that derris or cube dusts containing from 0.3 to 0.5 percent rotenone were very effective in killing the currant worm.

Extensive experiments were conducted in western New York in 1934 on the control of the cabbage aphid and cabbage worms on Danish cabbage. Both of these insects were unusually prevalent and caused serious damage in many fields. Derris dust containing 0.5 per cent rotenone proved more satisfactory for worm control than arsenate of lead or calcium arsenate, but appeared to have little value in protecting the plants against the cabbage aphid. On such crops as broccoli, cauliflower, brussels sprouts, and early or loose headed cabbage, a derris dust is advised to avoid arsenical residues. Where the cabbage aphid becomes abundant on these crops it will be necessary to make a separate treatment of a 4-percent lime-nicotine dust, since derris and lime are not compatible.

Comparative tests were made of derris and cube roots in powdered form and as extractives containing the toxic ingredients for the control of cabbage worms. Field tests indicated that extractives were inferior to powdered

root for spray purposes, and that sprays were not so effective as dusts. For spray purposes, the most satisfactory results were obtained with a mixture containing 4 pounds of powdered derris root to 100 gallons of water in addition to neutral coconut oil soap, penetrol, skin milk powder as a sticker. For dusting, equally satisfactory results were obtained with derris and cube mixtures of 0.5 to 1 percent rotenone strength, containing talc, clay, or air-floated gypsum as the silulent. Not all cabbage worms, however, were killed by rotenone-containing powders, for example the zebra caterpillar. Contact dusts containing pyrethrum or nicotine were highly toxic to this insect if applied in the early stages of larval development.

The Texas Agricultural Experiment Station (402) in its 48th annual report (published in 1936) reported that derris was considerably more effective than cube against the cabbage looper, Autographa brassicae, and the larvae of the diamond-back moth, Plutella maculipennis, regardless of the carrier used, according to tests conducted at Weslaco and Winterhaven during January 1935. The derris mixtures and the cube mixtures were more effective against the larvae of the diamondback moth than against the cabbage looper. Derris-sulphur (15-85) or cube-sulphur (15-85) containing 0.75 percent rotenone gave better control of cabbage worms than either arsenate of lead or barium fluosilicate on the average in the lower Rio Grande Valley, the Winter Garden, or Galveston County.

The Colorado Agricultural Experiment Station (87) in 1936 reported that during 1934 the insect infestation on cabbage and cauliflower consisted largely of the imported cabbage worm. A satisfactory control of these was secured with pyrethrum dusts containing 0.18 percent pyrethrins and with derris or cube dusts carrying 0.5 percent rotenone. The minimum amount of material and the number of applications to give seasonal protection remain to be determined. The infestation of the imported cabbage worm was so light in 1935 that this part of the work could not be completed.

The 1935 infestation consisted of the cabbage looper, alfalfa looper, and the diamondback moth. These are more difficult to kill. Dusts carrying 0.2 percent pyrethrins or 0.75 rotenone, which is higher than most recommendations and also higher than the contents of most commercial dusts, failed to give satisfactory control.

The Idaho Agricultural Experiment Station (210) in 1936 reported that cube-kaolin dust is effective against several insects. Preliminary tests were made with a cube-kaolin dust mixture containing 0.02 percent rotenone. This mixture, applied in the center and over the top of ant hills, killed most of the colony, and a second application two weeks later usually served to exterminate the colony. Occasional light dustings of the mixture around shrubbery or ornamentals or at places where the insects entered the buildings effectively controlled ants. The dust readily killed nymphs of the squash bugs but squash vines soon were reinfested. One thorough dusting of Virginia creeper killed most of the nymphs and adults of the grape leafhopper and a second dusting 10 days later produced complete control. Two dustings of the mixture, 10 days apart, controlled the grape leafhopper on grapes.

A committee of entomologists representing a number of the State agricultural experiment stations and the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, issued the following suggestions (421) for the control of the pea aphid at the 1936 meeting of the American Association of Economic Entomologists in Atlantic City.

"Dusting with derris or cube: Preliminary experiments with these materials, with a carrier such as talc, conditioned with a spreader and wetting agent, have given satisfactory control. Their use is suggested only on an experimental basis. Such dust should contain approximately 1 percent rotenone."

"Spraying with derris or cube: On the basis of ground derris or cube root containing 4 percent rotenone, 3 pounds should be used per 100 gallons of water. Corresponding dilutions should be used with derris or cube containing more or less than 4 percent rotenone. A spreader and wetting agent is necessary. The application per acre should be from 150 to 200 gallons. Pressure should not be less than 300 pounds. For information regarding spreading and wetting agents, consult your Experiment Station entomologist, or the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture."

C. A. Thomas (404) in 1936 reported tests made in Pennsylvania for the control of the tomato pin worm, Gnorinoschena lycopersicella Busck. Experiments show that pin worm larvae are very easily affected by derris, pyrethrum cube and nicotine dusts and sprays, and proprietary insecticides containing these materials, or extracts of them in combination with various carriers. Ground derris and cube root, of 2 to 4 percent rotenone content, and mixtures of these with carriers such as dusting sulphur, bentonite, inert C, etc., also are toxic, although the larvae die quietly without the violent reactions and strong regurgitation characteristic of pyrethrum effects. Tomato leaves dusted with a derris powder containing 4 percent rotenone were still quite toxic to these larvae at the end of four weeks, although the plants were exposed in a window during that time.

The Bureau of Entomology and Plant Quarantine (420) in its annual report for 1936 reported results of various tests with rotenone, derris and cube. Field experiments with insecticides in Ohio and Virginia on beans grown for the greenbean market or for canning have demonstrated that the Mexican bean beetle can be controlled at a minimum cost by applying sprays or dusts containing rotenone derived from derris or cube without danger of incurring harmful residues on the market product.

Experiments in California demonstrated that dust mixtures of derris, cube, or pyrethrum gave satisfactory results in the control of the three more common species of cabbage worms on cauliflower.

For the control of the pink bollworm, barium fluosilicate, cube, and cube-sulphur mixtures were selected for additional field-plot tests. All of these gave some control, as indicated by a reduction of the number of worms per boll, but none was very effective or satisfactory.

Weigel and Nelson (458) in September, 1936, reported that in greenhouse tests at Beltsville, Md., sprays containing 0.0056 percent rotenone and pyrethrum extract (1:10,000) with sulphonated castor oil added (1:300) as a spreader, and organic thiocyanate sprays diluted 1:300 were effective in killing adults and nymphs of Thrips tabaci Lind., without injury to the treated cucumber plants in the greenhouse. These sprays were applied at 300 pounds pressure by a specially devised greenhouse power sprayer. The addition of pyrethrum extract to either the derris or cube powder sprays was found to enhance their efficiency against the thrips. An immediate effect was evident against both the adults and the nymphs. The cube powder, plus the sulphonated castor oil, was not so effective as a derris powder spray, even though the rotenone content (0.0056 percent) of both was the same. Incidentally, it was observed that no mildew appeared in any of the sprayed plots, whereas in the check plots it was consistently present. This may indicate some fungicidal action on the part of the sprays containing rotenone or organic thiocyanates under the conditions of the experiment.

White (463) in 1936 in the publication E-376 of the Bureau of Entomology and Plant Quarantine, issued recommendations for the control of insects attacking certain vegetables, small fruits and tobacco. Derris is recommended for the control of several insects and by implication cube may be used in place of derris. Cube is specifically mentioned as follows:

"Preliminary experiments in California have shown that derris, or cube, or pyrethrum dust mixtures, at the same dilutions as have been mentioned for cabbage, gave as satisfactory results in the control of the three more common species of cabbage worms on cauliflower as they did on cabbage."

Cube is given as the equivalent of derris for the control of the Mexican bean beetle and the tobacco flea beetle.

Wisecup (473) in 1936 reported laboratory tests directed against quarter-grown larvae of the imported cabbage worm, Pieris rapae L., at Sanford, Fla. A cube dust mixture containing 0.055 percent rotenone was very effective in killing the larvae of this species, and this dilution is the most suitable of any of the dilutions tested for use in obtaining comparative results of the reactions of insecticides to P. rapae larvae.

Wisecup (474) in 1936 also reported laboratory tests made at Sanford, Fla., with half-grown larvae of the southern armyworm, Prodenia eridania Cram. In general, these laboratory tests indicated that poisoned-bait mixtures consisting of bran, cottonseed meal, or corn meal, paris green, cryolite, phenothiazine, or cube, with syrup and ground lemons, were not sufficient to overcome the attractiveness of the natural green food of the southern armyworm larvae. Paris green and synthetic cryolite were much superior to cube.

Felt and Bronley (144) in 1937 reported that cube powder appeared slightly less toxic than derris powder when applied as sprays at the rate of 3 lbs. of powder (rotenone = 4 percent) to 100 gallons of spray. Cube powder was also applied in a mixture of sumner oil 1:200 as a contact insecticide against shade tree insects in Connecticut. In general, results on ex-

posed tent caterpillars, Malacosoma americana Fab., were better than on cankerworms, Alsophila pometaria Harris.

Ewing and McGarr (134) in 1937 reported that neither powdered derris nor cube (each containing about 4 percent rotenone) showed any promise when dusted on cotton flea hoppers in cages. Cube root mixed with phenothiazine failed to give promising results.

Morrill and Lacroix (287) in 1937 reported tests to control the potato flea beetle, Epitrix cucumeris Harris, on shade and field tobacco in tobacco in the Connecticut valley. The following dusts containing rotenone were tested:

1 part cube powder (4% rotenone) plus 3 parts sterile tobacco dust (finely ground and certified by the manufacturers to be a by-product in the manufacture of nicotine sulfate) applied at the rate of 4 to 8 lbs. per acre.

2 parts cube powder (4% rotenone) plus 8 parts barium fluosilicate applied at the rate of 4 to 8 lbs. per acre.

Dust containing 1% rotenone applied at the rate of 12 lbs. per acre.

1 part cube powder (1% rotenone) plus 1 part barium fluosilicate applied at the rate of 15 lbs. per acre.
Proprietary dust containing 0.55% rotenone applied at the rate of 12 lbs. per acre.

Proprietary dust containing 0.83% rotenone applied at the rate of 8 lbs. per acre.

All these treatments, and also cryolite gave a distinct improvement over the untreated check. The mixture of cube root powder and tobacco dust showed the highest number of dead beetles and the next to the least total leaf injury. The mixture of barium fluosilicate and cube root powder was somewhat more effective if judged by the number of live beetles and the total leaf injury. This superiority is not believed to be sufficient to justify the increased cost of the mixture, since each material was used at nearly the same strength as when used alone.

Cube as a spray was also tested against the tobacco thrips, Frankliniella fusca Hinds. The cube powder (4% rotenone) was tried at 6 lbs. and also at 12 lbs. per 100 gals. plus sulfonated phenylphenol at 1:400 as a spreader. None of the materials (nicotine, pyrethrum, and lauryl thiocyanate were included) proved satisfactory.

Several growers have stated that they were of the opinion that the dusting with proprietary cube root powders, when the plants were wet with dew, had a controlling effect on the thrips population. They described the thrips infestation as potentially the worst in several years, but actual damage as being smaller than it has been at times in the past. The sprays were applied at the rate of .50 gallons per acre, equalling a dust of three to six pounds per acre. Since the dust is applied at the rate of eight pounds per acre, a heavy dew might form a toxic mixture, as in the case with the flea beetle. This heavier dosage is said to have been reported from Australia as effective and will be tested next season.

The South Carolina Agricultural Experiment Station (387) in its 1936 annual report stated that, upon the basis of recent experimental work, rotenone may be recommended for the control of the Mexican bean beetle. Slightly superior results have been secured when this product was used as a spray, but it may also be used as a dust when the proper diluent is used.

The following formulae have given best results:

Formulae for Liquid Spray Mixture

	Large quantities	Small quantities
No. 1 Powdered air-floated derris or cube root containing 5 percent rotenone.	1-3/4 pounds	1-3/4 ounces
Water	50 gallons	3 gallons
No. 2 Powdered air-floated derris or cube root containing 4 percent rotenone.	2-1/4 pounds	2-1/4 ounces
Water	50 gallons	3 gallons

Smaller portions of rotenone than the above may be used with good results, but the residual effect will not be as great. To obtain good protection the insecticide would have to be applied more frequently. One hundred to 150 gallons should be applied per acre at each spraying.

Formulae for Dust Mixtures

	To make 0.75% dust	To make 0.50% dust
No. 1 Powdered air-floated derris or cube root containing 5 percent rotenone.	15 pounds	10 pounds
Talc or inert clay	85 pounds	90 pounds

Formulae for Dust Mixtures (cont'd)

	To make 0.75% dust	To make 0.50% dust
No. 2 Powdered air-floated derris or cube root containing 4 percent rotenone.	18-3/4 pounds	12-1/2 pounds
Talc or inert clay	81-1/4 pounds	87-1/2 pounds

The rotenone content of the finished dust should not be less than 0.50 percent, and it is believed that the use of the 0.75 percent dust may be justified in view of the better protection afforded. Twenty to 25 pounds of the finished dust should be applied per acre at each dusting.

Many of the proprietary rotenone insecticides now on the market will give good results if used according to the instructions of the manufacturer.

Nine different combinations of insecticides were used in triplicate on seedling cotton as a control for thrips. Only one application of the materials was made. The following table shows the percentage of reduction in thrips population in each case. When the plants were practically mature in size, a count was made of injured stalks to determine any difference in protection given by the various materials used. The stalks considered as injured were those having two central stems instead of one.

The results of this count is also shown in the table. The stalks were counted on one row out of each of the six-row plots.

Tests of Insecticides for Control of Thrips,
Pee Dee Experiment Station

Application of May 13	Percent Reduction of thrips	Stalks injured	Stalks uninjured	Percent injured
Rotenone 15%*				
Sulfur 42.5%				
Tobacco dust 42.5%	65.56	147	144	50.52
Cheek	47.62	156	124	55.71
Paris green 10%				
Sulfur 90%	100.00	116	178	39.46

* This probably means 15 percent of a material containing 4 or 5 percent of rotenone.

At the Pee Dee Experiment Station tests against tobacco flea beetle were made with derris dust (1% rotenone) and cube dusts (0.5 and 1.0% rotenone). The difference in the percentage of reduction of living beetles with the rotenone and the non-rotenone dusts at the end of 72 hours was not sufficiently great to warrant the selection of any of the materials as outstanding. However, when the number of dead beetles is considered the derris and cube of 1 percent rotenone content yielded greater plant protection than the other materials. There was no significant difference between these two insecticides, although there was a tendency for the cube of 1 percent rotenone content to lose its effectiveness faster than the derris.

The Secretary of the United States Department of Agriculture (413) in his 1936 annual report wrote as follows:

"Laboratory and field tests with organic insecticides, particularly derris and cube, have brought many modifications in the recommendations for the control of certain insect pests. It has been demonstrated that these insecticides which do not leave residues objectionable from the standpoint of human health can be effectively used against a number of different truck-crop pests, such as certain cabbage worms and the Mexican bean beetle, and that they are effective against flea beetles destructive to growing tobacco. The further usefulness of these recently developed materials is evidenced by the determination that one application of sprays or dusts of derris or cube is effective against the pea aphid over a longer period than other recommended materials such as pyrethrum and nicotine."

In discussing insecticides suitable for combating the Colorado potato beetle at the Conference Internationale pour l'Etude de la Lutte en Commun contre le Doryphore held in Brussels January 22 and 23, 1936, under the auspices of the Belgian Department of Agriculture (26), Feytaud stated that powders containing 5 percent of cube or derris were in use for this purpose.

The Handelsmuseum of the Koloniaal Instituut of Amsterdam (249) in 1936 reported that comparative tests on derris and cube demonstrate that derris is more toxic than cube having the same rotenone content.

The Wisconsin Agricultural Experimental Station (472) in its annual report for 1935-1936 reported that derris-talc dust containing 0.48 percent of rotenone controlled the striped cucumber beetle. Alkaline diluents (e.g., hydrated lime, pH 12.5) reduce the effectiveness of derris and timbo for cabbage worms, but the more acid samples retain their effectiveness in storage.

Walker and Anderson (452) in 1936 reported experiments for the control of cabbage worms which were made in 1932-1936 inclusive. The authors conclude that repeated applications of derris and cube dusts containing from 0.5 to 0.75 percent rotenone and from two to three percent total extractives, and pyrethrum dusts containing from 0.3 to 0.5 percent pyrethrins have given good

control of these cabbage worms, while dusts of weaker concentrations of rotenone and pyrethrins were less effective. Derris and cube dusts having approximately the same rotenone and total ether extractive content appeared to be about equally effective for the control of these pests.

Van Gundia (447) in 1936 reported that control of the Japanese beetle with applications of rotenone dust, made from either cube or derris, was unsatisfactory. "We are not particularly interested in killing them by contact where the foliage is sacrificed, but we are interested in keeping them away from those treated plants. We are quite confident that something can be worked out to accomplish this."

LePelley and Sullivan (260) in 1936 reported a study of the toxicity of rotenone and pyrethrins, alone and in combination, to houseflies, when tested by the turntable method. A sample of foliage of Tephrosia vogelii was about one-fifth as effective as commercial samples of derris and cube.

The New Jersey Agricultural Experiment Station (303) in its 1936 annual report (published in 1937) reported that the discovery that insect toxication by cube is apparently identical with insect toxication by derris, provided the component toxic qualities are the same, is a matter of great importance because the price of derris has been skyrocketing, while the price of cube has remained much more stable.

The New York Agricultural Experiment Station at Cornell University (307) in its 1936 annual report (published in 1937) reported that rotenone added to naphthaleno-talc dust slightly increased the effectiveness of this treated against onion thrips. Rotenone dust used undiluted was not satisfactory as a control for onion thrips. Ground derris root and cube root as sources of rotenone in sprays controlled the immature stages, but they were not so effective against the adults. There were no noticeable differences in the effectiveness of these two sources of rotenone.

Against the hairy chinch bugs attacking lawns, nicotine sulfate, both as a spray and as a dust, has proved effective. Rotenone and tobacco dust also have given effective control in experimental work.

Lettuce yellows caused considerable losses to lettuce growers on Staten Island in 1935. Tests proved that the method of control by barriers afforded some reduction in the disease. Dusts containing sulfur, pyrethrum, and rotenone reduced the amount of yellows in experimental plots, through the control of leaf-hoppers which spread the disease.

Growers were supplied with full and timely information regarding the use of rotenone and pyrethrum insecticides to avoid objectionable residue on such crops as string beans, cauliflower, and market cabbage.

The Colorado Agricultural Experiment Station (88) in its 1936-1937 annual report reported that rotenone was found superior to pyrethrins in controlling the imported cabbage worm; 2.84 pounds of rotenone dust per acre gave a significant kill. The tests of the season failed to give a satisfactory control of cabbage loopers. The diamondback moth larvae rank about midway between the imported cabbage worm and the cabbage looper in resistance to pyrethrins and rotenone.

Nonpoisonous dusts were also used on the Mexican bean beetle and the cherry slug. A dust containing 0.75 percent rotenone used on the bean beetle failed to give satisfactory control. A spray of rotenone, 2 pounds of derris containing 4 percent of rotenone to 50 gallons of water, gave control equal to that effected by arsenite of zinc and arsenate of magnesium or phenothiazine, 2 pounds to 50 gallons of water, under heavy infestation. On the cherry slug, rotenone sprays, with 2 pounds of either derris or cube powder containing 3 percent rotenone to 50 gallons of water, gave controls equal to those effected by arsenate of lead.

The Texas Agricultural Experiment Station (403) in its 1936 annual report (published in 1937) reported on remedial measures for the pink bollworm. Seasonal infestation counts indicated that barium fluosilicate and cube-sulphur used separately as dusts or sprays reduced the worm population. This was more apparent on the plats dusted with barium fluosilicate. Further investigations are necessary to determine the merits of insecticides for pink bollworm control.

Results in two series of experiments indicated that there was very little difference between sulphur and fuller's earth when mixed with cube for the control of the cabbage looper.

The Idaho Agricultural Experiment Station (211) in 1937 reported that a kill of 94.31 percent of the grape leafhopper was obtained with one spray containing 0.49 percent nicotine sulphate and 0.63 percent summer oil. Better and more lasting results were obtained with this combination than with derris or cube powder in either dust or liquid form or with pyrethrum spray. Derris as a spray was more effective than as a dust.

Huckett (206) in 1937 recommended derris or cube for the control of the asparagus beetle, Crioceris asparagi L., and the spotted asparagus beetle, Crioceris duodecimpunctata L. In beds injury may be prevented by spraying or dusting the tips thoroly with derris mixtures during the cutting season to kill beetles and slugs. As a spray use 5 pounds of derris and 4 pounds of skim milk or Kayso to 100 gallons of water. As a dust use 15 pounds of derris to 85 pounds of clay or talc. Use powdered derris root of 4 to 5 percent rotenone content and 15 to 18 percent total extractive content; or, if derris is not available, substitute powdered cube or timbo root of comparable analysis.

Kearns and Umpleby (237), of the Long Ashton Research Station, England, in 1937 reported that grafts can be effectively protected from weevil injury by liberally painting them with a mixture consisting of 1 pound of derris or barbasco ground root containing not less than 1.5 percent rotenone, plus 2 pounds of lead arsenate powder (or 4 pounds paste or 2 quarts colloidal), plus 4 ounces of size. The derris and arsenate should be mixed with water to a consistency of thick cream and to this mixture the size added (previously soaked in 1 pint warm water). The grafts should be painted just prior to bud burst, and in some seasons a second application may be necessary, as the leaf weevils feed over a long period. These weevils are the clay-colored weevil, Otiorrhynchus singularis,

and the leaf-eating weevils Phyllobius pyri and P. oblongus.

Kearns and Marsh (235) in 1937 recommended derris or derris extract as a spray for the control of the plum sawfly. The wash should contain not less than 0.004 percent crystalline rotenone. The trees should be sprayed about May 10-20 and again 7 days later. Barbasco or any other rotenone-containing material may be used as a substitute for derris provided it is suitable for use with a white oil emulsion.

For the control of the pear slugworm or sawfly it is stated the second brood is best controlled by the application in mid-July of a wash containing 6 ounces of nicotine and 1/2 pound of wetter to 100 gallons of water, or 1-1/2 pounds of derris or barbasco root (containing not less than 1.5 percent rotenone) may be substituted for the nicotine.

Suitable wetters are Agral 2, Lethalate Wetting Preparation, and Sulphonated Lorol.

The Agricultural and Horticultural Research Station of the University of Bristol, England (47), at Long Ashton in 1937 reported that investigations were continued on the chemical and biological evaluation of rotenone-containing materials. The work included experiments with the ground root and extracts of Derris and Lonchocarpus spp.

Kearns, Marsh, and Martin (236) in 1937 reported tests made in England with combined washes to test the efficacy of spreaders. Tests were made with derris, derris extract, and barbasco (5.6% rotenone and 17% ether extractives).

Rotenone-containing insecticides are shown to be suitable for use in field trials for the comparison of the relative efficiencies of spray supplements as penetrants. The synthetic spreaders Agral 2 and sulphonated lorol used with rotenone-containing insecticides for the control of apple sawfly (Hoplocampa testudinia) have been proved more effective at 0.05 percent than sulphite lye at 0.75 percent, gamma-sulphonates at 0.05 percent being intermediate in efficiency. The most effective spray supplement examined was a refined (grade G) petroleum oil emulsified with sulphite lye, the superior efficiency of which as a penetrant may have been associated with solubility factors. The grade G petroleum oil proved more effective than a water-soluble spreader as a supplement for rotenone-containing sprays applied for the control of the plum sawfly, Hoplocampa flava.

In field tests against the tobacco flea beetle, Epitrix parvula, F. on shade-grown tobacco in Florida, Chamberlin (69) found cube dusts containing 1 or 1.5 percent rotenone more effective than a cube dust containing 0.5 percent rotenone.

White (464), in a revision of E-376 issued March 1937, gave essentially the same information as far as cube is concerned as in the previous edition.

Dudley, Bronson and Carroll (120) in 1937 reported no difference in the value of derris and cube sprays for the control of the pea aphid.

A spray containing not less than 0.005 percent rotenone applied at the rate of 144 gals. per acre increased the yield of peas about 100 percent. A cube-talc dust gave good results when applied at the average rate of 46 lbs. per acre.

Brannon (43) in 1937 summarized the results of insecticide tests performed against the Mexican bean beetle in 1936 on Fordhook lima beans, at the Norfolk, Va., laboratory. The best control was obtained with dust mixtures of derris-sulphur and cube-sulphur, each containing 0.5 percent rotenone. Derris-wettable sulphur and cube-wettable sulphur sprays (each containing 0.01 percent rotenone) also gave good control of the insect. The percentage of control with the dust mixtures was slightly superior to that obtained with the sprays.

Brannon (44) in 1937 reported that the sweetpotato leaf beetle, Typophorus viridicyaneus Crotch, has developed into a pest of distinct importance in northeastern North Carolina. Results of cage toxicity experiments demonstrated that undiluted calcium arsenate was more toxic to the insect than was a derris or cube dust mixture containing 0.5 percent rotenone or a water suspension of ground derris root containing 0.02 percent rotenone.

The Illinois Agricultural Experiment Station (212) in 1937 issued directions for spraying fruits in Illinois. The currant worm on currants and gooseberries may be controlled by spraying with 8 pounds ground derris or cube (containing 0.75 percent rotenone) in 100 gallons of water. Spraying should be done before the worms appear, just after the plants come into full foliage.

Danzel (111) in 1937 stated that derris has a greater activity than cube or other rotenone-bearing plants, but no experimental figures are presented.

Spoon (390) et al. of the Koloniaal Instituut of Amsterdam in 1937 compared the relative insecticidal value of dusts made from derris and cube. Eight sets of powders were prepared, each set consisting of one powder prepared with Derris, the other with Lonchocarpus, both powders containing equally high amounts of rotenone and ether extract. These powders were mixed with diatomaceous earth in order to obtain dusts with definite amounts of rotenone (0.5, 0.75 and 1 percent), according to the sensitivity of the various insects.

The dusts containing 0.5 percent rotenone were tested on larvae of Lophyrus pini L. and on Myrmica ruba L.; those with 0.75 percent rotenone on caterpillars of Euproctis chrysorrhoea L. (Nygmia phaeorrhoea Donovan) and on M. rubra L.; those with 1 percent rotenone on M. rubra L. only.

The results, shown in diagrams, are based on the observation of 120 specimens at least. The heights of the columns show the percentages of dead insects after 24 hours. In 7 of the 8 sets the effect of Derris is stronger than that of Lonchocarpus. The effect of Derris dust on caterpillars of Euproctis chrysorrhoea (Nygmia phaeorrhoea) and on larvae

of Lophyrus pini is about 1 1/2 times stronger than the effect of Lonchocarpus dust; and on Myrmica rubra the effect of Derris is twice as strong as that of Lonchocarpus.

Howard and Mason (201) in 1937 summarized information on derris and cube taken largely from United States Department of Agriculture Farmers' Bulletin 1624, revised.

"While much is yet to be learned concerning the relative value of the numerous toxic ingredients present in derris and cube roots as they come from the factory, we are especially fortunate that we are able to dilute these materials on the basis of their rotenone content with very satisfactory results. For this reason, we speak of rotenone-bearing materials in the terms of rotenone content."

It has been found by growers in New Jersey that the use of hoods behind power or traction dusters allows a considerable saving in the amount of dust applied for the control of the Mexican bean beetle. When hoods were used in dusting on the experimental plots of Howard and Mason, one-half the dosage gave as satisfactory results as could be obtained with a full dosage without the hoods. These hoods may be constructed of light framework, such as barrel hoops and bamboo poles, and may be covered with a cheap grade of muslin and attached behind the duster. They are, of course, not practicable for use on the hand machines.

Methods of making derris sprays and dusts and their use against the Mexican bean beetle, pea aphid, cabbage worms (3 species) harlequin cabbage bug, cucumber beetles, flea beetles on young tomato plants and young egg-plants are described. Derris or cube is ineffective against the celery leaf tier. For most purposes a dust containing 0.75 percent rotenone is considered of greatest value. It is possible that it may be necessary to use a 1 percent dust in the control of the pea aphid and the pea weevil.

Boyd (39) in 1937 discussed rotenone (from derris or cube) for the control of household insects. Reference is made to the use of rotenone in fly sprays and in bedbug sprays, for the control of clothes moths, as a remedy for follicular mange, in sprays for ants and roaches, and as a poison in baits for ants. Mixtures of rotenone with pyrethrum or thiocyanates are mentioned.

The New York Agricultural Experiment Station (305) in 1937 reported that powdered derris or cube root proved to be the most successful insecticide for use against the gooseberry fruitworm, Zophodia grossulariae (Riley), in 1935 tests. These materials may be applied either as sprays or dusts. When dusting, a mixture of cube or derris root with some inert carrier such as talc to give a 0.5 percent rotenone content, is suggested. For the spray, 3 pounds of the undiluted root in 100 gallons of water may be used. Two treatments are advised for heavy infestations. The first should be timed to coincide with the petal fall spray on apples, the second 10 to 14 days later. A single treatment applied halfway between the two should handle a light to moderate infestation.

The imported currant worm, Esteronidea ribesii Scopoli, is also readily controlled with rotenone sprays and dusts. As infestations of this insect in a given planting are often localized, "spot" spraying or dusting may be practiced to advantage.

All of the pests of currant for which arsenicals have previously been used may now be controlled by rotenone sprays or dusts on the use of which there are no legal restrictions.

Field tests of powdered derris, cube, and timbo root of comparable analytical quality showed that such powders were about equal in effectiveness when used for the control of the imported cabbage worm. With this insect, dusts of 0.5 percent rotenone content gave optimum results, and those of 0.33 percent rotenone content gave results that were commendably satisfactory considering costs. Spray mixtures containing 4 pounds of good grade powdered root in 100 gallons of water with a sticker gave fair results, the degree of control effected not being equal to that attained by the use of dusts. Infestations of thrips and aphids in the cauliflower seed-bed during July were effectively controlled by treatment with rotenone-containing dusts of 0.5 and 0.33 percent rotenone content, the applications being made late in the evening under calm conditions in anticipation of a more or less extended period of high relative humidity during the night.

Comparative tests were made of derris, cube, and timbo powder having about the same content in active ingredients in spray and dust mixtures for the control of the Mexican bean beetle, Epilachna corrupta (varivestis) Muls. The results showed that all three powders when used at comparable strengths in terms of active ingredients were effective, a slight superiority favoring derris. Spray mixtures containing 2 to 3 pounds of good grade powdered root in 100 gallons of water with sticker gave satisfactory results. Sprays during the current season were more beneficial to plant growth than dusts. Of the dust mixtures tested those of 0.5 and 0.75 percent rotenone content gave the best results. It is interesting to note that the yield of snap beans from plants effectively sprayed or dusted did not invariably result in marked increases in yield of pods. From such evidence it seemed highly probable that to formulate a rational method of control for the Mexican bean beetle emphasis should be placed more on the making of a few opportune number of applications and less on the necessity for the fulfilment of a definite series of applications according to schedule.

Beard (24) in 1937 reported tests of insecticides against the striped cucumber beetle in Connecticut. Potted squash plants were used for food material, and were covered by copper wire screen cages. Beetles were introduced into the cages, and the insecticides were applied through the wire screen. Five insecticides were tried, as follows:

Derris dust: containing 0.6 percent rotenone (derris root diluted with clay).

Derris spray: ground derris root used at a dilution of 1:200 with SS-3 spreader at a dilution of 1:1600.

Rotenone spray: a commercial product of cube root, containing 2.5 percent rotenone, used at a dilution of 1:200.

Calcium arsenate: 1 part diluted with 9 parts of gypsum.

Pyrethrum dust: a concentrated pyrethrum dust containing 2 percent pyrethrins diluted with talc 1:9.

Beetles were also caged over untreated plants to serve as a check. Twenty-four hours after the insecticides were applied, counts were made to determine the killing powers of the dusts and sprays. The results obtained are as follows:

Treatment	Number of tests	Number of beetles	Number killed	Percent killed
Derris dust	4	70	70	100.0
Derris spray	3	47	46	97.9
Commercial rotenone spray (derived from cube)	3	58	39	67.2
Calcium arsenate	2	40	18	45.0
Pyrethrum dust	1	38	38	100.0
Check	4	87	1	1.1

Derris was also the most effective insecticide when beetles were introduced into the cages 5 days after spraying or dusting.

In a block of Hubbard squash, one-half of the plants were treated with derris dust and one-half with cube dust, also containing 0.6 percent rotenone. There was no perceptible difference between the two, as the killing action was immediate in both cases.

From these tests it may be concluded that derris dust, containing 0.6 percent rotenone, is the most effective treatment against the striped cucumber beetle and is to be preferred to the calcium arsenate, which heretofore has been the standard recommendation of this Station.

Batchelder et al. (22) in 1937 reported good control of the European corn borer, *Pyrausta nubilalis* Hbn., in Connecticut with derris spray, but derris dust was unsatisfactory. As a spray finely powdered derris (rotenone 4 percent) was used at the rate of 4 pounds per 100 gallons of water. In dust form 1 part derris to 8 parts of talc were used to obtain approximately 0.4 percent rotenone content.

Cube diluted with talc to a rotenone content of 0.8 percent and applied as a dust, was found to be less effective insecticidally than dual-fixed nicotine dust (4 percent nicotine), which gave the same reduction of borers as a derris dust containing 0.8 percent rotenone. In comparing the performance of dust preparations tested in 1936, however, the frequency and the extent of the rainfall occurring during the critical period of residue effectiveness should be considered carefully. It is believed that the effectiveness of all materials was greatly reduced by those rains and that inconsistent results are attributable to residue losses occasioned by them.

The Bureau of Entomology and Plant Quarantine (422) in 1937 recommended 1-1/2 pounds of finely ground derris or cube (rotenone, 4 percent) to 50 gallons of water as a spray, or a dust containing 0.5 percent rotenone for the control of the Mexican bean beetle, Epilachna varivestis Muls. Suitable diluents are talc, clay, sulphur, tobacco, gypsum, or other powders except lime. Spraying has given better results than dusting. The under side of the leaves should be thoroughly covered. The first application of insecticide (spray or dust) should be made when Mexican bean beetles are found in the field or when eggs become numerous on the under side of the leaves. Repeat every week or 10 days if the insects are numerous.

Walker and Anderson (453) in 1937 reported on the control of larvae of diamondback moth, Plutella maculipennis Curtis in Virginia.

Kale plants infested with newly hatched larvae of the diamondback moth were dusted on October 31 and November 10, 1936, at the rate of about 25 pounds per acre with derris-talc and cube-talc dusts containing 0.5 percent rotenone, both in combination with and without Aresket. The derris-talc, derris-Aresket-talc, and cube-talc dusts gave 82 percent control and the cube-Aresket-talc dust gave 87 percent control, indicating that there is very little difference between the effects of any of the dusts and that if applied when the larvae of the diamondback moth are young, either a derris-talc or a cube-talc dust containing approximately 0.5 percent rotenone and 2 percent total extractives will give satisfactory control of this insect.

The Ohio Agricultural Experiment Station (310) in 1937 reported tests made by R. B. Neiswander for the control of the strawberry leaf roller, Ancyliis comptana Froel.

The efficiency of various insecticides was measured by the number of injured strawberry leaflets in a 600-leaflet sample taken from each replicate or each plot.

Sixteen insecticidal treatments were tested against the first brood in southwestern Ohio and each was replicated five times.

Applications were made on May 11-12, May 21-22, and May 27. In the third application, however, only those materials were used which would leave no poisonous residue on the berries. Differences in the amount of injury that could be detected in the various plots on May 21 were slight, but these differences increased as the season advanced. On June 10, 600 leaflets from each of the more outstanding plots were examined for leaf roller injury.

The powdered cube root, although it contained the same amount of rotenone (4 percent) and was used in the same manner (diluted 1 to 7 with gypsum), was significantly less effective than powdered derris root (47.2 percent control for cube; 75.7 percent control for derris).

Knowlton and Sorenson (246) of the Utah Agricultural Experiment Station in 1937 reported that cube or derris sprays applied with properly adapted power spray equipment at a pressure of at least 300 pounds, has given good control of the pea aphid in several States. Gound cube root or derris powder with a 4 percent rotenone content should be used at the rate of 3 pounds to 100 gallons of water. Other strengths of dust should be diluted to a like strength. To be most effective, such a spray should be applied on a quiet, warm day, and before the pea aphid causes noticeable injury to the plants.

The Runderhorzel-Bestrijdings-Commissie (362) of Holland in 1937 recommended aqueous suspensions of derris root for the effective control of the cattle grub. Derris powder containing some *Lonchocarpus* powder is encountered in commercial derris products. Although *Lonchocarpus* powder contains rotenone, and frequently has as high a rotenone content as derris, it is, nevertheless, much less effective than derris. Experiments at the Koloniaal Instituut showed derris to be from 1.5 to 2 times as effective as *Lonchocarpus*, in a large number of comparative biological tests.

The Bureau of Entomology and Plant Quarantine (423) in its annual report for 1937 reported that sprays or dusts of cube or derris control the Mexican bean beetle at a minimum cost. Cube or derris dusts plus sodium oleyl sulphate are effective against pea aphids and leave no rotenone or other constituents in peas taken from treated plants. Cube and derris dusts gave negative results against the corn earworm on lima beans. Tobacco flea beetles, *Epitrix parvula* F. and *E. cucumeris* Harr., are controlled by cube or derris dusts containing sterilized tobacco dust as the diluent. Cube dust did not control thrips on cotton.

Wallace (454), Secretary of Agriculture of the United States of America, in the United States Department of Agriculture Yearbook of Agriculture, 1937. wrote as follows:

"Laboratory and field tests with organic insecticides, particularly derris and cube, have brought many modifications in the recommendations for the control of certain insect pests. I

has been demonstrated that these insecticides which do not leave residues objectionable from the standpoint of human health can be effectively used against a number of different truck-crop pests, such as certain cabbage worms and the Mexican bean beetle, and that they are effective against flea beetles destructive to growing tobacco. The further usefulness of these recently developed materials is evidenced by the determination that one application of sprays or dusts of derris or cube is effective against the pea aphid over a longer period than other recommended materials such as pyrethrum and nicotine."

Wille, Ocampo, Weberbauer, and Schofield (471), of the Agricultural Experiment Station at Lima, Peru, published a complete review of information on cube in 1937. Insects against which cube has proved effective are listed in their families and also those against which it is ineffective. In tests against the chief pests of cotton in Peru, sprays of cube extract containing 0.05 or 0.01 percent rotenone proved as effective against Aphis gossypii Glov. as 0.5 percent nicotine sulphate. Dusts of ground cube root of 5 and 1 percent rotenone content gave 50 and 15 percent mortality, respectively, of adults of Anthonomus vestitus Boh., in the laboratory. Sprays of cube extract of up to 0.05 percent rotenone content had no effect on larvae of Anomis luridula Gn. (texana Riley) and Alabama argillacea Hbn., but in another series of tests, a spray of 0.01 percent rotenone content gave 75 percent mortality after 8 days, and surviving larvae were unable to moult normally. A suspension of cube dust in water to give a spray containing 0.3 percent rotenone killed 73 percent of the larvae in 5 days, but was not effective in the field, probably owing to imperfect wetting.

In laboratory tests against 20 adults of Dysdercus ruficollis L., a cube dust containing 5 percent rotenone killed 4 and paralyzed the others in 24 hours, and after 4 days, 19 were dead. Dusts of lower rotenone content also gave good results, one of 0.01 percent giving 80 percent mortality in 5 days. One unfavourable result of this slow rate of toxicity was that females were able to oviposit normally and their eggs hatched. Sprays of 0.1 percent rotenone content in three tests gave 52, 80 and 100 percent mortality, respectively.

It is concluded that in Peru cube root and its products cannot replace the customary insecticides against plant pests. On the other hand, highly satisfactory results were obtained against parasites of domestic animals.

Part of this publication deals with the use of cube in dips against Melophagus ovinus L. and Sarcoptes sp. on sheep, Haematopinus eurysternus Nitzsch on cattle, H. suis L. on pigs, and a species of Psoroptes on alpaca in Peru. In 1935 more than 300,000 sheep were treated with cube dip in the Junin region, and 150,000 in that of Puno. The dips were obtained either from an extract prepared by soaking the chopped roots in water for 48 hours, or from a powder finely ground so that 85 percent passed a sieve of 0.074 mm. mesh. Their practical application was studied in 1936 by J. F. Mitchell, who stated that the powder yielded a dip that

was more saponaceous, and therefore penetrated better, than that from the extract. Dips made with the powder did not keep for more than 48 hours, a disadvantage owing to the number of animals to be treated, whereas those made with the extract kept for up to a week. The addition of 1/2 pound of soap per 100 U. S. gallons was recommended and also that of 1/2 pound of sodium carbonate to counteract the hardness of the water. For complete control of the parasites, cattle usually required two dips, with about a fortnight's interval, twice a year, and sheep the same, except when seriously infested, in which case a third pair of dips was necessary.

The effective concentrations of ground root containing 6.8 percent of rotenone, and of extract containing 5.5 percent of rotenone were, respectively, 1:2000 and 1:10,000 for M. ovinus, 1:3000 and 1:15,000 for H. eurysternus, 1:2000 and 1:8000 for H. suis, and 1:1000 and 1:6000 for Sarcoptes sp. and Psoroptes sp. The ground root and the extract were equally effective, and were in no way inferior to other dips.

In preliminary tests, cube root containing 5 percent of rotenone had no effect on the larvae of Anopheles pseudopunctipennis Theo., after 15 hours, when used at a concentration at which it killed fish in 30 minutes.

Smith and Scales (383) in 1937 reported the results of insecticide tests against three cotton insects.

Tests were planned to compare derris, cube, and devil's shoestring containing equal amounts of rotenone in mixtures with sulfur. The mixtures were prepared, however, before the analyses were received, and the rotenone contents of the mixtures are only approximately equal.

Cube containing 4.9 percent of rotenone produced a higher mortality of boll weevils than derris containing 3.9 percent of rotenone, Devil's shoestring (1.7 percent of rotenone), or calcium arsenate. The mortality from calcium arsenate, however, was higher than that from derris, devil's shoestring or mixtures of cube, derris, and devil's shoestring with sulfur. Calcium arsenate caused a higher mortality of leaf worms than did either derris, cube, or devil's shoestring, used alone or in mixtures with sulfur.

Results were as follows:

Cage toxicity tests against the boll weevil and the leaf worm with derris, cube, and devil's shoestring.

Materials and proportions (and percentage of rotenone)	Percent mortality		Percent control	
	Boll weevil	Leaf worm	Boll weevil	Leaf worm
Derris-sulfur 40:60 (rotenone 1.56)	49	64	40	62
Derris-sulfur 20:80 (rotenone .78)	39	56	27	54
Derris-sulfur 10:90 (rotenone .39)	28	41	14	39
Cube-sulfur 40:60 (rotenone 1.96)	53	73	45	72
Cube-sulfur 20:80 (rotenone .98)	39	60	28	58
Cube-sulfur 10:90 (rotenone .49)	21	33	6	31
Devil's shoestring-sulfur 94:6 (rotenone 1.6)	37	39	25	37
Devil's shoestring-sulfur 47:53 (rotenone .8)	38	40	26	38
Devil's shoestring-sulfur 23.5:76.5 (rotenone .4)	31	41	18	39
Derris (rotenone 3.9, total extractives 11.6)	72	78	67	77
Cube (rotenone 4.9, total extractives 17)	83	77	80	76
Devil's shoestring (rotenone 1.7, total extractives 7.5)	37	46	26	44
Calcium arsenate No. 2	77	89	73	89
Checks	16	3		

Cube with pyrethrum and sulfur was tried against these insects and also Lygus pratensis with the following results:

Cage toxicity tests against the boll weevil, the leaf worm, and Lygus pratensis with pyrethrum and pyrethrum mixtures

Materials and proportions	Percent mortality				Percent control			
	Boll weevil	Leaf worm	<u>Lygus pratensis</u>		Boll weevil	Leaf worm	<u>Lygus pratensis</u>	
			Nymphs	Adults			Nymphs	Adults
Pyrethrum-cube-sulfur 10:10:80	34	65	79	52	9	63	71	21
Pyrethrum-sulfur 40:60	36	74	74	78	12	73	63	63
Pyrethrum (.76% total pyrethrins)	37	92	90	88	14	92	86	80
Sulfur			70	41			58	3
Checks	27	5	29	40				

Walker (451) in 1937 recorded tests with a sodium salt of water-soluble petroleum oil sulfonates designated as Ultrawet which possesses desirable qualities as a wetting and spreading agent for spray materials. Ultrawet at 1:1600 in water did not damage the foliage of many economic plants. Ultrawet is compatible with the insecticides and fungicides in common use.

The addition of Ultrawet to cube dust resulted in increased control of the potato flea beetle. The addition of Ultrawet to cube in sprays gave promising results in controlling onion thrips. The use of Ultrawet with cube root in sprays to control the European corn borer gave slightly increased protection.

Ultrawet added to sprays and dusts to control the Mexican bean beetle, striped cucumber beetle, imported cabbage worm, and cabbage looper did not provide increased protection.

One-half pound of Ultrawet added to 3 pounds of cube (4% rotenone and 14% total extractives) in 100 gallons water increased the control of the pea aphid from 93.5 to 98.7 percent and 1 pound of Ultrawet plus 3 pounds of cube gave a control of 98.8 percent. Ultrawet was added to derris-clay dust (0.75% rotenone) and also cube spray (3 lbs. per 100 gals.) and in both cases its addition enhanced the control of the potato flea beetle.

Bordeaux (4-4-50) plus 4 pounds of cube per 100 gallons was increased in effectiveness in the control of European corn borer in potatoes by the addition of Ultrawet 1:1600.

In tests against onion thrips, 4 pounds of cube per 100 gallons plus pounds of a mixture of sulfur and Ultrawet (16 to 1) gave a control of 56.4 percent as compared with 31.4 percent for the same mixture without cube.

Tests with miscellaneous truck crop pests.--Cube dusts (0.75 percent rotenone) and sprays (3 pounds per 100 gallons) were used to control the Mexican bean beetle, Epilachna varivestris Muls., the striped cucumber beetle, Diabrotica vittata Fab., the imported cabbage worm, Pieris rapae L. and the cabbage looper, Autographa brassicae Riley, both with and without Ultrawet. In most cases the addition of Ultrawet did not result in increased protection of the plants from these pests. The sprays and dusts without Ultrawet usually provided control.

Bromley (51) in 1937 reported that sprays of rotenone and other toxic extracts from derris and cube, if used at sufficient strength and with satisfactory wetting agents, will kill certain unprotected insects, but their use in shade tree spraying is to date rather limited. These materials possess little value as stomach poisons. The derris or cube rosin-residue emulsion is a promising repellent for the Japanese beetle. Various insecticides, including derris and cube, are known to have repellent qualities against certain insects, but their use for this purpose has not been developed to any extent for shade trees as yet.

Bourne and Boyd (36) in 1937 gave directions for the control of common insect pests in the home garden. Derris or cube dusts should contain 0.5 to 0.75 percent rotenone. For plant lice pyrethrum and rotenone sprays are also effective. For the control of the asparagus beetle, during the cutting season, leave occasional shoots uncut to attract the beetles for feeding and egg laying, and keep the rest of the bed closely cut; or apply non-poisonous pyrethrum or rotenone sprays or dusts. For the control of the Mexican bean beetle, after pods have formed, spray or dust pyrethrum or rotenone compounds as recommended for each brand. For cabbage worms, when caterpillars first appear, apply a fresh pyrethrum dust mixture containing at least 30 percent pyrethrum or a rotenone mixture containing 0.5 to 0.75 percent rotenone, using about 30 pounds to the acre. Commercial pyrethrum or rotenone sprays or dusts may also be used. They should be diluted as recommended by the manufacturer. In cases of light or "spotty" infestations only the infested plants need to be treated. Usually it is advisable to treat the entire planting. For the striped cucumber beetle, when beetles first appear, dust plants with a rotenone mixture containing at least 0.5 percent rotenone.

The Massachusetts Agricultural Experiment Station (272) in 1937 reported that for the control of the squash vine borer the most effective insecticidal treatment was a spray prepared from cube powder at the rate of 5 pounds in 100 gallons of water, which was made wettable with fish-oil soap at the rate of 1 quart in 100 gallons of spray. This reduced the injury 74 percent.

The United States Department of Commerce (439) in October 1937 reported that the government of the Union of South Africa is conducting researches to discover a cheap, efficient locust killer less poisonous than sodium arsenite. Some preliminary investigations undertaken with powders containing rotenone and with liquid sprays have not yielded very favorable results, but further investigations will be made, especially with powders containing rotenone from derris and cube for use in baits.

Bronson (53) in 1937 described an improved apparatus for mixing derris or cube powder with a diluent and a conditioner.

A dust containing 1 percent of rotenone for use against the pea aphid is made by mixing derris or cube root powder (containing 4 percent of rotenone), 15 pounds; talc (or other suitable diluent), 43.2 pounds; conditioner (wetter and spreading agent), 0.6 pound; water, 1.2 pounds. Satisfactory conditioners are sodium oleyl sulphate and an alkylphenyl-benzenesulphonic acid.

The derris or cube root powder should be of such a degree of fineness that not less than 90 percent of it will pass through a sieve having 200 meshes per linear inch and all of the material (100 percent) should pass through a sieve having 80 meshes per linear inch. The talc or other suitable diluent used should be of such a degree of fineness that all of the material will pass through a sieve having 300 meshes per linear inch.

The derris or cube root powder and the diluent are first poured together into the mixer. Approximately 10 to 12 quarts of rounded stones, 1 to 1-1/2 inches in diameter, are then placed in the mixer to aid in the mixing process. The cover of the hopper is clamped on, the mixer is placed in operation, and the material is mixed for 5 minutes. After this preliminary mixing, the mixture of the conditioner and water is atomized into the mixture of derris or cube root powder and talc inside the mixer (while the latter continues to roll) through the hole cut for this purpose in the center of the cover. The nozzle of the atomizer is inserted in this hole and held steadily while the mixer, with its contents, continues to revolve. It requires usually about 3 minutes to atomize the proper quantity of the conditioner into a 60-pound batch of the dust mixture. As soon as this process is completed the hole in the center of the cover of the mixer is plugged, and the mixing is continued for a period of 25 minutes. At the expiration of this period the mixer is thrown over to the emptying position and the dust mixture is dumped onto a large-mesh screen which separates the finished material from the stones.

Although talc has been mentioned specifically as a suitable diluent for use in preparing a dust mixture for combating the pea aphid, it should be emphasized that there are other available non-alkaline materials, such as finely ground clay, diatomaceous earth, infusorial earth, tobacco dust, or sulphur, which may be used for this purpose. Hydrated lime, however, should not be used as a diluent for derris or cube or other rotenone-containing insecticides.

Brannon (45) in December, 1937, reported that recent experiments at the Norfolk, Va., laboratory, designed to determine the relative effectiveness of derris, derris-sulphur, cube, cube-sulphur, pyrethrum-sulphur, and sulphur alone, applied as dusts or as sprays for the control of the Mexican bean beetle in association with the green clover worm, Plathypena scabra Fab., infesting snap beans, showed that in general the dusts were more effective than sprays for the control of the latter insect on beans. The derris and cube dust mixtures contained 0.5 percent rotenone, the derris and cube sprays contained 0.015 percent rotenone, and the pyrethrum-sulphur dust mixture contained 0.1 percent total pyrethrins. Wettable sulphur was used as a spray at the rate of 2 pounds to 50 gallons of water. It was also noted that sulphur dust alone gave foliage protection against Plathypena scabra comparable with that obtained when sulphur was used in combination with derris, cube, or pyrethrum, and that a derris-sulphur dust mixture gave better protection than a derris-talc dust mixture. These results indicate that sulphur acts as a repellent against P. scabra and that in instances where this pest occurs in association with a Mexican bean beetle infestation, sulphur should be used as a diluent for derris or cube for the combined control of the two insects.

Weigel and Nelson (459) in December, 1937, reported that experiments performed against Tetranychus telarius L. and Thrips tabaci Lind. on greenhouse-grown tomato and cucumber plants, in which four sprays were applied at 4-day intervals, gave the following results: A derris spray having a rotenone content of 0.0056 percent was as effective as one with 0.0112 percent rotenone content; the derris sprays used were superior to

cube sprays of the same rotenone content, the difference being explainable on the basis of the total extractives content, which was 18.6 percent for the derris and 12.3 percent for the cube; the addition of pyrethrum extract aided in killing thrips but did not improve the effectiveness of the sprays against the red spider; with sprays of the same rotenone content, containing sulphonated castor oil as a spreader, the result was a better kill than when either alkylphenylbenzenesulfonic acid, or rosin residue, was used.

In a second series of experiments, using the same insecticides as in the first but applied for times at weekly intervals, approximately the same results were obtained, except that on tomatoes the spray containing derris, pyrethrum, and alkylphenylbenzenesulfonic acid appeared to be as effective as the sulphonated castor oil sprays. None of the sprays except lauryl thiocyanate caused any permanent injury to either tomato or cucumber.

Chamberlin (70) in 1938 reported that experiments and observations during the last several years have indicated that finely ground and sterilized tobacco dust is the most satisfactory diluent for cube or derris when applied to shade-grown tobacco in combating the tobacco flea beetle, Epitrix parvula Fab. The addition of clay to the customary cube- or derris-tobacco dust mixture used for combating the tobacco flea beetle apparently did not improve its dusting qualities when applied with rotary hand-operated dusters. It appeared that the use of a dust mixture containing 1 percent rotenone, with 75 percent tobacco dust and 25 percent finely ground Georgia clay as a diluent, on shade-grown tobacco under favorable weather conditions at the rate of 6 pounds per acre did not leave conspicuous residues on the cured tobacco leaves. Heavier applications of this dust mixture, however, did leave conspicuous deposits on the cured product. In general, these experiments demonstrated that the addition of finely ground clay to the derris- or cube-tobacco dust mixture did not result in any appreciable improvement in the finished dust mixture and may cause a permanent white residue to remain on the treated leaves.

Gressman (97) in 1938 reported tests of sprays applied to lemon trees heavily infested with California red scale.

One percent of a heavy petroleum oil was used in all treatments. One application consisted of oil alone. In a second treatment nicotine was added at the rate of 1 part of nicotine to 1800 parts of total spray liquid. In a third treatment an extract of timbo was used to give a rotenone concentration of 1 to 10,000. The ratio of total extract of timbo to rotenone was 4 to 1. The concentration of toxicants in the third spray was not determined.

Determinations of the relative efficiency of the different treatments were based on counts of the late gray and later stages. Population density was estimated from the number of scales counted per leaf and the average number of scales counted per square centimeter on quarters of lemons.

The treatments in which toxicants were used showed a considerably higher scale mortality than the application of oil alone. Mortality on the leaves sprayed with oil alone ranged from 92 percent when there were 5 scales per leaf to 21 percent when there were 55 scales per leaf with an average mortality of 71 percent. Mortalities in treatments with oil plus timbo extract were 91 and 89 percent respectively, with few indications of any effect of population density. On the fruit the ranges in mortalities as the average infestation of scales counted changed from 1 to 5 scales per square centimeter were as follows: oil alone, from 86 to 58 percent; oil-timbo extract, from 93 to 84 percent; oil-nicotine, from 98 to 89 percent. There is no evidence that the addition of the toxic agents caused any injury to the trees.

The extract of timbo was prepared by a Whittier, Calif., company dealing in this product. The ratio of rotenone to other timbo extractives was stated to be 1:4. A mixture of 30 percent trichlorethylene and 70 percent butyl phthalate was used as a solvent. The butyl phthalate was incorporated at Cressman's suggestion in order to provide a relatively nonvolatile solvent which would increase the solubility of the rotenone in the oil phase. A small amount of this mixture was used in all emulsions in order to make them identical in respect to the oil content.

Emulsions were made up with a high speed stirrer using ground glue as an emulsifier. All sprays contained 1 percent of oil. One treatment consisted of oil alone. For another treatment, an amount of timbo extract calculated to give a rotenone content of 1 part to 10,000 parts of dilute spray was added to the soil before emulsification. However, there was a discrepancy between the statements on the label and statements of the company representatives as to the rotenone content, so that final information as to the rotenone concentration applied cannot be furnished until a sample that has been forwarded is analyzed. In a third treatment, nicotine was added at the time of dilution of the emulsion in the spray tank to make 0.054 percent of nicotine. This was equivalent to 1 part of nicotine to about 1800 parts of dilute spray.

Turner and Walker (409) in 1938 reported the results of tests of insecticides for the control of the onion thrips, Thrips tabaci Lind., in Connecticut during 1933 to 1937. In 1933 an extracted rotenone spray (Insect-Nox) plus 0.5 percent (by dry weight) potash-coconut oil soap applied twice reduced the number of thrips but was slightly less effective than nicotine sulphate at 1:800.

In 1936 cube dust (0.75 percent rotenone) and cube-sulfur dust containing 73 percent sulfur were applied 3 times. There was no satisfactory control of thrips, and sulfur caused some injury to the onion tops.

In 1937, cube, cube + Ultrawet, cube + Aresket, and cube + sulfur + Ultrawet were tried. The writers conclude as follows:

"The combination of pure ground cube root with a suitable spreader apparently protected onion plants from thrips if spraying was begun before the plants were heavily

infested. In the one series applied after heavy infestation, the reduction in number of thrips was not as satisfactory as in the other tests. The addition of sulfur increased the mortality in hot weather, but apparently reduced it in cooler weather. Since these tests were conducted on irrigated fields, drought did not seriously affect the yield of onions, but the irrigation had no marked effect on the number of thrips.

"Since the productive parts of this work cover only one season, no final conclusions can be drawn as to the practical effectiveness of sprays containing pure ground cube root and a suitable spreader. However, the use of such sprays offers promise as a control for onion thrips."

"Addition of a spreader to cube increased its effectiveness, and with a suitable spreader cube was more effective than nicotine sulfate."

Roark (352) in 1938 reviewed the comparative action of derris and cube of equal rotenone content on many insects. The results are tabulated as follows:

<u>Insect</u>	<u>Comparative Action</u>	<u>Reference</u>
<u>Alabama argillaceae</u> Hbn., cotton leaf worm	Dusts: derris > cube	Smith, Clark and Scales
	derris - cube	Smith and Scales
<u>Ancylis comptana</u> Froel., strawberry leaf roller	derris > cube	Ohio Agr. Expt. Sta.
<u>Anthonomus eugenii</u> Cano, pepper weevils	cube > derris	Campbell
<u>Anthonomus grandis</u> Boh., boll weevil	derris > cube	Smith, Clark and Scales
	derris = cube	Smith and Scales
<u>Aphis rumicis</u> L.,	Dusts, water suspensions, and acetone extracts: derris > cube	Ginsburg and Granett
<u>Ascia rapae</u> L., cabbage worms	Dusts: derris > cube	Campbell
	derris = cube	List and Sweetman

<u>Insect</u>	<u>Comparative Action</u>	<u>Reference</u>
<u>Autographa brassicae</u> Riley	Dusts: derris > cube derris > cube	Campbell Walker and Anderson
<u>Byturus tomentosus</u> F., raspberry and loganberry beetle	Sprays: derris = cube	Steer
Cabbage worms	Dusts or sprays: derris = cube derris = cube Dusts: derris = cube Sprays: derris > cube	Howard Howard and Davidson Huckett and Hervey Huckett and Hervey
<u>Carpocapsa pomonella</u> L., codling moth	Kaolin mixtures: little effectiveness	Haegeler
<u>Chlorochroa sayi</u> Stal	Dusts: derris > cube	Cassidy and Barber
<u>Diabrotica vittata</u> F., striped cucumber beetle	derris = cube	Beard
<u>Dysdercus mimulus</u> Hussey	cube > derris	Cassidy and Barber
<u>Epilachna varivestis</u> Muls., Mexican bean beetle	derris > cube Sprays: derris = cube Dusts and sprays: derris > cube derris = cube	Howard Howard N. Y. Agr. Expt. Sta. S. C. Agr. Expt. Sta.
<u>Epitrix parvula</u> F., tobacco flea beetle	Dusts: cube = derris	Chamberlin
<u>Euproctis chrysorrhoea</u> L. (= <u>Nygmia phaeorrhoea</u> Donov.), caterpillars	derris > cube	Spoon et al.

<u>Insect</u>	<u>Comparative Action</u>	<u>Reference</u>
<u>Euschistus impictiventris</u> Stal	cube > derris	Cassidy and Barber
<u>Illinoia pisi</u> Kalt., pea aphid	Sprays: derris = cube	Dudley, Bronson, and Carroll
<u>Lophyrus pini</u> L., larvae	derris > cube	Spoon et al.
<u>Lygus hesperus</u> Knight	derris > cube	Cassidy and Barber
<u>Lygus apicalis</u> Fieb., adults	Dusts: derris > cube	Smith, Clark, and Scales
<u>Lygus apicalis</u> Fieb., nymphs	cube > derris	do.
<u>Lygus pratensis</u> L.	cube > derris	Smith and Scales
<u>Lygus</u> sp.	derris > cube	Cassidy and Barber
<u>Musca domestica</u> L., house fly	Kerosene extracts: derris > cube Extracts: derris > cube	Campbell, Sullivan, and Jones Jones and Smith
<u>Myrmica rubra</u> L., larvae	Dusts: derris > cube	Spoon et al.
<u>Pectinophora gossypiella</u> Saund., first-instar pink bollworms	cube > derris	Chapman and Cavitt
<u>Pieris rapae</u> L.	Dusts: derris = cube	N. Y. Agr. Expt. Sta.
<u>Plutella maculipennis</u> Curt., diamondback caterpillars	Dusts: cube = derris derris > cube cube = derris	Campbell Walker and Anderson (1931 do. (1937)
<u>Popillia japonica</u> Newm., Japanese beetle	Extractives: derris > cube	Fleming and Baker
<u>Pyrausta nubilalis</u> Hbn., European corn borer	Dusts: derris > cube	Batchelder et al.

<u>Insect</u>	<u>Comparative Action</u>	<u>Reference</u>
Shade tree insects	Sprays: derris > cube	Felt and Bromley
<u>Stictocephala festina</u> Say	Dusts: cube > derris	Cassidy and Barber
<u>Tetranychus telarius</u> L., common red spider	Sprays: derris = cube	Richardson
<u>Thrips tabaci</u> Lind.	derris > cube	Weigel and Nelson
<u>Thyanta custator</u> F.	Dusts: derris > cube	Cassidy and Barber
<u>Zophodia grossulariae</u> Riley, gooseberry fruitworm	Sprays: derris > cube Dusts: derris = cube	Hammer do.

Roark concludes that the apparent superiority of derris over cube may be due to its finer particle size and to a higher rotenone content than is shown by analysis.

From information now available, any insecticidal superiority of derris over cube is more than offset by the present difference in price, which is 11 or 12 cents per pound. One hundred and thirty-two pounds of powdered cube can be purchased for the price of 100 pounds of powdered derris of the same (5 percent) rotenone content. Moreover, the principal agricultural insect pests against which rotenone is used, such as the Mexican bean beetle, the pea aphid, and three species of cabbage worms, are as readily controlled by cube as by derris of equal rotenone content. At present prices more economical control of those insects susceptible to rotenone can be secured with cube than with derris.

The New York Agricultural Experiment Station (306) in its 1937 annual report (published in 1938) reported that insecticides tested under orchard conditions against the apple maggot (Rhagoletis pomonella Walsh) in 1936 included phenothiazine, powdered cube root, and hydrated lime. Six small orchards were treated, all the trees in each block receiving a single test material as is customary in such experiments. Little or no control was obtained where hydrated lime alone was used, but the results were sufficiently promising with cube root and phenothiazine to warrant additional testing.

In tests conducted on the control of the gooseberry fruit worm (Zophodia grossulariae Riley) in heavily infested currant fields, excellent results were obtained with powdered derris or cube root applied either as a dust or spray. Two pounds per 100 gallons of a derris or cube

root containing about 5 percent rotenone is the suggested spray formula, and a dust should contain about 0.5 percent rotenone.

Rotenone-bearing sprays, when properly applied with adequate equipment, have proved highly effective in killing the pea aphid. The more recently developed rotenone-bearing dusts, as well as insecticides applied by means of airplanes, while promising, have not yet been subjected to field tests sufficiently severe to bring out all their possible limitations. Final judgment on these methods will have to be deferred until another season's work has been completed.

Field trials with derris, cube, timbo, and pyrethrum powders for control of cabbage worms indicated clearly that pyrethrum mixtures were more effective in circumstances where the cabbage looper (Autographa brassicae Riley) became the predominant species. Mixtures of comparable strength containing cube and pyrethrum powders were not as effective as those containing pyrethrum powder alone. Spray mixtures were less effective than dust mixtures.

Tests against the Mexican bean beetle were made with bordeaux mixture and rotenone-containing powders as a combination fungicide-insecticide spray for use on fall-grown lima beans. The results indicated that timbo powder in combination with bordeaux mixture was as effective as timbo powder alone as a spray.

The United States Department of Agriculture, Bureau of Entomology and Plant Quarantine (516), in 1938 published suggestions for the control of the pea aphid prepared by a committee of entomologists at the annual meeting of the American Association of Economic Entomologists at Indianapolis, Indiana, December 27, 1937.

The following recommendations are based on observations and data accumulated from experimental work done east of the Rocky Mountains.

Satisfactory control of the pea aphid has been accomplished by several methods. These include, without suggestion of preference, (1) dusting, (2) use of nicotine vaporizer, and (3) spraying. Success in the use of any of these methods will depend entirely upon adequate and efficient equipment and properly timed, thorough application. (1) Dusting with Derris or Cube: Field experiments with derris or cube dust mixtures containing talc or other suitable carriers, conditioned with a liquid spreading and wetting agent, have resulted in satisfactory control. Such dust should contain approximately 1 percent of rotenone.

For information concerning spreading and wetting agents in sprays or dusts consult your Experiment Station Entomologist or the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

In applying these dusts the boom should be completely enclosed and a trailer 25 feet or more in length should be used. Dusts should be applied

at the rate of 35 to 40 pounds per acre. The speed of the machine should not exceed 3 miles per hour or 300 feet per minute. Dusting is much less effective when the wind velocity exceeds 8 to 10 miles per hour. Spraying is an effective method of control but its economic usefulness is conditioned by the nearness of an adequate water supply.

On the basis of ground derris or cube root containing 4 percent of rotenone, 3 pounds should be used per 100 gallons of water. Corresponding dilutions should be used with derris or cube containing more or less than 4 percent of rotenone. A spreading and wetting agent, in either liquid or dry form, is necessary. The application per acre should be from 125 to 200 gallons. Pressure should be 225 to 300 pounds, and depends on size of disc apertures, type of nozzle, and pump capacity.

It is believed that an infestation that is reflected by 35 aphids per sweep for an average of 5 sweeps in different parts of the field, with a standard collecting net, is usually an indication that treatment should be begun.

The U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine, in February 1938 distributed a summary of the remarks made at the Pea Aphid Conference (316), Indianapolis, Ind., Dec. 27-28, 1937. Shropshire of Illinois reported on the efficiency of the numerous wetting agents offered for use with derris and cube. Over 50 of these combinations and dilutions were tested in replicated plots. It was found from these that some of the best wetting agents were the poorest for use with derris or cube for aphid control on peas. More detailed laboratory tests will probably be necessary to find out why this difference occurred in field tests.

Results of experimental work in 1937 tend to verify results obtained in 1936 with both nicotine and derris or cube for pea aphid control. They further show that cube is as effective as derris, assuming that the rotenone and total extractives are approximately the same in both samples. Derris or cube with a rotenone content of 4 percent was effective for pea aphid control when used at the rate of 2 or 3 pounds per 100 gallons of spray, assuming that the spray was applied at the rate of 125 to 150 gallons per acre. Aresket (liquid) used at the rate of 1 to 600 was used as a standard for comparison with other spreaders.

A rather extensive set of dust trials was planned for 1937 following a limited amount of work on them during 1936. Most of the dusts were made up to contain 1 percent of rotenone, other ingredients being varied as desired. Variables included diluents, wetting agents, some suggested by Dudley and Bronson, and irritants such as nicotine and certain thiocyanates. Results with rotenone-bearing dusts were variable in 1937 as was the case in 1936. In many cases the results were excellent; however, in certain instances they were far from satisfactory. These cases were not easy to understand, but apparently the poor performance was due to some weather condition, such as absence of free moisture (dew or rain) on the plants. In spite of some very poor results obtained with rotenone-bearing dusts it is felt that they have sufficient merit to warrant recommendation with reservation.

The use of wetting agents or irritants in dusts for use on peas is not recommended.

Graham and Ditman of Maryland reported that in 1937 derris and cube sprays, when properly applied, gave good results. Nicotine fumigation gave the most complete and quickest kill. Derris dusts seemed less effective than sprays, possibly because of improper application of dusts. Derris powder (8% total extractives) was used at the rate of 2 pounds or 4 pounds per 100 gallons, plus sodium lauryl sulphate (1/4 or 1/2 lb.) or Orthex Spreader (1 pint) as a wetting agent.

Hutson of Michigan reported the order of effectiveness of insecticides for the control of the pea aphid to be as follows--nicotine vaporizer, nicotine dust, sprays, and rotenone dusts.

Pepper of New Jersey reported tests with derris powder diluted with talc to a rotenone content of 1 percent. When the wind velocity and temperature were favorable at the time of application the 4-percent nicotine dust proved to be more effective than did the derris root dust mixtures. The derris root dust without a conditioning agent proved to be more effective than the derris root dust containing a conditioning agent (1 percent). This was also true in a series of small plot experiments. No significant differences could be noted in the kill of aphids between applications on dry foliage and wet foliage. From the small plot tests no residual effects of derris root dust to pea aphid was noted. The aphid population, however, was depleted very rapidly by natural enemies.

Preliminary experiments were conducted with vaporized oil sprays applied from an airplane. The oil, of course, contained an insecticide. The insecticides tested in the vaporized oil were nicotine, derris extract, and pyrethrum extract. Mixtures of derris and pyrethrum extracts were also tested. The data from the experimental plots showed a kill of approximately 75 percent with some of the oil-insecticide combinations. Derris root dust applied from an airplane proved totally unsatisfactory as a control for the pea aphid.

Hugh Glasgow of New York reported that in the case of the rotenone-bearing dusts, the initial kill was often surprisingly good, but the fact that this kill was not always as consistent or as uniformly high as where either rotenone sprays or nicotine preparations were used was somewhat disturbing:

Knowlton of Utah reported that ground cube and derris root gave good control as a spray when diluted at the rate of 3 pounds of 4 percent rotenone bearing dust (or equivalent) to each 100 gallons of water, to which a liquid spreading and wetting agent was added. "Agicide" semi-fluid spray concentrate also was effective, no significant difference in control being noted between applications at strengths of 1:50, 1:100, 1:150, and 1:200.

Cube and derris dust mixtures containing from 1 to 2 percent of rotenone usually gave good control, but the results were less consistent than the derris and cube spray treatments.

Dudley and Bronson of the Madison, Wis., station of the Bureau of Entomology and Plant Quarantine reported that in a large replicated plot experiment satisfactory aphid control was secured by treatment with derris spray, derris dust mixture, and nicotine vapor, but not with nicotine dust. The largest increase in the yield of shelled peas resulted from the derris dust treatments, with the nicotine vapor treatment second, and the derris spray treatment third. The plots treated with nicotine dust yielded less than the checks. Derris spray was used at a rotenone concentration of 0.01 percent plus sodium oleyl sulphate and in some cases also 1 percent aliphatic thiocyanate.

Hamilton (185) in 1938 reported the results of tests of cube and derris powders (4% rotenone and 16 to 18% total extractives) applied as a spray at the rate of 4 pounds per 100 gallons, with the addition of 4 pounds of rosin residue emulsion.

Cube powder appeared to be as effective as derris powder in the rosin emulsion spray, both as a contact insecticide and as a repellent.

These tests were made by members of the National Shade Tree Conference under a cooperative project with the Hercules Powder Company, manufacturers of rosin residue, and five of the principal suppliers of derris and cube powders. Sufficient spray material to make from 500 to 1000 gallons of diluted spray was sent to each of 38 cooperators in 14 States, together with instructions for using the spray and a report blank to be used in giving the results of the tests.

The results against insects were as follows:

Cankerworms (various species of Lepidoptera, Geometridae) on various shade trees were satisfactorily controlled. The spray acts as a contact poison and as a repellent. The effective period is 3 days to 2 weeks. One spraying before larvae were more than two-thirds grown gave good kill.

Tent caterpillars (Malacosoma americana F., Lepidoptera, Lasiocampidae) on wild cherry, apple, and hawthorn trees were satisfactorily controlled. The spray acts as a contact poison and as a repellent. The effective period is 6 to 8 days. Caterpillars would not feed on sprayed foliage.

Fall webworms (Hyphantria cunea Drury, Lepidoptera, Arctiidae) on walnut trees were satisfactorily controlled. The spray acts as a contact poison, the effective period being 6 days. There was 100 percent kill of larvae in sprayed webs.

Catalpa sphinx moth caterpillar (Ceratomia catalpae Boisduval, Lepidoptera, Sphingidae) on catalpa trees was controlled satisfactorily. The spray acts as a contact poison. Within a few hours there was 100 percent kill of all sizes of caterpillars.

Spiny elm caterpillar (Euvanessa) Aglais antiopa L., Lepidoptera, Nymphalidae) on elm trees was satisfactorily controlled. The spray acts as a contact poison. The effective period is 3 to 4 days. There was 100 percent kill by actual count.

Oak leaf rollers (Argyrotoxa semipurpurana Kearf., Lepidoptera, Tortricidae) on pin oak trees were controlled satisfactorily in one test out of three tests given. The spray acts as a contact poison. The effective period is 3 to 4 days. There is 50 to 100 percent kill.

The tussock moth larvae (Hemerocampa leucostigma Smith and Abbott, Lepidoptera, Lymantriidae) on various shade trees were not satisfactorily controlled. The spray acts as a contact poison and as a repellent. There was 10 percent control in one test and 50-75 percent control in other tests.

Bagworms (Thyridopteryx ephemeraeformis Haworth, Lepidoptera, Psychidae) on evergreen trees were satisfactorily controlled in 3 out of 4 tests. The spray acts as a repellent. The period of effectiveness was 3 to 4 days. Bags do not fall off the trees, larvae cease feeding and do not increase in size.

Larch case bearers (Coleophora laricella Hbn., Lepidoptera, Coleophoridae) on larch trees were 75 percent controlled. The spray acts as a stomach poison. The effective period is 3 to 4 days. Results are slow.

Pear slugs (Eriocampoides limacina Retzius, Hymenoptera, Tenthredinidae) on pear trees were controlled 100 percent. The spray acts as a contact poison and as a repellent. The effective period is 6 days.

Pine sawfly larvae (Neodiprion lecontei Fitch, Hymenoptera, Tenthredinidae) on white pine trees were controlled 100 percent. The spray acts as a contact poison. The effective period was 4 to 6 days. Full-grown larvae were fairly easily killed.

Currant worms (Pteronidea ribesii Scop., Hymenoptera, Tenthredinidae) on currant trees were controlled 100 percent. The spray acts as a contact poison. There was 100 percent kill in 1 or 2 days.

Elm leaf beetles (Galerucella xanthomelaena Schrank, Coleoptera, Chrysomelidae) on elm trees were not satisfactorily controlled. Five tests were made, two of which were satisfactory. The spray acts as a contact poison and as a repellent. The period of effectiveness is 5 to 7 days. Control seems to depend on time of application.

Japanese beetles (Popillia japonica Newm., Coleoptera, Scarabaeidae) on various trees, shrubs and flowers were fairly well controlled. The spray acts as a repellent. The effective period is 6 to 7 days. Satisfactory repellency can be obtained by spraying 6 or 7 days apart.

Asiatic garden beetles (Autoserica castanea Arrow, Coleoptera, Scarabaeidae) on various flowers were fairly well controlled. The spray acts as a repellent. The effective period was 4 to 5 days. Control is not as good as for Japanese beetle.

June bugs (Lachnosterna spp. = Phyllophaga spp., Coleoptera, Scarabaeidae) were fairly well controlled. The spray acts as a repellent. The effective period was 6 days. Feeding is checked for 6 or 7 days.

Rose leaf beetles (Nodonata puncticollis Say, Coleoptera, Chrysomelidae) on bush honeysuckle were 60 percent controlled. The spray acts as a repellent. The effective period is 4 to 6 days. Repeated sprays should give satisfactory control.

Willow leaf beetles (Lina spp. = Chrysomela spp., Coleoptera, Chrysomelidae) on black willow trees were well controlled. The spray acts as a repellent and contact poison. There is good control of larvae.

Mexican bean beetles (Epilachna varivestis Muls. (=corrupta Muls.) Coleoptera, Coccinellidae) on beans were satisfactorily controlled. The spray acts as a contact poison and as a repellent. The effective period is 8 days. Eighty percent kill of larvae, 20 percent repellency on beetles. Repeated sprayings would give good control.

Striped cucumber beetles (Diabrotica vittata F., Coleoptera, Chrysomelidae) on cucumbers were controlled 100 percent. The spray acts as a contact poison or as a repellent. The effective period was 2 weeks. No beetles were observed after more than 2 weeks after spraying.

Woolly aphids (various species of Homoptera, Aphididae) on beech, elm, larch, and white pine trees were not satisfactorily controlled. Very little kill by contact against any of the woolly aphids.

Aphids (species of Homoptera, Aphididae) on roses and white pine trees were satisfactorily controlled. The spray acts as a contact poison. Good kill on roses, poor on pine.

Lace bugs (Corythuca arcuata Say, Hemiptera, Tingidae) on Sycamore, azaleas, and asters were satisfactorily killed in three out of four tests made. The spray acts as a contact poison. There was 90 to 100 percent kill.

Euonymus scale (Chionaspis euonymi Comst., Hemiptera, Coccidae) on euonymus trees was controlled satisfactorily. The spray acts as a contact poison. Control was satisfactory against young scales.

Juniper scale (Diaspis carueli Targ., Hemiptera, Coccidae) on juniper trees was satisfactorily controlled if applied against young scales. The spray acts as a contact poison.

Cottony maple scale (Pulvinaria vitis L., Homoptera, Coccidae) on maple trees was fairly well controlled. Nicotine was better. The spray acts as a contact poison.

Spider mites (Tetranychus telarius L., class Arachnida, order Acarina, family Tetranychidae) on spruce, juniper, and privet trees were controlled in four tests out of six tests made. The spray acts as a contact poison. Probably not effective against the eggs.

Wallis (455), in February 1938, summarized the results of tests performed with insecticides against the Mexican bean beetle in Colorado in 1937. He reported that sprays containing derris and cube gave better results than any other materials tested, the increase in yield ranging from 10.4 to 48.7 percent over the check plots.

Elmore (126) in 1938 reported tests of insecticides against the tomato pinworm, Gnorimoschema lycopersicella Busck, at Alhambra, Calif. Cube extract was ineffective. Cryolite and cuprous cyanide, in either sprays or dusts, were the most effective.

Batchelder (21) in 1933 reported that during the previous year at New Haven, Conn., derris spray reduced the corn borer population in ears of early market sweet corn 77 percent. Cube dust reduced the corn borer population infesting dahlias in experimental plots about 90 percent.

Huckett (207) reported tests of cube mixed with each of the following: sulphur, sulphur and celite, bordeaux mixture, and celite and clay for the control of the Mexican bean beetle, Epilachna varivestis Muls. Two samples of cube powder were compared, one analyzing 2 percent rotenone and 18 percent total ether extractives and the other 5 percent rotenone and 12 to 14 percent total ether extractives. These powders were applied in sulfur spray and dust mixtures at strengths equivalent to 4 pounds of cube powder to 100 gallons of wettable sulfur spray and 10 pounds of cube powder in 100 pounds of a cube plus celite plus ground sulfur dust mixture.

Huckett concludes that according to larval population counts of E. varivestis and yield of pods, mixtures containing cube powder of 2 percent rotenone and 13 percent total ether extractives were as effective at the dosages used as those containing cube powder of 5 percent rotenone and 12 to 14 percent total ether extractives.

In field tests on lima beans sprayed and dusted with copper-lime mixtures for control of plant diseases it was observed that bordeaux mixture, as applied, possessed considerable merit in that it had notably reduced the amount of feeding by E. varivestis. This effect, it was observed, was slightly enhanced by the addition of cube powder to the mixture at the time of application or by making separate applications of cube-clay dusts following treatment with bordeaux mixture.

Weigel and Nelson (460) tested derris and cube with various wetting agents (alkylphenylbenzenesulphonic acid, sulphonated castor oil, ammonium caseinate plus rosin residue emulsion, etc.) for the control of the common

red spider, Tetranychus telarius L., and thrips, especially onion thrips, Thrips tabaci Lind., on greenhouse tomatoes and cucumbers. The authors conclude that the results of the first series indicate that a derris spray having a rotenone content of 0.0056 percent is as effective as one with a 0.0112 percent rotenone content when sulfonated castor oil is used as a spreader; that the derris sprays used in these tests are superior to cube sprays of the same rotenone content, the difference being explainable on the basis of the total extractives; that the addition of pyrethrum extract aids in killing thrips but does not improve the spray's effectiveness against the red spider; that with sprays of the same rotenone content with sulfonated castor oil as a spreader, the kill is better than with either alkylphenylbenzenesulfonic acid or ammonium caseinate with rosin residue; and that proprietary thiocyanate spray is as effective as the derris spray plus sulfonated castor oil. None of the derris or cube sprays plus the spreader or the proprietary thiocyanate caused any permanent injury to either tomato or cucumber. The lauryl thiocyanate spray with sodium oleyl sulfate plus synthetic resin spreader caused severe injury to both the foliage and fruit of tomato.

McTavish (279), in an address before the 24th annual meeting of the National Association of Insecticide and Disinfectant Manufacturers, New York, December, 1937, discussed mothproofing problems. Frequently vegetable insecticides are dissolved in hydrocarbons--the favorites are pyrethrum extract, cube and derris roots. These tend to prolong the larvicide action after the solvent has evaporated away. Unfortunately deterioration of these natural insecticides under ordinary atmospheric conditions is relatively rapid.

Friend and Plumb (153) in 1938 reported the results of tests made in 1936 and 1937 to control the European pine shoot moth, Rhyacionia buoliana Schiff. Derris (4% rotenone, 14% ether extractives) plus the proprietary wetting agent SS₃ or powdered skim milk gave greater reduction in infestation than lead arsenate. Cube (same analysis as the derris) was tried with powdered skim milk, milk, rosin residue, and Ultrawet. The authors conclude that field experiments on the control of the European pine shoot moth on red pine in Connecticut have shown that spraying with a mixture of 4 pounds of ground derris root or ground cube root and 1 pound of powdered skim milk in 100 gallons of water is superior to spraying with a mixture of 3 pounds of lead arsenate and 1 pint of fish oil in 100 gallons of water. One application of cube about July 2 is as effective as three or four applications of lead arsenate at 10-day intervals in June and July. Two applications of cube, one July 2 and one July 12, are significantly more efficient in reducing tip injury than one application July 2. As a spreader and sticker, powdered skim milk is as efficient as any other materials tried at the concentrations used. It was found that spraying during the first half of June did not give good results in controlling the insect in 1936 and 1937.

Derris and cube were equally good. Exposure to sunshine for 166 hours did not completely destroy the insecticidal value of these materials. The laboratory experiments with newly hatched larvae on sprayed twigs show that, after an exposure of 11 days in the field, ground cube root used with powdered skim milk or Ultrawet was as effective in preventing boring as was the lead arsenate and fish oil combination.

Experiments performed in 1937 at South Point, Ohio, against Epilachna varivestis Muls. by N. F. Howard and H. C. Mason, (202) of the Columbus, Ohio, laboratory, gave the following results with the various insecticides tested: Phenothiazine at 2 pounds to 50 gallons of water gave good control, but slight plant injury resulted; derris, cube, timbo, and devil's shoestring gave good control at a concentration of 0.015 percent rotenone and usually at concentration of 0.01 percent rotenone. While the use of a varnish sticker with derris and cube increased the degree of control in one instance, no increase could be noted in two other experiments. The use of sulphur with derris or cube sprays, and its use as a diluent with dust mixtures of these materials, does not consistently result in improved control in Ohio; however, its use farther east usually results in better bean crops.

Wilcox and Stone (468), in March 1938, reported that cube dust mixtures containing as high as 2 percent rotenone have given inferior results and are not recommended for use against the tomato fruit worm, Heliothis obsoleta F.

Johns-Manville (218), in April 1938, called attention to Celite 209, an amorphous silica which on account of its fineness (essentially below 10 microns particle size) and its lightness (8 pounds per cubic foot) is useful as a diluent for insecticides, especially powdered derris, cube, and pyrethrum.

LIST OF INSECTS MENTIONED

Insects mentioned in this review against which cube has been tested or recommended are listed as follows:

A list of insects against which cube has been tested.

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
(<u>Euvanessa</u>) <u>Aglais antiopa</u> L.	Effective	Hamilton 185
<u>Alabama argillacea</u> Hbn.	Equal to derris (76% control)	Smith and Soales 382
	Ineffective	Wille et al. 471
	Less effective than calcium arsenate	Smith and Scales 382, 383
Alfalfa looper	Ineffective	Colo. Agr. Expt. Sta. 87
<u>Alsophila pometaria</u> Harris	Less effective than derris	Felt and Bromley 144
<u>Anasa tristis</u> DeGeer	Effective against nymphs	Idaho Agr. Expt. Sta. 210

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
<u>Ancylis comptana</u> Froel.	Effective against nymphs	Ohio Agr. Expt. Sta. 310
<u>Anomis luridula</u> Gn. (<u>texana</u> Riley)	Ineffective	Wille, Ocampo, Weberbauer, and Schofield 471
<u>Anopheles pseudopunctipennis</u> Theo.	Ineffective	do.
<u>Anthonomus grandis</u> Boh.	80% control	Smith and Scales 382 383
	More effective than calcium arsenate	do.
<u>Anthonomus vestitus</u> Boh.	Ineffective against adults	Wille et al. 471
Ants	Effective	Idaho Agr. Expt. Sta. 210; Boyd 39
Aphids	Effective	Bourne and Boyd 36
		New Jersey Agr. Expt. Sta. 302
Aphids on cauliflower	do.	New York Agr. Expt. Sta. 305
Aphids on roses and white pine	Effective	Hamilton 185
<u>Aphis gossypii</u> Glover	do.	Wille et al. 471
<u>Aphis pomi</u> DeGeer	Less effective than nicotine	Farrar 138
<u>Aphis spiraeicola</u> Patch	do.	do.
<u>Aphrophora permutata</u> Uhl.	Recommended	Edwards 124
<u>Argyrotoxa semipurpurana</u> Kearf.	Effective	Hamilton 185
<u>Autographa brassicae</u> Riley	Effective	Howard and Davidson 200

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
<u>Autographa brassicae</u> Riley	Effective	Howard and Mason 201; U. S. Dept. Agr. 414, 420; Walker 451; White 463, 464
	Ineffective	Colo. Agr. Expt. Sta. 87, 88
	Less effective than derris	Texas Agr. Expt. Sta. 402
	Less effective than pyrethrum	New York (Geneva) Agr. Expt. Sta. 306
	More effective than lead arsenate	Texas Agr. Expt. Sta. 402
	Recommended	Crosby and Chupp 109; Hervey, Hockett, and Glasgow 191; F. L. Thomas 405; U. S. Dept. Agr. 413
	Some control	Texas Agr. Expt. Sta. 403
<u>Autoserica castanea</u> Arrow	Fairly effective	Hamilton 185
<u>Bruchus pisorum</u> L.	Effective	Howard and Mason 201
Cabbage aphids	Ineffective	Colo. Agr. Expt. Sta. 86; New York (Geneva) State Agr. Expt. Sta. 304
Cabbage worms	Dust more effective than sprays	Colo. Agr. Expt. Sta. 86; New York (Geneva) State Agr. Expt. Sta. 304
	Less effective than pyrethrum	N. Y. Agr. Expt. Sta. 306
	Effective	U. S. Dept. Agr. 413; Wallace 454; Walker and Anderson 452; White 463; Wisc. Agr. Expt. Sta. 472
	Recommended	Bourne and Boyd 36

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
Cankerworms	Effective	Hamilton 185
<u>Carpocapsa pomonella</u> L.	Highly toxic in laboratory tests	F. L. Campbell 60
	Ineffective in the orchard	Childs 79; Haegele 182; U. S. Dept. Agr. 418
<u>Ceratonia catalpae</u> Bdv.	Effective	Hamilton 185
Cherry slug	Dust ineffective	Colo. Agr. Expt. Sta. 88
	Spray equal to lead arsenate	do.
<u>Chionaspis euonymi</u> Comst.	Effective	Hamilton 185
<u>Chlorochroa sayi</u> Stal	Less effective than derris	Cassidy and Barber 65
<u>Chrysomphalus aurantii</u> Maskell	Effective	Cressman 97
Clothes moths	do.	McTavish 279 Boyd 39
<u>Coleophora laricella</u> Hbn.	75% effective	Hamilton 185
<u>Corythuca arcuata</u> Say	Effective	do.
<u>Crioceris asparagi</u> L.	Recommended	Huckett 206; Bourne and Boyd 36
<u>Crioceris duodecimpunctata</u> L.	do.	Bourne and Boyd 36
Cucumber beetles	Effective	Howard and Mason 201
<u>Diabrotica trivittata</u> Mann.	do.	McKinney 278
<u>Diabrotica vittata</u> F.	do.	Walker 451; Wisconsin Agr. Expt. Sta. 472
	Effective and equal to derris	Beard 24
	100% effective	Hamilton 185
	Recommended	Bourne and Boyd 36

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
<u>Diaphania hyalinata</u> L.	Recommended	U. S. Dept. Agr. 417
<u>Diaphania nitidalis</u> Stoll	do.	do.
<u>Diaspis carueli</u> Targ.	Effective against young scales	Hamilton 185
<u>Dysdercus mimulus</u> Hussey	Less effective than derris	Cassidy and Barber 65
<u>Dysdercus ruficollis</u> L.	Effective	Wille et al. 471
<u>Epilachna varivestis</u> Muls.	do.	Bourne and Boyd 36 Brannon 40, 43, 45; Hamilton 185; Howard 198; Howard, Brannon, and Mason 199; Howard and Mason 201; Hockett 207; N. Y. Agr. Expt. Sta. 305; S. C. Agr. Expt. Sta. 386; U. S. Dept. Agr. 413, 414, 420 Bur. Ent. & Pl. Quar. 423; Walker 451; Wallace 454; Wallis 455; White 463, 464
	Dust ineffective	Colo. Agr. Expt. Sta. 88
	Recommended	Crosby and Chupp 109; S. C. Agr. Expt. Sta. 387; U. S. Dept. Agr. 417, 422
	Some control	Walker 451
<u>Epitrix cucumeris</u> Harris	Effective	Morrill and Lacroix 287; S. C. Agr. Expt. Sta. 387; Bur. Ent. & Pl. Quar. 423
	Effective with Ultrawet	Walker 451
<u>Epitrix fuscata</u> Crotch	Effective	Howard and Mason 201

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
<u>Epitrix parvula</u> F.	Effective	Chamberlin 68, 69, 70; Howe 204; S. C. Agr. Expt. Sta. 387; Bur. Ent. & Pl. Quar. 423; White 463, 464
<u>Eriocampoides limacina</u> Retz.	100% effective	Hamilton 85
<u>Erythroneura comes</u> Say	Effective Less effective than nicotine	Idaho Agr. Expt. Sta. 210
<u>Euproctis chrysorrhoea</u> L. (<u>Nygmia phaeorrhoea</u> Donovan)	Less effective than derris	Spoon 390
<u>Euschistus impictiventris</u> Stal	Less effective than derris	Cassidy and Barber 65
Flea beetles on tobacco	Effective	U. S. Dept. Agr. 413; Wallace 454
<u>Frankliniella fusca</u> Hinds	Ineffective	Morrill and Lacroix 287
<u>Galerucella xanthomelaena</u> Schrank	Ineffective	Hamilton 185
<u>Gnorimoschema lycopersicella</u> Busck	Ineffective Effective	Elmore 126; C. A. Thomas 404
Grapevine pests	Effective	Delassus, Lepigre, and Pasquier 112; Idaho Agr. Expt. Sta. 210
<u>Haematobia irritans</u> L.	Ineffective as a repellent	Laake 256
<u>Haematopinus eurysternus</u> Nitzsch	Effective	Wille et al. 471
<u>Haematopinus suis</u> L.	Effective	do.
Hairy chinchbugs	Effective	N. Y. State Agr. Expt. Sta. at Cornell Univ. 307
<u>Heliothis obsoleta</u> F.	Ineffective	Brannon 41; Bur. Ent. and Pl. Quar. 423; Wilcox and Stone 468
	Effective with sulphur	F. L. Thomas 405

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
<u>Hellula undalis</u> F.	Recommended	U. S. Dept. Agr. 417
<u>Hemerocampa leucostigma</u> Smith and Abbott	Ineffective	Hamilton 185
<u>Hoplocampa flava</u>	Effective	Kearns and Marsh 235; Kearns, Marsh and Martin 236
<u>Hoplocampa testudinia</u>	Effective	Kearns, Marsh and Martin 236
<u>Hyphantria cunea</u> Drury	Effective	Hamilton 185
<u>Hypoderma</u> larvae	Less effective than derris	Runderhorzel-Bestrijd- ings- Commissie 362
<u>Hysteronura setariae</u> Thomas	Less effective than nicotine	Farrar 138
<u>Illinoia pisi</u> Kalt.	Effective	Bronson 52, 53; Dudley, Bronson, and Carroll 120; Howard and Mason 201; Knowlton and Soren- son 246; Pea Aphid Conf. 316; U. S. Dept. Agr. 413, 417, 421, 423; Walker, 451 N. Y. Geneva Agr. Expt. Sta. 304
	Promising	
	More effective than pyrethrum and nicotine	U. S. Dept. Agr. 413; Wallace 454
<u>Lachnosterna</u> spp. = <u>Phyllophaga</u> spp.	Fairly effective	Hamilton 185
Leafhoppers on lettuce	Effective	N. Y. Agr. Expt. Sta. at Cornell Univ. 307
Leafworm	Equal to derris	Smith and Scales 382
<u>Leptinotarsa decemlineata</u> Say	Effective	Feytaud 146; Feytaud and Lapparent 147, 148
<u>Lina</u> spp. = <u>Chrysomela</u> spp.	Effective	Hamilton 185
Locust (grasshopper)	Ineffective	U. S. Dept. Com. 439

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
<u>Lophyrus pini</u> L.	Less effective than derris	Spoon 390
<u>Lygus hesperus</u> Knight	Less effective than derris	Cassidy and Barber 65
<u>Lygus pratensis</u> L.	Ineffective	Smith and Scales 382, 383
<u>Malacosoma americana</u> F.	Less effective than derris	Felt and Bromley 144
	Effective	Hamilton 185
<u>Mamestra picta</u> Harr.	Ineffective	Hervey, Hockett and Glasgow 191; N. Y. (Geneva) Agr. Expt. Sta. 304
<u>Melittia satyriniformis</u> Hbn.	Effective	Mass. Agr. Expt. Sta. 272
<u>Melophagus ovinus</u> L.	Effective	Wille et al. 471
<u>Murgantia histrionica</u> Hahn	Effective	Howard and Mason 201
<u>Musca domestica</u> L.	Effective	LePelley and Sullivan 260
<u>Myrmica rubra</u> L.	Less effective than derris	Spoon 390
<u>Neodiprion lecontei</u> Fitch	100% effective	Hamilton 185
<u>Nodonata puncticollis</u> Say	60% effective	Hamilton 185
<u>Otiorrhynchus singularis</u>	Effective	Kearns and Umpleby 237
<u>Paratetranychus citri</u> McG. (Adults and eggs)	Ineffective	Boyce 37
Pear slugworm or sawfly	Effective	Kearns and Marsh 235
<u>Pectinophora gossypiella</u> Saund.	Some control	U. S. Dept. Agr. 420
	Ineffective	Chapman, Hollingsworth, Robertson 71

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
<u>Pectinophora gossypiella</u> Saund.	Less effective than calcium arsenate	Chapman and Williams 72
<u>Philaenus spumarius</u> (<u>leucophthalmus</u>) L.	Less effective than barium fluosilicate Recommended	Texas Agr. Expt. Sta., 402 Edwards, 124
<u>Phlyctaenia rubigalis</u> Guen.	Ineffective	Howard and Mason 201
<u>Phyllobius oblongus</u>	Effective	Kearns and Umpleby 237
<u>Phyllobius pyri</u>	Effective	Kearns and Umpleby 237
	Less effective than barium fluosilicate or calcium arsenate	Chapman and Williams 72
	Some control	Bur. Ent. and Pl. Quar. 420; Texas Agr. Expt. Sta. 403
<u>Pieris rapae</u> L.	Effective	R. E. Campbell 62; Colo Agr. Expt. Sta. 86, 87 Howard and Davidson 200; Howard and Mason 201; U. S. Dept. Agr. 414, 417, 420; Walker 451; White 463, 464; Wisecup 473
	More effective than pyrethrins	Colo. Agr. Expt. Sta. 88
	Recommended	Crosby and Chupp 109; Hervey, Hockett and Glasgow 191; N. Y. Agr. Expt. Sta. 305; F. L. Thomas 405
<u>Plathypena scabra</u> F.	Cube dust plus sulfur effective	Brannon 45
Plum sawfly	Recommended	Kearns and Marsh 235
<u>Plutella maculipennis</u> Curtis	Effective against young larvae	Walker and Anderson 453

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
<u>Plutella maculipennis</u> Curtis	Effective	Howard and Mason 201; U. S. Dept. Agr. 414, 417, 420; White 463, 464
	Ineffective	Colo. Agr. Expt. Sta. 87
	Cube less effective than derris	Texas Agr. Expt. Sta. 402
	Recommended	Crosby and Chupp 109; Hervey, Hockett and Glasgow 191; F. L. Thomas 405; U. S. Dept. Agr. 417
	Some control	Colo. Agr. Expt. Sta. 88
<u>Popillia japonica</u> Newm.	One-half as effective as derris as a repellent	Fleming and Baker 150
	Promising as a repellent	Bromley 51
	Fairly effective	Hamilton 185
	Ineffective	van Gundia 447
<u>Prenolepis</u> sp.	Effective	British Guiana Dept. Agr. 48
<u>Prodenia eridania</u> Cram.	Less effective than paris green against half-grown larvae	Wisecup 474
<u>Psallus seriatus</u> Reut.	Ineffective	Ewing 133; Ewing and McGarr 134
<u>Psoroptes</u> sp.	Effective	Wille et al. 471
<u>Pteronidea ribesii</u> Scop.	Effective	Illinois Agr. Expt. Sta. 212; N. Y. Agr. Expt. Sta. 305
	100% effective	Hamilton 185
	Dusts very effective	N. Y. (Geneva) Agr. Expt. Sta. 304
<u>Pulvinaria vitis</u> L.	Fairly effective	Hamilton 185

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
<u>Pyrausta nubilalis</u> Hbn.	Effective	Batchelder 21; Hervey 190; Walker 451
	Less effective than derris or nicotine	Batchelder et al. 22
<u>Rhagoletis pomonella</u> Walsh	Promising	N. Y. Agr. Expt. Sta. 306
<u>Rhyacionia buoliana</u> Schiff.	Effective	Friend and Plumb 153
Roaches	Effective	Boyd 39
<u>Sarcoptes</u> sp.	Effective	Wille et al. 471
<u>Solenopsis</u> sp.	Ineffective	Brit. Guiana Dept. Agr. 48
<u>Stomoxys calcitrans</u> L.	Ineffective as repellent	Laake 256
<u>Tetranychus telarius</u> L.	Effective	Hamilton 184; Richardson 340; Weigel and Richardson 461
	Less effective than derris	Weigel and Nelson 459, 460
Thrips on cauliflower	Effective	N. Y. Agr. Expt. Sta. 306
Thrips on cotton	Effective	S. C. Agr. Expt. Sta. 387
	Ineffective	Bur. Ent. & Pl. Quar. 423
<u>Thrips tabaci</u> Lind.	Effective	Weigel and Nelson 458
	Effective with Ultrawet	Walker 451
	Effective against immature stages	N. Y. Agr. Expt. Sta. at Cornell Univ. 307
	Promising	Turner and Walker 409
	Less effective than derris	Weigel and Nelson 459, 460
<u>Thyanta custator</u> F.	Less effective than derris	Cassidy and Barber 65
<u>Thyridopteryx ephemeraeformis</u> Haworth	Effective	Hamilton 185

<u>Insect</u>	<u>Result</u>	<u>Reference</u>
Ticks on llamas	Effective	Klinge 245
<u>Typophorus viridicyaneus</u> Crotch	Less effective than cryolite	Brannon 42
<u>Typophorus viridicyaneus</u> Crotch	Less effective than undiluted calcium arsenate	Brannon 44
Woolly aphids on beech, elm, larch, and white pine trees	Ineffective	Hamilton 185
<u>Zophodia grossulariae</u> Riley	Effective	Hammer 186; N. Y. Agr. Expt. Sta. 306
	Very effective	N. Y. Agr. Expt. Sta. 306

COMMON AND SCIENTIFIC NAMES OF INSECTS

The common and scientific names of the insects mentioned in this publication are listed below. The names marked with an asterisk (*) are those approved by the American Association of Economic Entomologists.

<u>Common name</u>	<u>Scientific name</u>
*Apple maggot	<u>Rhagoletis pomonella</u> Walsh
Apple sawfly	<u>Hoplocampa testudinia</u>
*Asiatic garden beetle	<u>Autoserica castanea</u> Arrow
*Asparagus beetle	<u>Crioceris asparagi</u> L.
*Bagworm	<u>Thyridopteryx ephemeraeformis</u> Haw.
*Boll weevil	<u>Anthonomus grandis</u> Boh.
*Cabbage looper	<u>Autographa brassicae</u> Riley
Cabbage webworm	<u>Hollula undalis</u> F.
Cankerworms	<u>Alsophila pometaria</u> Harris
*Catalpa sphinx moth caterpillar	<u>Ceratomia catalpae</u> Bdv.
Celery leaf tier	<u>Phlyctaenia rubigalis</u> Guen.
Clay colored weevils	<u>Otiorrhynchus singularis</u>
*Citrus red mite	<u>Paratetranychus citri</u> McG.
*Codling moth	<u>Carpocapsa pomonella</u> L.
*Colorado potato beetle	<u>Leptinotarsa decemlineata</u> Say
Common cabbage worm	<u>Pieris rapae</u> L.
*Common red spider	<u>Tetranychus telarius</u> L.
Corn earworm	<u>Heliothis obsoleta</u> Fab.
Cotton boll weevil	<u>Anthonomus grandis</u> Boh.
*Cotton flea hopper	<u>Psallus seriatus</u> Reut.
*Cotton leaf worm	<u>Alabama argillacea</u> Hbn.
*Cottony maple scale	<u>Pulvinaria vitis</u> L.
Currant worm	<u>Pteronidea ribesii</u> Scop.
*Diamondback moth	<u>Plutella maculipennis</u> Curtis

<u>Common name</u>	<u>Scientific name</u>
*Eastern tent caterpillar	<u>Malacosoma americana</u> F.
*Eggplant flea beetle	<u>Epitrix fasciata</u> Crotch
*Elm leaf beetle	<u>Galerucella xanthomelaena</u> Schr.
Euonymus scale	<u>Chionaspis euonymi</u> Comst.
*European corn borer	<u>Pyrausta nubilalis</u> Hbn.
*European pine shoot moth	<u>Phacelia buoliana</u> Schiff.
*Fall cankerworm	<u>Alsophila pometaria</u> Harr.
*Fall webworm	<u>Hyphantria cunea</u> Drury
*Gooseberry fruitworm	<u>Zophodia grossularice</u> Riley
*Green clover worm	<u>Plathypena scabra</u> F.
*Harlequin bug	<u>Murgantia histrionica</u> Hahn
*Horn fly	<u>Haematobia irritans</u> L.
*Housefly	<u>Musca domestica</u> L.
*Imported cabbage worm	<u>Pieris rapae</u> L.
*Imported currant worm	<u>Pteronidea ribesii</u> Scop.
*Japanese beetle	<u>Popillia japonica</u> Newm.
June bug	<u>Ichnosterna</u> spp. = <u>Phyllophaga</u> spp.
Juniper scale	<u>Diaspis carueli</u> Targ.
Lace bug	<u>Corythucha arcuata</u> Say
*Larch casebearer	<u>Coleophora laricella</u> Hbn.
Leaf-eating weevils	<u>Phyllobius oblongus</u>
*Melonworm	<u>Diaphania hyalinata</u> L.
*Mexican bean beetle	<u>Epilachna varivestis</u> Muls.
Oak leaf roller	<u>Argyrotoxa semipurpurana</u> Kearf.
Onion thrips	<u>Thrips tabaci</u> Lind.
*Pea aphid	<u>Illinoia pisi</u> Kalt.
*Pea weevil	<u>Bruchus pisorum</u> L.
*Pear slug	<u>Eriocampoides limacina</u> Retz.
*Pickleworm	<u>Diaphania nitidalis</u> Stoll
Pine sawfly larvae	<u>Neodiprion lecontei</u> Fitch
Plum sawfly	<u>Hoplocampa flava</u>
*Potato flea beetle	<u>Epitrix cucumeris</u> Harr.
Red spider mite	<u>Tetranychus telarius</u> L.
Red stinging ant	<u>Solenopsis</u> sp.
*Rose leaf beetle	<u>Nodona puncticollis</u> Say
*Southern armyworm	<u>Prodenia eridania</u> Grmn.
Spider mites	<u>Tetranychus telarius</u> L.
Spiny elm caterpillar	(Ervenesse) <u>Aglais antiopa</u> L.
Spittle bug	<u>Aphrophora permutata</u> Uhl.
Spittle bug	<u>Philaenus spumarius</u> (<u>leucophthalmus</u>) I
*Spotted asparagus beetle	<u>Crioceris duodecimpunctata</u> L.
*Squash borer	<u>Melittia satyriniiformis</u> Hbn.
*Stablefly	<u>Stomoxys calcitrans</u> L.
*Strawberry leaf roller	<u>Ancyliis comptana</u> Froel.
*Striped cucumber beetle	<u>Diabrotica vittata</u> F.
Sweetpotato leaf beetle	<u>Tyrophorus viridicyaneus</u> Crotch
*Tarnished plant bug	<u>Lygus pratensis</u> L.
Tent caterpillar	<u>Malacosoma americana</u> F.
Thrips	<u>Thrips tabaci</u> Lind.
*Tobacco flea beetle	<u>Epitrix parvula</u> F.

<u>Common name</u>	<u>Scientific name</u>
Tobacco flea beetle	<u>Epitrix cucumeria</u> Harr.
*Tobacco thrips	<u>Frankliniella fusca</u> Hinds
Tomato fruitworm	<u>Heliothis obsoleta</u> F.
*Tomato pinworm	<u>Gnorimoschema lycopersicella</u> Busck
Tussock moth larvae	<u>Hemerocampa leucostigma</u> Smith & Abbott
*Western striped cucumber beetle	<u>Diabrotica trivittata</u> Mann.
Willow leaf beetles	<u>Lina</u> spp. = <u>Chrysomela</u> spp.
*Zebra caterpillar	<u>Manestra picta</u> Harr.

PATENTS

These abstracts of patents are arranged in order of their dates of issuance under each country; the countries are listed alphabetically.

The Standard Oil Development Co. (394), assignee of Sankowsky and Fulton, in British patent 394,977, issued July 4, 1933, applied for January 4, 1932, in the United States January 5, 1931, claim an improved insecticide comprising hydrocarbons rich in unsaturated hydrocarbons and obtained by the extraction of a petroleum naphtha with a solvent having a preferential solvent action for said unsaturated hydrocarbons in admixture with an insecticidal plant extract. The insecticidal plant extract may be from pyrethrum, cube, derris or the like.

The Booth Steamship Co., Ltd., and Ward (34 and 35), in British patent 437,171, issued October 24, 1935, applied for March 30, 1935, and in French patent 794,206, published February 11, 1936, applied for August 27, 1935, have patented a process of extracting rotenone and other toxins from derris, barbasco and timbo roots which consists in digesting the ground root with alcohol acidulated with sulphuric acid. The filtrate may be neutralized with sodium carbonate and refiltered. The final filtrate is mixed with soft soap so as to obtain a semisolid product which can be diluted with water before use.

Fawcett and Imperial Chemical Industries, Ltd., (139 and 213), in British patent 446,576, issued April 29, 1936, applied for October 29, 1934, and also in French patent 797,052, published April 20, 1936, applied for October 29, 1935, claim a process for the production of rotenone and/or preparations having insecticidal value and containing rotenone, which comprises subjecting the natural substances containing rotenone, to distillation at raised temperature in a high vacuum and collecting the distillate. A vacuum of between 10^{-2} and 10^{-6} mm. of mercury is used. The condensate from the distillation may suitably be removed from the condensing surface by melting down, by scraping, or by rinsing with a solvent. An example of the process is as follows: Fifty parts of dry ground cube root are mixed with 100 parts of a linseed oil stand oil which has previously been treated in a high vacuum at 220° C. to remove volatile constituents. The mixture of cube root and oil is fed on to a heated surface or surfaces maintained at about 120° C. and in close proximity to a cold condensing surface, the whole apparatus being evacuated to about 10^{-4} mm. of mercury. A pale

yellow condensate is obtained, giving the reactions of rotenone and containing substantially all the active material present in the original root.

Other carrier liquids such as Apiezon, heavy mineral oil, cotton-seed oil, olive oil, etc., may be used when it is desired to obtain a solution of the active ingredients as distillate, the dry powdered derris or cube root may be mixed with a carrier liquid which is either wholly distillable at the temperatures and pressures employed, or comprises a portion so distillable. Thus a mixture of the oils known respectively under the trade names "Apiezon A" and "Apiezon K" may be used. The active ingredients distil over together with the "Apiezon A" leaving behind a suspension or solution of the residue in the "Apiezon K." The distillate, which is a more or less concentrated solution of the rotenone etc. in "Apiezon A" (the concentration can be varied by varying the proportion of "Apiezon A" taken), is suitable for dilution with kerosene or other volatile mineral oil for use as insecticidal spray.

Imperial Chemical Industries, Ltd., assignee of Fawcett (214), in Canadian patent 369,499, issued October 26, 1937; applied for October 28, 1935; claims the process for the production of rotenone preparations which comprises subjecting a natural rotenone-containing substance to distillation without ebullition at a pressure of 10^{-2} to 10^{-6} mm. of mercury under such conditions that the evaporating and condensing surfaces are substantially co-extensive and are in close proximity to one other, and collecting the distillate. The material may be dried and ground and mixed with a carrier liquid which is substantially volatile at the temperature and pressure to be employed. This is similar to British patent 446,576, French patent 797,052, and United States patent 2,096,678.

Eichhorn (125), in German patent 630,483, issued May 28, 1936, applied for November 22, 1932, extracts powdered derris (or cube) powder at 40 to 50° C. with an equal quantity of a dilute (10 percent) solution of sodium bisulphite, then neutralizes and concentrates in vacuo.

Chromek (80), in German patent 643,804, issued April 17, 1937, applied for February 7, 1932, claims an insecticide consisting of an extract of a rotenone-bearing root in aliphatic hydrocarbons, especially petroleum, hexachloroethane, ammonium linoleate and water. An example is derris powder 7 parts, hexachloroethane 12 parts, ammonium linoleate 4 parts, petroleum 25 parts, methyl salicylate 2 parts, and water 50 parts.

Schotte and Görnitz (368), assignors to Schering-Kahlbaum A. G. of Berlin, in U. S. patent 2,024,392, issued December 17, 1935, applied for December 12, 1933; in Germany November 13, 1931, claim an insecticidal preparation consisting of a mixture containing rotenone and veratrin. They state:

"As is well known to those skilled in the art, insecticides prepared from the roots of plants belonging to the genus Derris, Lonchocarpus and others and containing

rotenone or the like are particularly efficient, but the high price of these drugs has proven to be prohibitive as regards their use on a large scale."

Hamilton (184), in U. S. patent 2,030,584, issued February 11, 1936, applied for June 5, 1934, claims an insecticide including water, a suitable oil and finely powdered natural parts of a plant selected from the group consisting of derris and cube root containing an inherent emulsifier and properties toxic to insects. Reference is made to the use of acetone, alcohol, ether and ethylene dichlorides as solvents for the active principles of derris and cube. To prepare the paste, 3 or 4 parts of finely powdered derris or cube root are added to 8 parts of water and 8 parts of oil, either mineral, vegetable or animal, and the mixture emulsified in a suitable machine. In case the derris is reduced to 1 part it is necessary to add $\frac{2}{3}$ to 1 part colloidal clay (wilkeite, bentonite, etc.) to make a physically stable emulsion. A preservative such as $\frac{1}{2}$ to 1 percent carbolic acid may be added; a sodium, potassium or an ethanalamine soap may be used instead of the clay, and an anti-oxidant such as tannic acid may also be added.

The paste emulsion insecticide produced as aforesaid, makes a quick breaking emulsion when diluted with water for spraying. Insecticide sprays of this invention possess from 15 to 20 percent greater toxicity to plant lice than sprays of the same high dilution made from derris and cube insecticides of the chemically extracted kind.

Buc (56), of the Standard Oil Development Co., in U. S. patent 2,042,296, issued May 26, 1936, applied for March 12, 1931, uses an aryl alkyl ether to keep rotenone and rotenoids from derris or cube in solution in kerosene.

An example of the invention is 0.5 percent rotenone, 5 percent secondary hexyl cresyl ether, 94.5 percent petroleum oil having a gravity of 27° A.P.I. and a viscosity of 115 Saybolt at 100° F. Buc states that he has prepared a stable kerosene solution containing 0.25 percent of rotenone with only 0.75 percent of secondary hexyl phenyl ether as mutual solvent.

Wotherspoon (476), in United States patent 2,052,374, issued August 25, 1935, applied for April 28, 1934, claims an aqueous disseminatable composition of matter consisting of an insecticide obtainable from derris and similar insecticidal-containing plant materials containing rotenone, deguelin, tephrosin and toxicarol and a water-soluble phenol containing at least two hydroxyl groups.

"I have found that if rotenone, dihydrorotenone, finely ground derris or cube, solid extracts of derris or cube, the hydrogenated derivatives of same, either alone or in mixtures, are melted or intimately mixed with a solid water-soluble phenol containing two or more hydroxyl groups, the resulting product after cooling and grinding is soluble, or miscible, with water in any proportions.

"The products thus produced may be mixed, if desired, with any powdered materials which act as wetting agents, such as soap, alkali salts of sulphonated hydrocarbons or alcohols, sulphonated oils, et cetera.

"Fillers such as starch, glue, gums, dextrins, flour, clays, talc, bentonite, chalk, diatomaceous earth, et cetera may also be incorporated therein if desired.

"The maximum results are obtained with these insecticides when treated in this manner.

"The phenols referred to above may be one or more of the dihydric phenols such as catechol, resorcinol and quinol and their homologues, and the trihydric phenols such as pyrogallol, phloroglucinol and hydroxyquinol and their homologues."

Examples are: (A) 12.5 parts by weight of rotenone are mixed with 87.5 parts by weight of resorcinol in a vessel equipped with a heating arrangement. Heat is applied, and when melted the contents are withdrawn and allowed to cool. The product is then ground in a suitable grinding mill. This material is miscible with water in all proportions and when so mixed is highly toxic to most insects. (B) Twelve and one-half parts by weight of dry hydrogenated derris extract are melted with 43.75 parts by weight of resorcinol. The cooled product is ground to a fine powder and mixed with 50 parts by weight of powdered soap. The resulting product when mixed with water is quickly dispersed and yields a most satisfactory horticultural spray. (C) Ten parts by weight of dihydrorotenone are melted with 90 parts by weight of pyrogallol. The resulting product when ground and dissolved in water yields a valuable insecticide that may be used for mothproofing woolen materials.

Organic solvents mentioned as suitable for dissolving the active principles of Derris, Lonchocarpus, Spatholobus, etc., are ethyl acetate, benzol, acetone, chloroform, ethylene dichloride and safrol.

Ward (456), in United States patent 2,056,438, issued October 6, 1936, applied for September 4, 1935, in England March 30, 1935, claims the process for extracting toxins for the manufacture of insecticides from Barbasco root, comprising the steps of treating the root, in a broken up state, with common alcohol in the proportion of 100 grams of the root to 400 cc. of common alcohol to which is added 1.5 percent by volume of chemically pure sulphuric acid, allowing the mixture to digest under the action of the internal heat generated, the common alcohol dissolving out the rotenone, tephrosin, deguelin and toxicarol, raising the temperature of the mixture by heat derived from an external source, filtering the mixture, neutralizing the filtrate by adding sodium carbonate thereto, refiltering, this final filtrate containing not only the rotenone but also the deguelin, tephrosin and toxicarol, and mixing the final filtrate with soft soap. Reference is made to the process of obtaining rotenone by extracting the roots with ether and recrystallizing from carbon tetrachloride. This invention relates to the

extraction of toxins, for the manufacture of insecticides, from Derris, Barbasco and Timbo roots, such, for example, as Lonchocarpus nicou, Derris elliptica, D. chinensis, D. malaccensis, and other roots containing rotenone.

Wotherspoon (477), in United States patent 2,058,200, issued October 20, 1936, applied for September 12, 1932, assigned to Derris, Inc., claims a composition of matter consisting of a nonaqueous solution of the insecticidal principles obtainable from one or more members of the group consisting of derris and pyrethrum in at least one member of the group of alkylated phenolic ethers consisting of safrol, anethol, methyl eugenol and camphor oil, said solvents being in sufficient quantities to maintain the insecticidal principles in solution. Solvents previously used to extract derris and cube include benzene, acetone, acetone-alcohol mixture, petroleum distillate, chloroform, ethylene dichloride, ether, toluol, xylene, etc. Solvents less effective than safrol, etc., include oil of turpentine, pine oil, terpeneol, dipentene, phellandrene, terpinolene, limonene, cedrene, and petroleum distillates. The new solvent extracts of derris or cube may also be used in conjunction with water, provided a proper colloid is present to form a stable emulsion. These colloids are soap, starch, gum acacia, gum ghatti, gum karaya, gum tragacanth, dextrin, glucose, sucrose, saponin or extracts of plants rich in the latter.

Sankowsky (365), in United States patent 2,058,832, issued October 27, 1936; applied for March 17, 1933, assigned to Stanco, Inc., claims a method for preparing a clear concentrated liquid insecticide which comprises extracting rotenone, and other constituents toxic to insects, from a plant containing such toxic substances, by treating said plant with a mixed solvent, which is capable of selectively dissolving said toxic substances to the exclusion of resinous materials which, upon dilution of the extract with kerosene, would be precipitated, comprising a petroleum distillate having a maximum boiling point below 625° F. and a sufficient amount of an organic solvent soluble in the petroleum distillate and having solvent power for said toxic substances to dissolve at least 2.5 percent of said toxic substances.

Derris root, cube root, or other plants containing rotenone are extracted by a counter-flow method, or by percolation, etc., with about 20 to 30 percent solution of ethylene dichloride in a petroleum distillate. A concentrated extract is obtained containing about 2.5 percent of rotenone and about 5 percent of rotenoids. This concentrated extract, after being clarified if turbid by the addition of a small amount of ethylene dichloride or other similar solvent (e. g., p-dichlorobenzene is mentioned) may be used for the preparation of insecticidal solutions by diluting with a petroleum distillate to the strength desired without the formation of a residue, or it may be first mixed with a concentrated solution of other insecticides and then diluted to the desired strength. The petroleum distillate preferably used is one having a maximum boiling point below 625° F. The term rotenoids is applied to the insecticidal constituents of Derris, Lonchocarpus and Tephrosia other than rotenone. Other solvents that may be used mixed with a petroleum distillate to extract rotenone and rotenoids from derris root, cube root or

other plants containing rotenone, are as follows: acetone, benzol, chloro-benzene, chloroform, dichloroethyl ether, ethylene chlorohydrin, n-propyl formate, toluene, trichloroethylene and xylene.

Mikeska (282), in U. S. patent 2,066,184, issued December 29, 1936, applied for October 29, 1932, assigned to the Standard Oil Development Co., claims an improved insecticide, comprising a hydrogenated extract obtained by extracting petroleum oil with a solvent having a preferential solvent action for aromatic and unsaturated hydrocarbons of a petroleum oil, separating the solvent from the extract, hydrogenating the separated extract, and dissolving in the hydrogenated extract the active principles of a fish poisoning plant. For example, kerosene having a solvent power for rotenone and/or rotenoids of from 0.25 to 0.05 percent was extracted with sulphur dioxide. The extract was separated from the solvent by means of distillation, and the solvent power for rotenone was found to be increased to 2.3 percent. The extract was then hydrogenated, and marked improvements both in the odor and the solvent power were found. The solvent power of the hydrogenated extract for rotenone and/or rotenoids was increased to 7.2 percent.

The hydrogenated extract is suitable for use as a solvent in extracting the toxic ingredients from the fish poisoning plants, by percolation or by maceration of the plant in the presence of the solvent and separating the solvent containing the toxic ingredients from the residual solids.

The hydrogenated extract with the toxic ingredients in solution may be diluted and used as a spray in killing insects, such as flies, mosquitoes, etc.

A spray of the emulsion type may be prepared for dipping and spraying animals to control external parasites, such as lice, ticks, mange mites, cattle grub, etc. The emulsion for cattle dips or sprays is prepared by taking hydrogenated oil extract solution containing 5 to 10 percent of rotenone and/ or rotenoids and mixing with water, using a suitable emulsifier such as oil-soluble sulphonated soap, fish oil soap, saponin, etc. Other insecticides may be added to the emulsion, such as lead arsenate, nicotine, pyrethrum, etc.

Another use for the spray solution of the emulsion type is for spraying plants such as trees, shrubs, etc. to control parasites such as aphids, leaf hoppers, thrips, greenhouse white flies, tent caterpillars, red spiders, squash bugs, roaches, Mexican bean beetles, Japanese beetles, potato beetles, etc.

This invention relates to the art of manufacturing improved insecticides or insect repellents containing novel solvents for toxic ingredients and more particularly it relates to the use of improved solvents for the toxic ingredients of fish poisoning plants known as derris, cube, etc. The non-crystalline constituents of fish-poisoning plants known to be a mixture of deguelin, tephrosin, toxicarol, etc., are called rotenoids by Mikeska.

Hunn (208), in United States patent 2,087,599, issued July 20, 1937, applied for September 8, 1932, assigned to Stanco, Inc., claims an insecticide including water, a suitable oil and finely powdered natural parts of a plant selected from the group consisting of derris and cube root containing an inherent emulsifier and properties toxic to insects.

The following specific example is given of one way of carrying out the invention: Spent pyrethrum flowers containing approximately 10 percent oil residue extract from a previous extraction of the fresh flowers with oil are pulverized and mixed with water in the proportion of 1 part of flowers to 3 parts of water, and about 2 percent of cresylic acid (based on the whole mixture) is added as a preservative. This mixture is, after proper agitation, suitable as a stock emulsion which will be ready for use with mere dilution with water. Ground derris or cube root can be satisfactorily used in a composition similar to the above instead of the spent pyrethrum.

Simanton (378), in U. S. Patent 2,089,766, issued August 10, 1937, applied for March 7, 1936, assigned to Gulf Research and Development Company, claims an improved insecticide comprising in stable admixture a petroleum fraction, a substance chosen from the class consisting of ethylene glycol monoethyl ether acetate and diethylene glycol monoethyl ether acetate, pyrethrins and at least one of the active toxic ingredients of derris and cube.

Among the solvents commonly employed as blending agents in combination with petroleum naphthas are ethylene dichloride, carbon tetrachloride, acetone, camphor, sassafras oil, benzol, and chloroform. These solvents are each and all objectionable for a variety of reasons, chief of which is that their odor is distinctly disagreeable.

Ethylene glycol monoethyl ether acetate and diethylene glycol monoethyl ether acetate are each completely miscible with the petroleum fractions known as naphthas and are also miscible to a more limited extent with higher boiling petroleum fractions.

In one actual embodiment of the invention the patentee prepared an insecticidal solution by first forming a 5 percent solution of crystalline rotenone in diethylene glycol monoethyl ether acetate and then adding one part of this solution to 100 parts of a petroleum naphtha extract of pyrethrum flowers prepared by extracting 1.2 pounds pyrethrum flowers with a deodorized petroleum naphtha. The resulting product was a stable, non-volatile, substantially odorless solution of excellent insecticidal properties. When tested according to the Peet-Grady method the solution repeatedly gave a knock down value of 98 and a kill of 85.

Coe (85), in U. S. patent 2,090,109, issued August 17, 1937, applied for November 15, 1933, claims a composition of matter comprising a suspension of a powdered insecticide of plant origin subject to deterioration by ordinary light, in a colored globule-forming liquid of adhesive tendency and nonrepellent to insects, the color of the globule-forming liquid

having a spectral transmission of above 4900 Angstrom units of the visible spectrum. He also claims a composition of matter comprising rotenone the individual particles of which are coated with a dry chlorophyll-green film.

As an example of the application of this invention, a liquid gelatin is formed by dissolving the gelatin in water. The resulting liquid gelatin is then colored with a water-soluble chlorophyll-green dye which may be made of thiocarmine blue and tartrazine yellow. Powdered rotenone is then added to the chlorophyll-green liquid gelatin. The amount of rotenone to be used is governed by the desired toxic strength of the insecticide, and sufficient water is added to bring the suspension to the desired consistency for spraying purposes.

Donlan (117), assignor to Stanco, Inc., in United States patent 2,096,885, issued October 26, 1937, applied for October 21, 1933, claims an insecticidal composition comprising as an active ingredient a substantial quantity of mineral oil of 500° to 600° F. boiling range consisting predominantly of paraffinic hydrocarbons segregated from the normally accompanying naphthenic hydrocarbons and added active insecticidal principles of vegetable origin, e. g., pyrethrum, cube, tuba and haiari.

Jones (222), in United States patent 2,103,195, issued December 21, 1937, applied for July 3, 1937, dedicated to the free use of the people of the United States of America claims a new chemical combination of rotenone and dichloroacetic acid having the empirical formula $C_{23}H_{22}O_6 \cdot C_2H_2O_2Cl_2$. He also claims a process for making a chemical compound of rotenone and dichloroacetic acid, which comprises essentially dissolving an extract of plant material (e.g., Derris, Lonchocarpus, Tephrosia) containing rotenone in dichloroacetic acid, adding water, and separating the resulting crystalline product. Reference is made to the addition compounds of rotenone with acetic acid, propionic acid, and alpha-chloropropionic acid, in each of which the molecular ratio is two mols of rotenone to one mol of acid.

O'Kane (311), in United States patent 2,104,757, issued January 11, 1938, applied for May 31, 1934, claims as an insecticidal agent a substantially nonaqueous combination of an oil selected from the class consisting of vegetable and animal oils, a contact insecticide selectively soluble in said oil, and an emulsifying agent soluble in said contact agent in proportions to give an unstable dispersion in water.

Among the insect poisons, a wide variety of materials may be included, and particularly exemplifying the nerve poisons or contact insecticides, there may be mentioned the extracts of pyrethrum flowers, and other oil-soluble extracts, such as those of derris root, cube root, or oil-soluble nerve poisons, such as the active principle of strychnia, as well as synthetic chemicals including various amine derivatives.

PROPRIETARY INSECTICIDES MADE FROM LONCHOCARPUS

J. D. Smith (384), American Commercial Attache at Lima, Peru, on May 21, 1934, advised that "Cubex" is an insecticide made from Peruvian cube by Piaggio and Turpino at Lima, Peru. Clark (82), Assistant Trade Commissioner at Lima, Peru, in 1937 reported that the cube used in manufacturing Cubex is sold by W. R. Grace and Company who bring it from Iquitos to Lima. According to Crilley (108), more Cubex was sold in 1936 than previously. Greenup (175), American Commercial Attache at Lima, Peru, in 1937 advised that Cubex is used only as a general household insecticide for killing flies, etc., but it is understood that the manufacturer is planning to make a compound for agricultural purposes.

Fisher and Bailey (149) in 1937 published a compilation of information on commercial insecticides. Products made from cube include Pyrote made by the Mechling Bros. Chemical Co., Camden, N. J., and Ro-Tone made by the Lucas Kil-Tone Co., Vineland, N. J.

STATISTICS AND PRICES

Information on the exportation of cube from Peru is given by A. J. F. (135), Anon. (4), Crilley (99, 100, 103, 104), Dennis (113), Koloniaal Instituut of Amsterdam (251), Spoon (389), and the United States Department of Agriculture (412), but the official statistics of the Peruvian government (320-324) are given below.

Exportation of barbasco (cube) from Peru (in pounds*)

<u>To</u>	<u>1931</u>	<u>1932</u>	<u>1933</u>	<u>1934</u>	<u>1935</u>	<u>1936</u>
Australia						1,155
Belgium					5,485	
France		944	3,801	10,236	135,562	401,125
Germany		172	229	7,535	99,118	68,839
Great Britain		2,436	9,905	42,565	147,346	166,187
Holland						3,660
Sweden		1,490				
United States	3,979	11,936	21,520	501,104	581,517	156,338
Total	3,979	16,978	35,455	561,440	969,028	797,304
<u>From</u>						
Callao	827	1,733	336	8,867	3,624	5,406
Eten			229			
Iquitos	3,152	15,179	34,340	552,573	964,866	791,461
Mollendo						437
Paita		66			538	
Total	3,979	16,978	35,455	561,440	969,028	797,304

*Calculated to the nearest whole pound from the original figures (kilograms), using the factor 1 kg. = 2.20462 pounds.

According to Dennis (113) a shipment of 100 kg. of cube made by him in 1928 constituted the first commercial shipment of this commodity from Peru to the United States.

The Imperial Institute of Great Britain (217) in 1934 reported the appearance in London of samples of cube and remarked, "Should supplies of cube root become available in commercial quantities it seems likely that it will prove a serious competitor of derris."

The Handelsmuseum (249) of the Koloniaal Instituut of Amsterdam in 1936 compared exports of cube from Brazil during 1930 to 1934, inclusive with exports of derris from the Malay States and the Dutch East Indies. These figures show an increasing use of cube.

According to Kansanjan (224), American Vice Consul at Para, Brazil, exports of timbo roots from the State of Para, Brazil, showed a substantial increase in 1936 over 1935 deliveries.

Exportation of timbo from the State of Para, Brazil (in pounds)

To	1935		1936	
	Roots	Powder	Roots	Powder
United States	154,325	290,020	82,673	1,457,891
Europe	-----	13,629	145,725	345,001
Japan	-----	6,614	-----	11,023
South Brazil	-----	13,984	657	12,059
Total	154,323	329,247	229,055	1,825,974

Seltzer (371), American Consul at Para, Brazil, reported on rotenone in Brazil under date of June 29, 1935. There are reported to be several varieties of plants commonly known as "timbo" that yield a poison used for killing fish, but real "timbo" is scarce, except on some of the upper rivers. Several shipments of the roots were made in 1933 and early in 1934, but some proved to be worthless because the natives collecting the roots in the interior were not acquainted with the plants that yield a sufficient percentage of rotenone, nor were the firms exporting in a position to guarantee that the roots shipped contained any rotenone at all. By a decree of April 3, 1934, the State of Para prohibited the exportation of "timbo" roots, permitting exportation of only the powder. However, it is reported that no such law exists in the State of Amazonas, but while several small trial shipments were made from Manaus in 1933, no firms have yet gone into the business of exporting these roots.

The Chemical Division of the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce (429), on June 29, 1935, announced that it had been informed of the interest of two Ecuadorian firms in the sale of rotenone-bearing botanicals to American importers.

Crilley (99) on July 10, 1935, reported that the Peruvian Government was planning to instal at Iquitos a plant for grinding the roots so that these would be exported in pulverized form only, thus reducing transportation charges and at the same time preventing the exportation of fresh roots.

McDonough (276, 277), American Consul General at Guayaquil, in September 1935, and again in October 1935, reported that in Ecuador there has been established an export market for a domestic product called "barbasco." Although only small shipments have been made so far, it is understood that deliveries of barbasco for export purposes are increasing. Twenty-six sucres per quintal equivalent to about 5¢ per pound is the price paid in Guayaquil by exporters. The foreign market for barbasco is the United States, where it is to be used as an insecticide.

Browne (55), American Consul at Medan, Sumatra, on October 10, 1935, transmitted a copy of a pamphlet issued by the Agricultural Insecticide and Fungicide Association, 285 Madison Ave., New York City, in which it is stated that according to "Association Terms" whole cube must not contain more than 12 percent moisture on arrival.

Exports of nekoe roots from Surinam were reported as follows by the Handelsmuseum of the Koloniaal Instituut (248) of Amsterdam in 1934:

<u>Year</u>	<u>Metric Tons</u>
1929	4 (8,818 pounds)
1930	0.2 (441 pounds)
1931	---
1932	6.5 (14,330 pounds)

The United States Department of Commerce, Bureau of Foreign and Domestic Commerce (430), on March 21, 1936, announced that it was prepared to supply monthly a specially prepared statistical statement showing imports entered for consumption of cube (timbo or barbasco) root, and derris or tuba root. Particulars will be furnished of quantity and foreign value by countries of shipment, and by United States Customs districts. Typewritten statements will be sent to subscribers 4 to 6 weeks after the close of the month under review. Subscription price is \$5 for one year.

On April 1, 1936, Wright (478), Secretary of the National Association of Insecticide and Disinfectant Manufacturers, Inc., called attention to this announcement.

The United States Department of Commerce, Bureau of Foreign and Domestic Commerce (434), on June 13, 1936, made a further announcement concerning rotenone import statistics. Effective with January, 1936, statistics, the Bureau has made available monthly import statistics by

quantity and value for (a) customs districts of entry, and (b) countries from which entered for (1) crude cube (timbo or barbasco) root and (2) derris (tuba) root. Effective with April statistics, the service will include data for the classification (3) "Cube (timbo or barbasco) root, and derris (tuba) root, advanced in value" (dutiabale).

Greenup (174), American Commercial Attache at Lima, Peru, on April 7, 1936, reported that practically all Peruvian exports of cube are from Iquitos. For instance, during 1935 only 2,888 kilos were shipped from other ports - 2,644 from Callao and 244 from Paite.

Demand for barbasco has been such as to suggest that this product will take a place among the more important exports of the nation. Exports gained from 1.8 metric tons in 1931 to 429.5 metric tons in 1935, the United States having been the market for 100 percent of the 1931 total. Although exports to the United States have increased from year to year, those to the United Kingdom, France, and Germany have been relatively greater. The distribution of 1935 exports was as follows: United States, 60 percent; United Kingdom, 15.20 percent; France, 14.00 percent; Germany, 10.23 percent; and Belgium, 0.57 percent.

Crilley (104), Assistant Commercial Attache at Lima, Peru, on July 22, 1936, wrote that "Huasco barbasco" is a local name applied to cube.

"Peruvian exporters of cube ship only on the basis of irrevocable letter of credit before shipment. American firms attempting to deal direct with Iquitos merchants may find it difficult to protect themselves. Since the importer in the United States will have to pay on shipping weight the loss on fresh root might be heavy. No peruvian firm is known to be willing to ship by draft against documents with acceptance of the draft subject to analysis upon arrival.

"The price per pound of guaranteed 4 percent rotenone content is said to be 18 to 20 cents in New York. Peruvian cube is sold often at 4 percent minimum content with a premium payable for each additional percent in proportion. It is the practice of some houses in the United States to buy entirely on the basis of 5 percent rotenone content, paying for nothing over 5 percent.

"Quotations at Iquitos are not as yet obtainable in Lima. Iquitos firms buy cube green and dry it before shipment, paying, it is said, from 40 to 50 centavos Peruvian per kilo (10 to 15 cents U. S. Cy.). Arrivals of cube at Iquitos are irregular. Small lots come down the river by raft, canoe, and river steamers. When the demand is strong cube prices seem to be related with those for fish in the Amazon regions since the Indians and small farmers may prefer to use their home-grown crop for fishing rather than transport it to Iquitos for sale."

Crilley (105) on September 23, 1936, advised that Peruvian cube stocks at Iquitos, Peru, were low.

"Several sources state that exploitation has decreased in consequence of the low-prevailing prices for cube in the New York and European markets. Another reason for reduced stocks is that old cube plantations are about exhausted and new plantings will not begin to produce until next year.

"Exporters of cube in Iquitos frequently guarantee a rotenone content not less than 5 percent. In many cases shipments have contained from 5 to 8 percent while in others the range has been from 3-1/2 percent to 11 percent rotenone content. One Iquitos firm states that for some time it has been selling its entire production exclusively to European consumers, but at present it can only supply "5 tons monthly at 3 cents gold per lb. C. I. F. New York per unit of rotenone content, without limit, on weight at time of unloading, which is the price obtained in Europe."

Schraud (369), American Vice Consul at Puerto Cortes, Honduras, in 1936 reported that a firm in San Pedro Sula is of the opinion that cube root and other rotenone-bearing plants grown in Honduras can be exported to the United States.

Crilley (102), U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce, reported on December 23, 1936, that Peruvian cube production may be curtailed.

Cube planters in the Iquitos district have decided to limit root extraction until the local price increases to 60 centavos per kilo, according to reports received in Lima. It is also said that further plantings might not be made. Planters claim American users of rotenone pay 20 cents U. S. Cy. per pound for cube of 8 percent content or 2.5 cents U. S. Cy. for each one percent rotenone, which does not justify the low prices of 40 to 50 centavos per kilo paid to planters by cube buyers in Iquitos. One editorial in a Lima paper advocated Government intervention in regulating cube prices and suggested the establishment of a chemical laboratory in Iquitos to assist producers in ascertaining the exact rotenone content of their shipments.

The Koloniaal Institute of Amsterdam (251) in 1936 summarized recent Dutch work on the insecticidal value of derris and Lonchocarpus. Rotenone also occurs in the roots of various species of Lonchocarpus (especially Lonchocarpus nicou). These are commonly known by their native names of cube (Peru), timbo (Brazil), nekoe (Surinam) (L. chrysophyllus), nicou (French Guiana), and haiari (British Guiana). Cube root is becoming a serious competitor of derris via the American market, being exported to the U. S. A. on the Amazon. Biological tests suggest, however, that, with the same rotenone content, derris is to be preferred to cube owing to the greater activity of the non-rotenone components. In recent years Lonchocarpus (white and black

haiari) from British Guiana has been cultivated experimentally in Malaya. The roots, harvested after two years, were, however, found to contain only a low content of rotenone and of ether extract. The cultivation of nekoe from Surinam is also being tried out at Buitenzorg. The exportation of cube from Peru and of derris from Malaya and the Dutch East Indies is shown from 1930 to 1935 (9 months).

Clark (82), Assistant Trade Commissioner at Lima, Peru, in 1937, reported on the production of cube in Peru. Iquitos is the port of export and distributing point for all exports produced in the region served by the Amazon and its navigable tributaries. Several fair-sized firms carry on a general import and export business and finance various parties engaged in exploiting the resources of the region. There has been considerable dissatisfaction among the primary suppliers in the Iquitos region because of the low prices paid for cube by the Iquitos merchants. It is said that the Indians in retaliation mix cube with other materials, thus resulting in a low rotenone content per ton. It appears that the established Iquitos merchants can be circumvented in this trade only by the appointment of an individual or firm to buy directly and exclusively on the behalf of an American firm. Since the traffic in cube is limited it is highly improbable that an individual could be found that could work in competition with these organized suppliers and quote prices considerably lower. Cube root is grown in scattered regions in the southern part of Peru, but not in dependable commercial quantities. To transport the cube to Callao from these areas would necessitate the use of the railroads or trucks, which would entail considerable more expense than the crude raft transportation medium employed in carrying cube to Iquitos. May and June is the gathering season. Cube root from a plantation in the Department of Ayacucho is said to have a rotenone content of 7.5 to 8 percent. It appears on the whole that the Iquitos prices could not be bettered at present, because it is only in Iquitos that cube can be reliably obtained in commercial quantities. To illustrate, a farmer in Ayacucho might promise three tons in six month's time and in the end perhaps a half ton would be delivered.

The United States Department of Commerce(436) in 1936 issued statistics on rotenone-bearing root imports into the United States during the first 9 months of 1936, and in 1937 it (438) published preliminary statistics for the entire year 1936.

The United States Tariff Commission (445) in 1937 also published statistics of 1936 imports of derris and cube.

Bohan (32), American Commercial Attache at Santiago, Chile, reported in 1937 that derris and cube roots have not been used in the Chilean agricultural insecticide market.

According to Nabuco de Araujo 294, about 10 tons of timbo were exported from Brazil during 1933, at about 430\$000 (about 28 dollars) per metric ton. During 1936 exportation amounted to 868 tons of powdered timbo with a value of 3,600 contos de reis, and in 1937

exportation of 10,000 tons is expected at an average price of 500\$000 per metric ton. Six extraction plants are now in operation, with 3,500 contos de reis of capital and employing about 300 workmen.

Crilley (107) in 1937 reported that cube planters in the Iquitos district of Peru have decided to limit root supplies until the local price increases to 60 centavos per kilo, according to reports received in Lima. It is also said that further plantings might not be made. Planters claim that the American market prices do not justify the low prices of 40 to 50 centavos per kilo paid to planters by cube buyers in Iquitos.

An editorial in a Lima paper advocated Government intervention in regulating cube prices and suggested the establishment of a chemical laboratory in Iquitos to assist producers in ascertaining the exact rotenone content of their shipments.

Crilley (108) in 1937 reported on cube exports from Peru. The exports of cube root from Peru increased from 254,665 kilos in 1934 to 439,544 in 1935. In the first 10 months of 1936 exports totaled 303,125 kilos. Planters complained during 1936 of low prices and exporters complained of unethical practices such as shipping root of mixed qualities of rotenone content, which fact may tend to influence foreign buyers unfavorably. It is believed that new plantings are not being made as rapidly as was reported to be the case last year. Practically all shipments are exported from Iquitos. Government intervention in regulating prices and standardizing the new industry was suggested. Principal buyer of Peruvian cube is the United States, which took 263,772 kilos of 1935 exports.

Cube was used to an increasing extent in Peruvian production of cattle dips and insecticides, for the sale of which considerable advertising was done. At least one small factory in Lima ground the root for local use. The insecticide "Cubex" was reported to have been sold in larger volume in 1936 than previously. Some criticisms were heard from home users concerning the odor of domestic insecticides as compared with the more pleasing scent of certain imported American products.

Spoon et al. (390) in 1937 published the following statistics of Lonchocarpus root exports:

Exports (in metric tons)

<u>Year</u>	<u>From Peru</u>	<u>From Surinam</u>
1930	?	0.2
1931	2	--
1932	8	7
1933	16	--
1934	255	1
1935	440	6
1936	362	--

Clark (81 and 83), Assistant Trade Commissioner, at Lima, Peru, on August 26, 1937, reported that although only 361,651 kilos of cube was exported from Peru in 1936, as compared with 439,544 kilos in 1935, plantations have been laid out on nearly all the rivers of the Amazon region, and good shipments are expected in the near future. Exports during the first five months of 1937 were 168,556 kilos, valued at 439,217 soles. France was the principal purchaser in 1936, importing 181,947 kilos; followed by England with 75,331 kilos; and the United States, which had been the largest consumer of the Peruvian root since 1931, imported only 79,914 kilos, as compared with 263,112 kilos during 1935.

Dennis (114) in 1937 discussed the growing competition of Brazilian timbo with Peruvian cube.

"Certain scientists, especially some in the Department of Agriculture at Washington, unwittingly gave out the impression that rotenone was the toxic element in cube, when as a matter of fact it is the whole cube root that is valuable."

"One reason for the arrival of so much from Brazil, in fact the main reason, was that the product was offered much cheaper, the average price was 6 cents a pound, while the average of Peruvian cube was 11."

"I also have a registered trade mark and hope to educate the trade to expect the trade name CUBE ROOT."

Barrington (19, 20), Assistant Trade Commissioner, at Rio de Janeiro, Brazil, on September 30, 1937, reported exports of timbo from Brazil during January to June 1937, inclusive, to be as follows:

	<u>Pounds</u>	<u>Value</u>
Timbo root	268,831	\$ 25,175.25
Timbo powder	<u>1,080,577</u>	<u>191,996.47</u>
Total	1,349,408	217,171.72

The northern States of Pará and Amazonas are the largest producers of this product. Exports are made primarily from the port of Belém, Pará. During 1936, shipments from Belém totalled 863,108 kilos (1,902,823 pounds), valued at 3,593 contos (\$261,066). Six firms of that city were active in the trade, with two accounting for a substantial share of the total.

The United States Department of Commerce, Bureau of Foreign and Domestic Commerce, in October 1937 (440) published statistics for the first 8 months of 1937 and in 1938 (443) it published preliminary statistics on imports for the entire year of 1937 of rotenone-bearing roots into the United States.

The final figures for 1936 and the preliminary figures for 1937 are shown in the following table:

Rotenone-bearing root imports into the United States

Item and Country	1936		1937	
	Pounds	Value	Pounds	Value
Derris root, crude				
British Malaya	332,251	\$69,182	401,975	\$72,613
Netherlands Indies	28,581	5,145	57,524	11,329
Philippine Islands	149,505	21,626	110,528	14,046
Other Br. West Indies	---	---	314	63
Total	510,337	95,953	570,341	98,051
Cube, timbo, or barbasco				
Root, crude				
Brazil	508,570	34,044	197,892	16,677
Colombia	1,200	156	---	---
Peru	171,600	19,350	294,484	35,070
Venezuela	22,750	1,775	---	---
Total	704,120	55,325	429,376	51,697
Advanced in value				
Brazil	1,124,936	172,239	1,162,228	175,733
Total	2,339,393		2,161,945	

The United States Department of Commerce (442) in December, 1937, reported that cube exports from Peru were down. The total cube root exported from Peru for the first 8 months of 1937 amounted to 254,082 kilograms, valued at 568,705 soles (one sole equals approximately 25 cents, U. S.), as compared with 287,716 kilos, valued at 609,817 soles, in the corresponding period of 1936.

No cube is shipped from the Peruvian ports on the Pacific Coast, with the exception of small sample lots of the dried root which have been brought overland from Iquitos, or sample lots of rotenone extracted from such roots in Lima. Almost all cube shipped from Peru is from the Amazon River port of Iquitos and goes to the United States or Europe by way of the Amazon River and the Atlantic Ocean.

The American Commercial Attache (325) at Lima, Peru, on March 12, 1938, reported that preliminary statistics of the United States imports of cube root show an increase from 171,600 pounds in 1936 to 294,484 in 1937. It is stated in Lima that the failure of cube root to obtain greater acceptance on the American market has been caused in some measure by the lower quotations offered on Brazilian timbo and the poor quality of the roots shipped from Iquitos during 1935. It is said that in 1937 the buyers of cube root in Iquitos were more alert in purchasing roots from the native planters. The practice of analyzing the roots for rotenone content before shipment was established, and in some cases roots were dried before shipment. Foreign buyers reported that shipments arrived in better condition and fewer claims were in evidence.

Cube was used in increasing amounts in Peru in the local production of cattle dips and household insecticides. There is one cube grinding plant of importance in Lima and one in Iquitos.

Brooks (54), American Commercial Attache at Bogota, Colombia, in October, 1937, submitted samples of rotenone-carbon tetrachloride solvate manufactured by the Cia. de Productos Quimicos, S. A., Apartado 1635, Bogota, Colombia. These were analyzed by the Division of Insecticide Investigations of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, and found to be as represented and to be 94 percent pure. The United States Department of Commerce (441) in November, 1937, called attention to the desire of this firm to develop an export market for this product.

Derris, Inc. (115), under date of June 14, 1937, stated their prices of derris and cube powders to be as follows:

Domestic milled derris powder

	<u>4%</u>	<u>5%</u>
2,000 lbs. to 10,000 lbs.	35¢	41¢
1,000 lbs. to 2,000 lbs.	36-1/2¢	42-1/2¢
200 lbs. to 1,000 lbs.	38¢	44¢
Less than barrel prices:		
100 lbs.	39¢	45¢
50 lbs.	40¢	46¢
25 lbs.	41¢	47¢
10 lbs.	43¢	49¢
Less than 10 lbs.	47¢	53¢

Domestic milled cube powder

2,000 lbs. to 10,000 lbs.	24¢	29¢
1,000 lbs. to 2,000 lbs.	26¢	31¢
200 lbs. to 1,000 lbs.	28¢	33¢
Less than barrel prices:		
100 lbs.	29¢	34¢
50 lbs.	30¢	35¢
25 lbs.	31¢	36¢
10 lbs.	33¢	38¢
Less than 10 lbs.	37¢	42¢

Terms: 1% 10 days, 30 days net.

These prices apply to all territory in U. S. A. and Canada. All prices f.o.b. Newark or Baltimore, sales to Pacific coast points freight paid to seaport. Contracts will be accepted for delivery up to September 30, 1937.

Larger quantities are available at lower prices. Quotations sent upon request.

LAWS RELATING TO LONCHOCARPUS

The Bureau of Customs of the United States Treasury Department, in Treasury Decision 47230 (446), issued August 25, 1934, classified ground timbo and derris roots as follows:

"(1) Insecticides of vegetable origin.--Ground timbo root and ground derris root, vegetable substances which are natural and uncomounded, advanced in value by grinding, and not containing alcohol, and which are used as insecticides in manner and purpose identical with the manner and purpose in which ground pyrethrum flowers are used, are dutiable under paragraphs 35 and 1559, Tariff Act of 1930, by similitude to ground pyrethrum flowers.

"Pyrethrum extracts and other vegetable extracts are excluded from classification under paragraph 35, directly or by similitude, because they are not natural substances (T. D. 33522). If they are insecticides and not chiefly used for the prevention of disease in man or animals (T. D. 47038), they are dutiable as nonenumerated manufactures at the rate of 20 percent ad valorem under paragraph 1558, Tariff Act of 1930. Bureau letter to the collector of customs, New York, N. Y., August 3, 1934."

Griffith (177), of the Bureau of Customs, United States Treasury Department, on May 8, 1936, advised a prospective exporter of cube in Venezuela as follows:

"The Bureau is of the opinion that crude barbasco (cube root) is entitled to free entry as a crude drug under paragraph 1669 or crude vegetable substance under paragraph 1722 of the Tariff Act of 1930. Powdered barbasco (cube root) is classifiable by similitude to ground pyrethrum flowers and is dutiable at 10 percent ad valorem under paragraphs 35 and 1559 of the Act."

Griffin (176), in an address before the twenty-third annual meeting of the National Association of Insecticide and Disinfectant Manufacturers at Philadelphia, December 1936, outlined the provisions of the Federal Insecticide Act of 1910 and the procedure followed by the Food and Drug Administration in enforcing it. Relative to cube the following was said:

"In preparations containing derris or cube root extractive material, it is known that the rotenone, the deguelin and certain other compounds are insecticidally active. However, there are no practical methods known for identifying and determining the percentages of every one of the active consti-

tuents other than rotenone and since it has been found that all of the active constituents of derris root or cube root can be extracted with ethyl ether, no objection is raised to considering this ethyl ether extract, known as "derris resins" or "cube resins," as the active ingredient of derris or cube preparations."

The United States Department of Agriculture, Food and Drug Administration (427), on February 8, 1938, issued the following ruling on the labeling of derris and cube powders and other rotenone-bearing insecticides.

Derris root powder and cube root powder are inherently insecticides. Derris contains as active ingredients rotenone and certain other compounds, such as toxicarol, tephrosin, and deguelin, and cube contains, in addition to rotenone, tephrosin and deguelin, as well as others. In the absence of practical methods for determining the percentages of these constituents, other than rotenone, and since all of these active ingredients are soluble in ethyl ether, no objection has been raised to considering all of that portion of the root which is soluble in ethyl ether as active and designating it "derris resins" or "cube resins", as the case may be. The root fiber which is not soluble in ethyl ether is inert. For derris root powder, the following form of ingredient statement, which should appear upon the front or main panel of the label, is acceptable:

ACTIVE INGREDIENT	
Derris resins	_____%
INERT INGREDIENTS	_____%
TOTAL	_____100%

the correct values being inserted in the blank spaces where indicated. A similar form of statement may be used for cube root powder, substituting the percentage of cube resins for that of derris resins. It does not fulfil the requirements of the law to state "Derris and/or cube resins", since a statement of this character does not definitely specify the active ingredient.

ROTENONE: In enforcing the Insecticide Act, the Administration has not required that the percentage of rotenone be stated on the label of derris root powder or cube root powder. However, owing to the trade practice of selling on the basis of rotenone content, manufacturers frequently desire to make such a statement on their labels and no objection is raised to this procedure, provided the value given is correct. It should be in terms of percentage of pure rotenone and not "Crude rotenone", which contains considerable amounts of impurities.

The following forms of ingredient statement may be used:

For derris powder:

ACTIVE INGREDIENTS	
Rotenone	_____%
Other Derris Resins	_____%
INERT INGREDIENTS	_____%
TOTAL	100%

For cube powder:

ACTIVE INGREDIENTS	
Rotenone	_____%
Other Cube Resins	_____%
INERT INGREDIENTS	_____%
TOTAL	100%

the correct values being inserted in the blank spaces where indicated. Claims that products containing the active ingredients of derris root and cube root are non-poisonous or harmless are unwarranted. Products recommended for dusting the coats of animals should not be labeled as "Non-poisonous when used as directed."

TIMBO AND BARBASCO: At the present time, methods for differentiation between cube roots and similar roots which may be imported under the name "timbo" or "barbasco" have not been worked out. Therefore, no objection has been raised to considering all of these closely related products as cube roots.

According to the United States Department of Agriculture, Food and Drug Administration (426), R. J. Prentiss & Co. Inc., on May 10, 1937 pleaded guilty to a charge of adulterating and misbranding derris. This product was represented to be derris, which contained a minimum of 5 percent of rotenone, but which in fact consisted of cube root containing less than 5 percent of rotenone.

The Bonide Chemical Co., Inc., on December 9, 1936, pleaded guilty to a charge of misbranding Bonide Dog-Zop Shampoo and Flea Killer. The percentage of water was not stated.

Cox (93), Chief of the Division of Chemistry of the California State Department of Agriculture, in his annual report for 1935 held that only rotenone in cube or derris would be considered active. It is permissible, but not required, to state whether the rotenone in an insecticide comes from derris or cube. Later Cox (63) modified this ruling to permit California manufacturers of insecticides to label their rotenone products with the total ether extractive content so as to conform with the ruling of the U. S. Food and Drug Administration.

Seltzer (372), American Consul at Para, Brazil, in a letter dated June 25, 1936 furnished the following information concerning the timbo industry of Brazil.

"It is understood that there are numerous varieties of plants in the Amazon Valley that are commonly known as "timbo" and that yield the poison that is used for killing fish. Several shipments of the roots were made from Para in 1933 and during the early part of 1934. The natives collecting the roots in the interior were not acquainted with the plants that yield a sufficient percentage of rotenone. The firms exporting the roots were also unacquainted with the plants and were not in a position to guarantee that the roots they shipped really contained any rotenone at all. Consequently some of the shipments made to the United States at the time proved to be worthless. The two best yielding varieties of this plant are said to be the "timbo macaquinho" (Lonchocarpus nicou) and "timbo urucu" (Lonchocarpus urucu).

"By decree No. 1259 of April 3, 1934, the Government of the State of Para prohibited the exportation of timbo roots and permitted its exportation only when ground into powdered form. The purpose of the decree was to promote the local manufacture of this product.

"A committee of important business men appointed by the local chamber of commerce to prepare suggestions bearing on the revocation of the mentioned decree, presented to the Governor of the State on July 5, 1935, a memorial signed by 71 firms, which emphasizes the fact that the prohibition decree is causing losses to trade, to the people and to the State Treasury, and benefiting Peru and the other producing countries; and that as a result of prohibition the market price of the roots immediately fell. The memorial recommended that the trade, exportation and industry be free.

"The Governor of the State was evidently in favor of permitting the exportation of the timbo roots. Accordingly, with his permission, one of the local firms on July 23, 1935, shipped 60,000 kilos of these roots to New York. However, inasmuch as only the State Legislature can modify the law, the Governor on September 26, 1935, sent a message to the State Legislature requesting immediate action. Late in November 1935 the Committee of the Legislature reported in favor of continuing the prohibition of exportation of the roots. The regular session of this Legislature terminated on December 31, 1935, without having taken any definite action.

"Inasmuch as the general policy in recent years has been to promote and protect the manufacture locally of all natural and cultivated products, and as the consensus of opinion here seems to favor the retention of the prohibition, it is definitely understood that should this bill come before the Legislature at its session due to begin in July of this year, the prohibition decree will be approved and retained.

"As a result of the opinion favorable to the retention of the prohibition decree, those exporters who had accumulated large stocks of the roots, which they expected to be able to ship, rather than lose the large amounts of money tied up in these stocks, decided to install the necessary machinery for grinding the roots into powder. As a result there are now five firms in Para that are shipping or will soon be ready to ship the powdered timbo root.

"Although it is understood that there is a growing sentiment in Manaus in favor of prohibiting the exportation of timbo roots, as far as is known the State of Amazonas has not yet passed any law that prohibits their exportation. Information obtained from Manaus indicates that exports of timbo roots in 1934 amounted to 7,244 kilos and in 1935 to 54,176 kilos. All of the shipments went to New York. It is understood that a new source of supply of good-yielding timbo has been found on the Solimoes River in the State of Amazonas, with the result that several firms are now actively interested in the exportation of roots.

"Numerous varieties of the timbo plant are also known to exist in the States of Maranhao and Piahy. Information obtained recently from one of the leading exporters in Maranhao indicates that a sample shipment was recently sent to the United States for analysis, which gave negative results. The same firm also sent samples for analysis to Rio de Janeiro and Sao Paulo. If this analysis should indicate a satisfactory percentage of rotenone, American firms will have in the State of Maranhao another source of supply of these roots. It is understood that there is a plan on foot to erect a factory for the grinding of the roots into powder and when that is ready for operation, there is a probability that the Government of that State will prohibit the exportation of the roots.

"Timbo plants are also known to exist in the State of Piahy, but unfortunately none of the larger exporting firms in Parnahyba seems to have shown any interest in this commodity up to the present time.

"This consulate has been given to understand that the State Departments of Agriculture both in Para and Manaus have in their nurseries a certain number of the timbo plants and that it is the intention of these Departments to distribute these plants to farmers and individuals. The Japanese plantation on the Acara River and another large agricultural undertaking are known to have planted the timbo. The native in general, however, does not seem to show much interest in planting. As in the cases of other economic plants in the Amazon Valley, the native worker will undoubtedly gather whatever timbo roots he finds available, and when the wild plants are no longer available, he will turn to other work.

"Colonel Raymundo Monteiro da Costa, one of the best known Brazilian authorities on all that concerns the Amazon Valley, gave this consulate to understand that it is his opinion that unless the natives in general soon begin planting timbo, at the end of three or a maximum of four years, no timbo roots will be available in the State of Para"

The United States Department of Commerce, Bureau of Foreign and Domestic Commerce (437) in 1936 published information received from the commercial Attache at Caracas, as follows:

"A 90 percent cut in the tax imposed on barbasco exploitation under the law of Forests and Waters has been announced by the Venezuelan Ministry of Agriculture. It is said that the high tax made it commercially unfeasible to develop collection of the roots on an export basis."

Barrington (18), Assistant Trade Commissioner at Rio de Janeiro, in May 1937, reported that the Government of Para, in a recent decree, concedes exemption of State taxes, including State export taxes, for a period of ten years to any firm establishing a plant for the extraction of rotenone from timbo roots, according to notices appearing in the Rio de Janeiro press.

Nabuco de Araujo (294) in 1937 wrote that *Lonchocarpus* species grow abundantly throughout the Amazon basin, and Brazil seems destined to become the largest producer of cube, or timbo as it is called in that country. Several firms and individuals have recently started a campaign locally to interest farmers in the cultivation of the species of timbo that will give the largest percentage of rotenone. They have also obtained the cooperation of government authorities, and recently several deputies have proposed a law establishing three experimental stations in order to facilitate the planting and cultivation of timbo roots on a scientific base. This law will represent an effort to avoid the exportation of timbo roots and to increase the present output of the grinding industry.

REVIEWS AND MISCELLANEOUS INFORMATION

The most complete reviews of the literature on rotenone-bearing plants are those by Roark on Derris (342), on *Lonchocarpus* (348), and on *Tephrosia* (350). These contain 456, 409, and 601 references, respectively.

Willbaux (467) in 1935, in a very thorough monograph on *Tephrosia vogelii* and related species, reviewed the chemistry of rotenone, deguelin, tephrosin, and toxicarol; the action of rotenone as an insecticide; etc. Reference is made to several species of *Lonchocarpus*.

Kindt (243) in 1935 reviewed information on derris and *Lonchocarpus* taken mostly from Dutch sources.

Mann (267) in 1935 published a very complete review of the pyrethrins, rotenone and nicotine. Tilemans (406) in 1936 published a review of the use of rotenone with 114 references.

Silva (376) in 1935 wrote of Brazilian timbo as a source of rotenone, and Caminha (36) in the same year published a review of information on timbos. The United States Department of Commerce (431) has called attention to Caminha's paper.

Morales y Valcarcel (286) of the Agricultural Experiment Station of Santiago de las Vegas, Cuba, in April 1935, published a popular account of rotenone and of the principal plants in which it is found, namely, Derris, Lonchocarpus and Tephrosia. A list is given of insects, arranged according to host plant, against which derris has been used.

Lecointe (259) in 1936 reviewed information on the rotenone-bearing plants Lonchocarpus, Derris and Tephrosia from the Amazon Valley.

Martin (269) in 1937 published an excellent review of Derris, Lonchocarpus, Tephrosia and Mundulea with special reference to their chemistry and methods for their evaluation.

Wille, Ocampo, Weberbauer and Schofield (471) have recently published a bulletin of 117 pages, 26 figures and 163 references on cube and other barbaços of Peru. The following topics are discussed: the botany, cultivation, chemistry, use as an insecticide, and commercial importance of cube.

Clark (81), Assistant Trade Commissioner at Lima, Peru, on August 26, 1937, and again later (83) called attention to this bulletin of Wille et al. on cube.

Many reviews and popular articles that mention rotenone, cube, timbo, and related plants have appeared in Spanish, Portuguese, French, German, and English in recent years.

The Argentine Republic, in its Boletín de Informaciones Petroleras (10), in 1934 briefly reviewed the chemistry, use, and occurrence of rotenone in Derris, Lonchocarpus and Tephrosia.

Brazilian writers on rotenone and Lonchocarpus include Silva (374); Nabuco de Araujo (290); and de Oliveira (312).

Krieg (254) in 1934 reviewed information on rotenone, its action on insects, its occurrence in Derris and Lonchocarpus, etc., with 11 references to the literature; and Sprengel (391) in 1937, in a review of scientific progress in the field of chemical insecticides, made reference to work with derris and cube.

In France much interest has been manifested in rotenone, and popular reviews on this subject that include reference to *Lonchocarpus* have been published by J. Chevalier (75); Guerin (178); and Scarone (366). A. Chevalier (73) in 1937 reviewed information on fish-poisoning plants of the genera *Tephrosia* and *Mundulea*. Reference is made to *Lonchocarpus sericeus* L., the bark of which is used to poison fish in America.

Frappa (152) in 1937 reviewed the botany of *Tephrosia*, *Mundulea*, *Lonchocarpus* and *Derris* with special reference to the possibility of their cultivation in Madagascar; and summarized the action of rotenone on mammals, fishes and the different orders of insects.

Much fragmentary information concerning *Lonchocarpus* is scattered through the literature. Brief abstracts of these articles are as follows:

An abstract of Martin's paper on timbo is given by an anonymous (1) writer in the *Pharmaceutical Journal and Transactions* for June 16, 1877.

Hanriot (187) in 1907 pointed out that tephrosin was analogous to but not identical with the timboine of Pfaff (*Arch. Pharm.* 229: 31-48. 1891) and the derride and pachyrizide of Van Sillevoldt (*Arch. Pharm.* 237: 595-616. 1899).

Sack (363) in 1910, in a list of plant products of Dutch Guiana, listed *Lonchocarpus* sp., called nekoe or stinkhout. Reference is made to its use as a fish poison and to the work of Borst Pauwels (Dissertation, Leyden, 1903).

Zornig (480) in 1911 included *Lonchocarpus cyanescens* Benth. in a list of plants that yield indigo.

DeSornay (385) in 1913 gave information concerning the uses of *Lonchocarpus formosianus*, *L. latifolius*, *L. oxycarpus*, *L. sericeus*, and *L. sp.* (Savonnette blanche) as medicine and in industry.

Tschirch (408), in an article on "Cortex Derridis" published in 1925, stated that the derrid of Greshoff and Sillevoldt also apparently occurs in *Lonchocarpus* and other leguminous plants.

Campbell (59), in his review of information on the insecticidal value of rotenone issued in 1932, referred to Bishopp et al. who tested powdered cube against cattle grub, and Clark who isolated deguelin from cube. Cube root has been received by the U. S. Department of Agriculture that was riddled by tunnels of a bostrichid beetle.

Cory (92), at the 1934 meeting of the American Association of Economic Entomologists, acted as discussion leader of the topic, Arsenical substitutes for insects attacking vegetable crops. Cube was mentioned by Hockett and Hervey of New York; Cubor and Kubatox by Turner of Connecticut, Watson of Florida and Marcovitch of

Tennessees. Derris was mentioned by practically all participating in the discussion.

Silva (375) in 1935 reviewed information on rotenone, Derris and Lonchocarpus.

Howard, Mason and Davidson (203) in 1935 stated that "Rotenone dusts" on the market are either derris or cube dusts and the term is a misnomer. Pure rotenone is of little value in the field under practical conditions.

Roark (347), at the Codling Moth Conference held February 26 and 27, 1935, at Urbana, Ill., spoke of the results obtained with derris and cube for codling moth control. The maximum rotenone residue found on a freshly sprayed apple was 10 micrograms per square inch. Cube and derris have not given better results because very little has been put on. The decomposition of rotenone films by light was discussed.

Robinson (357) in 1935, in writing on the preparation and use of insecticidal sprays, mentioned rotenone (from derris and cube) briefly.

Fryer (156) in 1936 spoke of the need of a chemical method for evaluating derris and cube.

Witten (475) in 1936 reported Wm. La Varre's explorations in the Guianas, and in 1937 La Varre (257) himself wrote on exploring for profit. Mention is made of "nekku" and its use as a fish poison and insecticide.

D. H. K. (231) in 1936 briefly referred to recent work of Ambrose and Haag and of Lightbody and Mathews on the toxicology of rotenone and extracts of derris and cube.

Georgi and Teik (163) in 1936 spoke of the increasing competition that Derris faced from other plants, notably cube root (Lonchocarpus sp.), possessing similar insecticidal properties.

Roark and Busbey (354) in 1936, in a list of patented moth-proofing materials, referred to Canadian patent 338,896 which covers a chlorinated hydrocarbon extract of cube as a mothproofing composition.

The article by Page (313) is abstracted by Crilley (101), Assistant Commercial Attache at Lima, Peru, in Economic and Trade Note No. 116, dated October 20, 1936, of the U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce, and is also referred to in the World Trade Notes of that Bureau (106).

J. Chevalier (76) in 1936 reviewed rotenone-bearing plants. Under the name "Cube du Perou" are found in commerce the roots of Lonchocarpus violaceus (= Robinia nicou Aublet), L. rufescens Benth. and some neighboring species. According to Spoon and Rowan, L. chrysophyllus contains rotenone.

Barnett (15) in 1936 reported A. S. Small, High Commissioner for the Malay States, as referring to cube root as an important rival of derris.

Faloon (137) in an article entitled "Is Rotenone Poisonous?" refers to derris and cube powders being diluted with talc to a rotenone content of 0.75 or 1 percent rotenone. "Scientific tests have been made to determine the residue left on apples after a thorough dusting with pure ground cube root--dust that analyzed four percent rotenone. It was found that the apples analyzed six one-hundredths (6/100ths) of a grain of cube dust per pound of apples. Inasmuch as the rotenone represented only four percent of the total dust applied, it is self-evident that the actual rotenone residue would be infinitesimal."

Grilley (103) in 1936 reported the use of cube in Peru for curing mange, as a remedy for certain skin diseases, and for killing lice.

Stoddard (397) in 1937 discussed the growing trend toward derris, cube, and pyrethrum in the use of agricultural insecticides.

"The surface has hardly been scratched as yet. Derris and cube have possibilities which have only been lightly touched. Better and more effective methods of using them will open up new fields. * * * The older insecticide industry was based on a few insecticides of the heavy chemical type, requiring extensive equipment and large capital investment for their economical production. Derris, cube and pyrethrum as raw materials require no investment on the part of the insecticide manufacturer for their production and the investment required in the equipment necessary to convert them into the varied types of finished insecticides which can be made from them is small in proportion to the production and probably within the means of the average small company which is adequately financed."

In an account of the translation of derris constituents in bean plants Fulton and Mason (157) in 1937 mentioned that observation of the use of cube as an insecticide showed similar phenomena.

Nabuco de Araujo (291) in November 1936 and again (293) on March 10, 1937, reported on household insecticides marketed in Brazil. Recently various manufacturers of household insecticides have recommended the addition of small amounts of rotenone to the pyrethrum extracts. The rotenone extract used in Brazil is obtained from Timbo root, which is found in several places in this country, especially in the State of Para. Timbo root is also exported to the United States and several European countries.

The United States Department of Agriculture, Food and Drug Administration (420), in its annual report for 1936, called attention to the rapid development of plant insecticides, such as those containing derris, cube, pyrethrum extracts, and synthetic organic preparations,

particularly for use on vegetables and for late-season sprays on fruits, in order to avoid dangerous spray residues. Since these preparations are new, their limitations are not known and practical tests must be made to determine the truth of the representations under which they are sold and to make sure that they will not cause injury to plants.

Georgi, Lambourne and Teik (162) of the Federated Malay States Department of Agriculture wrote in 1936 that because of growing competition from cube root (Lonchocarpus sp.) the necessity for standardizing high-grade Derris becomes of greater importance.

Tattersfield (400) in 1937 published a report of the work of the Department of Insecticides and Fungicides of the Rothamsted Experimental Station, England, for 1918-1936, in which the investigations on Derris, Lonchocarpus, Tephrosia, and other fish poisoning plants are reviewed.

McDonnell (275) in November 1937 spoke as follows in his address as president of the Association of Official Agricultural Chemists:

"The most recent development in the field of new products is the use of rotenone-bearing plant material and extractives, which are highly toxic to many forms of insect life attacking plants and animals and those occurring in the home. Rotenone is a constituent of many plants of the Leguminosae family and at present the principal commercial sources are Derris elliptica (usually referred to merely as "derris") and Lonchocarpus nicou (known commercially as "cube"), which are imported from the British and Dutch East Indies and the northern parts of South America. It has been known for many years that the roots of these plants contain ingredients highly toxic to insects and some other forms of animal life, but it is only during the past five years that their commercial use for insect control has reached large proportions. There are now scores of commercial insecticides on the market that owe their activity to these materials or extracts made from them. In 1936 this country imported more than two and one-half million pounds of derris and cube in the form of unground and powdered roots. The importations for 1937 will greatly exceed this figure."

F. L. Campbell (61) in 1937 presented information on derris, cube, devil's shoestring, and pyrethrum before the Ohio Vegetable Growers Association. The actions of rotenone and the pyrethrins on insects are compared.

Boam, Cahn and Stuart (30) in 1937 reported on the identification of tephrosin and deguelin from different sources. Clark is credited with having isolated pure tephrosin, m. p. 197-198, from Lonchocarpus nicou roots in 1930 and Boam, Cahn and Stuart in 1936.

Articles or books on insecticides, popular writings on insect control, and reviews of the literature on rotenone and derris which include information on cube have been published as follows:

1929	Wardle, 457
1930	Anonymous, 2
1934	Peet, 317
1934	Roark, 345
1934	Roark, 344.
1935	Hamilton, 183
1935	Hooper, 197
1935	Neu, 301
1935	Maas, 265
1935	Roark, 346
1935	Whittaker, 465
1935	Whittaker & Whittaker, 466
1936	Peters, 326
1936	Martin, 268
1936	Poole, 331
1936	Nat. Cannors Assoc., 295
1936	Nat. Cannors Assoc., 296
1936	Raucourt, 339
1936	Vinas, 450
1937	Cates, 67
1937	Consumers Res., 89
1937	Nat. Cannors Assoc., 297

The United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, by means of press releases, annual reports and the Monthly News Letter, has from time to time called attention to its work on cube. Roark's (348) publication on Lonchocarpus is noted in the News Letter (349) for May 1936, and attention is called to Jones' (219) paper on the optical rotatory power of extracts of derris and cube roots in the News Letter (220) for March 1937. Roark's (350) compilation of information on Tephrosia, which contains some references to Lonchocarpus, is noted in the News Letter (351) for May 1937.

The United States Department of Agriculture (414) on January 13, 1936, published the following under the heading "Search is on for organic chemicals deadly to insects but safe for man."

Preparations containing rotenone -- a natural principle of derris and cube, plants of the Far East and South America -- are now used in many parts of the United States for some insect pests. Certain disadvantages, however, bar their use for some types of insects. For example, derris is not effective against all insects. It is not effective against the celery leaf tier. It repels, but has no other effect, on the semitropical army worm. It does kill the common cabbage worm, however. Like many organic compounds, rotenone and related compounds are rather easily destroyed by sunlight. Although toxic to

codling moth larvae in the laboratory, rotenone preparations, exposed to light and air in a thin spray film, decompose too rapidly for economical use. If the present search for a stabilizer is successful, Mr. Strong says, these compounds may become valuable orchard sprays.

The United States Department of Agriculture, Bureau of Entomology and Plant Quarantine (419), in its annual report for 1935 reported various tests with derris. Cube is mentioned as being studied. Rotenone residues from cube sprays were investigated and 70 samples of derris, cube, and other rotenone-containing powders were examined.

The United States Department of Commerce, Bureau of Foreign and Domestic Commerce, Chemical Division, in its World Trade Notes on Chemicals and Allied Products has frequently called attention to its reports and publications dealing with cube. For example, in the World Trade Notes (432) for May 16, 1936, reference is made to the report of Greenup (174); and in the issue (435) of September 5, 1936, reference is made to Seltzer (372).

The News Edition of Industrial and Engineering Chemistry (433) stated that cube, derris, and other rotenone-bearing roots are rapidly growing in favor with American manufacturers but as yet importations are small. This information is from the Chemical Division, Bureau of Foreign and Domestic Commerce, United States Department of Commerce.

Many casual or incidental references to the occurrence of rotenone in cube are found in the literature of insecticides. These are listed chronologically as follows:

1930	U. S. Dept. Agr., 416
1931	Skinner, 379
1931	Spies, 388
1932	U. S. Dept. Agr., 410
1932	Chevalier, 75
1932	U. S. Dept. Agr., 411
1933	Frydlender, 154
1933	Frydlender, 155
1933	Klein, 244
1933	London Chem. Soc., 264
1933	Schmitt, 367
1933	Crane, 95, 96
1933	Storgaard, 398
1934	Rothamsted, 361
1934	Gimingham, 165
1934	Kindt, 243
1934	British Pharmaceutical Codex, 327
1935	Robin, 355
1935	Burkill, 57
1935	Blijdorp, 29
1935	Butenandt in Richter, 341
1935	Canneri and Magini, 63
1936	Gehlsen, 159

1936	Boyce, 38
1936	Federated Malay States, 142
1936	Nihon Nohyaku Co., 309
1937	Wheatley, 462
1937	Hill, 194
1937	Tisdale, 407
1937	Killip, 242

Dietz of the DuPont Company (116) in 1938 discussed the use of plant extractives in insect control. Mention is made of Derris, Lonchocarpus, Tephrosia, Pyrethrum, etc. Although a search for insecticidally active plant extractives other than those now known is admittedly a fascinating problem, it is one on which a tremendous amount of effort can be spent without yielding any immediate, highly practical or profitable results.

A review of recent progress in stomach poison insecticides, derris, cube, pyrethrum, etc., by an anonymous writer (6) appears in the News Edition of Industrial and Engineering Chemistry for January 10, 1938.

Work with derris and cube for the control of the Mexican bean beetle, the pea aphid, and other pests by State and Federal entomologists is reviewed by the National Cannery Association, Bureau of Raw Products Research, C. G. Woodbury, director (298), in a bulletin issued in January, 1938.

The United States Bureau of Entomology and Plant Quarantine has called attention to the comparison by Roark (353) of cube and derris; and to the procedure of Jones and Graham (226) for the determination of rotenone in derris and cube by extraction with chloroform.

Sievers et al. (373), in their study of North American species of Tephrosia as commercial sources of insecticides, refer to Jones, Campbell and Sullivan (225), who pointed out that the rotenone content of samples of native species of Tephrosia examined by them are not on a par with that of derris (Derris sp.) and cube (Lonchocarpus nicou (Aubl.) DC.) now available, but suggest that more toxic individuals of these species may be found and that the rotenone content may perhaps be increased by selection, breeding, and cultivation.

D. W. Smith (380,381), of the United States Department of Commerce, Bureau of Foreign and Domestic Commerce, has called attention to the report by Spoon (389).

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