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Mitchell,W.C.; Andrew,C.O.; Hagen,K.S.; Hamilton,R.A.; Harris,E.J.; Maehler,K.L Rhode,R.H.

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9. ABSTRACT
Fruit flies have long been considered an economic problem in the Central American countries and Panama (CAP), but not enough data have been available to assess the seriousness of the problem. Accordingly, a seven person, University of California/A.I.D. team was selected to visit seven CAP countries, assess the problems presented by the Mediterranean Fruit Fly (medfly) and other fruit flies (Anastrepha spp.), and recommend needed actions to CAP policymakers. It was concluded that the medfly was a minor pest of minor crops, and that it causes relatively small economic losses in CAP countries. U.S.D.A. quarantine data on coffee and citrus fruit show that CAP imports are a lesser source of medfly introductions than imports from Hawaii. The medfly problem is only one among several related production and marketing problems for host fruits in CAP countries. Much research needs to be conducted to obtain information as a basis for effective action. Thirteen recommendations are made in this study report. The first is that technical assistance should be provided CAP countries to train people and set up an integrated pest management program. Other recommendations concern standardizing trap data and fruit infestation data, effective use of fruit fly parasites, the need for a central quarantine facility, use of malathion-bait sprays, citrus cultural practices, taxonomic aids, economic analyses, the need for a CAP Pest Management Program Center, and means of strengthening the quarantine programs in CAP countries.

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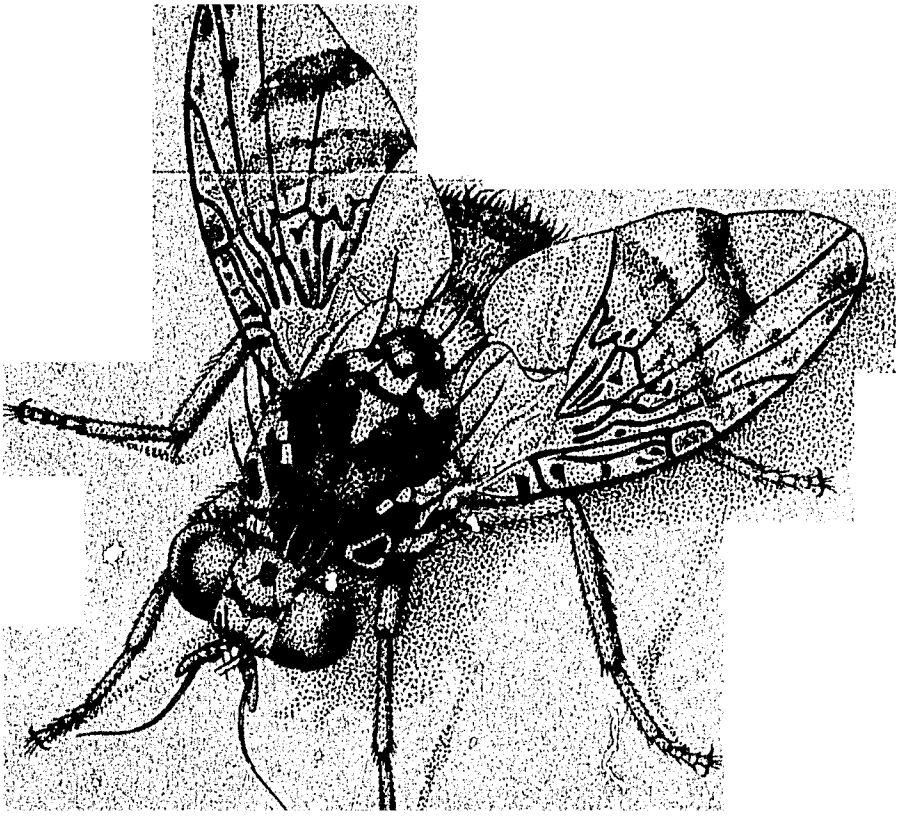

Ceratitis capitata (Wied.)

UC/AID Pest Management and Related Environmental Protection Project

977

THE MEDITERRANEAN FRUIT FLY AND ITS ECONOMIC IMPACT ON CENTRAL AMERICAN COUNTRIES AND PANAMA

A Multidisciplinary Study Team Report

UC/AID PEST MANAGEMENT
AND RELATED ENVIRONMENTAL PROTECTION PROJECT

University of California
Berkeley, California

by

Dr. Wallace C. Mitchell
Entomologist and Team Leader
University of Hawaii, Honolulu

Dr. Chris O. Andrew
Agricultural Economist
University of Florida, Gainesville

Dr. Kenneth S. Hagen
Biological Control Specialist
University of California, Berkeley

Dr. Richard A. Hamilton
Horticulturist-Tropical Crops
University of Hawaii, Honolulu

Dr. Ernest J. Harris
Entomologist-Fruit Fly Ecologist
Hawaiian Fruit Fly Laboratory
USDA, Honolulu, Hawaii

Mr. Kenneth L. Maehler
Entomologist-Quarantine Specialist
4 Donald Pl., Moraga, California

Mr. Robert H. Rhode
Research Entomologist
USDA, Weslaco, Texas

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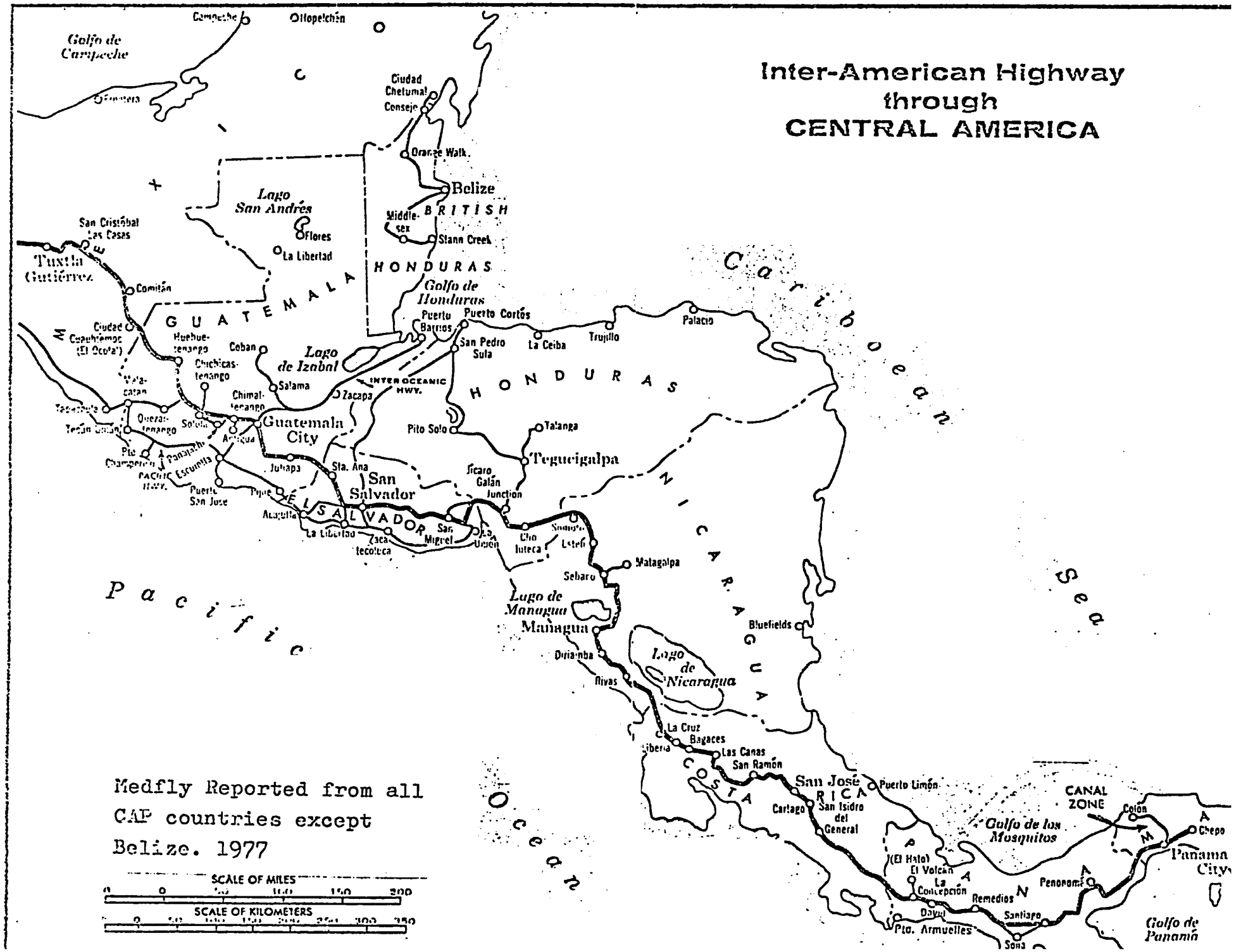
Inter-American Highway
through
CENTRAL AMERICA
Golfo de Campeche
Campeche
Ciudad Chetumal
Consejo
Orange Walk
Belize
BRITISH
Middlesex
Stann Creek
HONDURAS
Lago San Andrés
Flores
La Libertad
GUATEMALA
San Cristóbal Las Casas
Tuxtla Gutiérrez
Comitán
Ciudad Cuauhtémoc (El Ocote)
Huehuetenango
Ceban
Lago de Izabal
Chichicastenango
Salama
Chimaltenango
Zacapa
INTER OCEANIC HWY.
Guatemala City
Antigua
Escuintla
Puerto San José
Pacific Hwy.
Golfo de Honduras
Puerto Barrios
Puerto Cortés
San Pedro Sula
La Ceiba
Trujillo
Palacio
Pito Solo
Talanga
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Sicaro Galán Junction
Choluteca
Estelí
Matagalpa
Sebaco
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Managua
Diriamba
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Bluefields
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La Cruz
Bagaces
Las Canas
San Ramón
Liberia
COSTA RICA
San José
Cartago
San Isidro del General
Puerto Limón
Golfo de los Mosquitos
CANAL ZONE
Colón
Chepo
Panama City
Golfo de Panamá
PANAMA
Penonomé
Santiago
Remedios
La Concepción
El Volcán
(El Hato)
Dávid
Pto. Armuelles
Sona
Medfly Reported from all CAP countries except Belize. 1977
SCALE OF MILES
0 50 100 150 200
SCALE OF KILOMETERS
0 50 100 150 200 250 300 350

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CHAPTER 1

SUMMARY

1.1 Introduction

Any attempt to summarize the medfly observations and conclusions based on an on-site investigation in seven countries is understandably difficult. For an in-depth discussion one needs to refer to the various chapters. This report is organized into seven chapters followed by ten appendices. The recommendations in Chapter 2 reflect the conclusions of the team on specific steps which should be taken to improve the medfly situation in CAP countries. The rationale for the recommendations is presented in Chapter 7.

The Appendices, including the medfly host list, its world distribution, parasites, and USDA list of fruits and vegetables from CAP countries approved for entry under specified conditions and treatments, should be of value to those concerned with such information.

1.2 Organization and Personnel

Most of the countries visited had national and/or private educational institutions offering Ingeniero Agrónomo curricula in two or more areas: plant production, animal production, agricultural economics and forestry. The curricula in plant and animal production included a basic course in general entomology and/or economic entomology. Formal academic programs specializing in entomology were not available. Additional training in entomology is available to students selecting an insect problem for their thesis. A masters program is available in Costa Rica in plant production, animal production and forestry.

Institutional library facilities for medfly research varied from modest to inadequate and was often limited to personal reprint collections.

Research facilities in Costa Rica and Panama were fairly well equipped and modern. This was the exception rather than the rule. In most countries, there was a need for basic research supplies, equipment and technicians to carry out a medfly research program.

Reference insect collections of economic insect pests and fruit flies were available in some of the countries visited. There was little information available on beneficial insects and their role as controlling agents in the ecosystem.

In CAP countries, there is a shortage of trained scientists and supporting technicians in all disciplines needed to develop the valid data base necessary to plan and develop an integrated pest management medfly program.

1.3 Detection and Chemical Control

All CAP countries have at one time or another conducted medfly and Anastrepha spp. survey and detection programs utilizing sticky and/or tub traps and/or fruit collections to monitor fruit fly populations. These programs within each country were limited to commercial fruit host production areas. Costa Rica, El Salvador and Honduras have cut back on these programs. Many CAP countries obtained data on medfly abundance, but did not gather information on Anastrepha spp. which is more of a problem.

Medfly in Panama is limited to the Chiriquí Province and authorities are expanding the survey and detection program outside the province to determine if medfly has spread. Belize is expanding the survey and detection program on medfly and Anastrepha spp. To date, medfly has not been collected in Belize. Guatemala has the most comprehensive and well organized survey and detection program, the MOSCAMED program, which is a cooperative effort with Mexico. There has been limited use of tub traps containing protein hydrolysate solution in conjunction with sticky traps in order to trap both female and male fruit flies.

In Honduras, five of the eighteen Departments have reported the presence of medfly. Interior quarantine stations have been established to delay the spread.

Many countries did not sample host fruits to ascertain medfly or Anastrepha spp. infestation levels, percent parasitization, competition data and host fruit range.

All CAP countries utilized insecticide-bait sprays for chemical control of fruit flies. Malathion-protein hydrolysate bait sprays are more effective than malathion-molasses bait sprays. Lebaycid, an effective chemical with better residual qualities, is used by some countries in place of malathion. Bait sprays were applied to alternate trees or rows. Protein hydrolysates available in CAP countries are Naziman and Buminol.

The papaya fruit fly, Toxotrypana curvicauda, is a serious pest of papaya and is widespread in most CAP countries.

1.4 Biological Control

Nearly all CAP countries expressed strong interest in developing classical biological control research as a component of the integrated pest management approach. Presently, only a few countries are actively conducting biological control research because of lack of funds, lack of trained specialists in biological control and systematics and lack of proper quarantine facilities which precludes handling foreign shipments containing mixed insect material.

Nine species of medfly parasites have been introduced into CAP countries, most of which were released in Costa Rica. Millions of parasites of the four species, Biosteres longicaudatus[1/], Opius concolor, Aceratoneuromyia indica and Pachycrepoideus vindemiae, were released in Costa Rica and Panama after the OIRSA insectary in Costa Rica developed an effective program of mass culturing these species. The OIRSA insectary also provided millions of B. longicaudatus and O. concolor to El Salvador and over five million A. indica to Nicaragua for release in those countries.

Based on the few evaluation studies conducted to determine the impact of released parasites on the medfly and Anastrepha spp. population, it appears that only B. longicaudatus has become established in Costa Rica and El Salvador. In addition, A. indica and P. vindemiae are probably established in Costa Rica. The latter parasite has been known to occur in Panama since 1940 and may be widely distributed in all CAP countries.

In Costa Rica, it is believed that periodic inundative releases of millions of several species of parasites has resulted in a reduction of medfly populations in areas where the parasites were released. Anastrepha spp. were also parasitized by some of the introduced parasites. Medfly in Nicaragua was found to be parasitized by a native Opius species.

1.5 Quarantine

All CAP countries have a quarantine organization within the Ministry of Agriculture with inspectors deployed at international border crossings, airports, seaports and general post offices. They have a pest act, or its equivalent, and legal agricultural requirements which provide the necessary authority to enforce their quarantine programs. The agriculture inspectors work closely with Customs who do the actual inspection of baggage, cargo and mails. Agriculture material seized by Customs is turned over to the inspectors for inspection, release or destruction. The reporting procedures vary, but generally provide an insight into the workloads, staffing and volume of agricultural material inspected, treated and/or destroyed. The men in charge of the

---

[1/] Fischer (1971) recognizes the genus Biosteres which now includes a group of species formerly placed in the genus Opius (see Appendix VIII).

program are generally knowledgeable and committed. Their staffs apparently perform their routine duties adequately, but most of them could benefit from additional training in plant quarantine procedures and related sciences.

Some countries have an intra-quarantine program. Nicaragua has one in an attempt to contain the coffee rust. Generally, intra-quarantines in small countries are not apt to be effective because of the difficulties of adequately checking all avenues of movement. Furthermore, wind-borne coffee rust spores do not lend themselves to quarantine control.

The main movement of medfly seems to be along the Pan American Highway and in adjacent coffee and citrus growing areas. To prevent a northward movement would require careful inspection of vehicles, cargos, passenger baggage and personal effects to assure that fruit fly host material is not transported across international boundaries. Natural movement of the adult fruit flies would be expected to be slow compared to movement of larvae in hosts being carried in commerce.

The quarantine program in each country would benefit if key personnel received additional training in plant quarantine and related sciences. Selected personnel could be sent to the USDA Plant Quarantine Training Center and upon completion of the training bring the new techniques and training into their own organization.

Personnel of the other government agencies with which Agriculture Inspectors work should be indoctrinated and educated as to the merits of the quarantine program so they will cooperate more fully and effectively. The fact that a large percentage of persons are involved in agriculture should make them more concerned and aware.

1.6 Field Observations

Climates of the CAP countries are similar and can be divided into three major climatic zones based on the potential for the development of horticultural crops: the hot zone, the temperate zone and the cold zone. The hot zone extends from sea level to about 1,200 meters in elevation and most bananas and some coffee grow within this zone. The temperate zone extends from 1,200 meters to 2,400 meters in elevation, and is favorable for growing avocados, citrus, coffee, guavas, mangos, sapote, etc. At the higher elevations of the temperate zone, some deciduous fruits such as peaches and plums are grown. The cold zone extends above 2,400 meters and is too cold and foggy for most fruit crops. The hot and temperate zones may be divided into humid and dry regions.

The temperature ranges from freezing to 35°C and the precipitation varies from 500 mm to 6,000 mm. There is a distinct wet and dry season on the Pacific slope. The dry season may last from three to six months. Rainfall is more evenly distributed throughout the year on the Caribbean side.

Areas under cultivation and varieties of fruit grown vary from country to country. Most of the people of the CAP countries live in the temperate zone on the Pacific side of Central America. This same zone is suitable for fruit culture. The medfly and Anastrepha occur commonly in the hot and temperate zones and can potentially become established in all fruit growing areas up to 2,000 meters above sea level.

Coffee is an excellent host for medfly and provides a tremendous reservoir which allows the medfly to bridge the season when other host fruits are not available.

Guatemala has the greatest area with a temperate climate and the largest fruit production. Fruit flies are found on the Pacific side of Guatemala from the El Salvador border to the Mexican border. Panama is located predominately in the hot zone and reportedly has medfly only in the temperate area of Chiriquí Province near the Costa Rican border. In general, fruit flies, and medfly in particular, are found more on the Pacific side of the CAP countries.

1.7 Economics

Current production estimates for oranges and grapefruit in CAP countries show that production has increased by about 50% since 1961-1965 (Table 1). There were no major shifts in percent of total production noted in CAP countries from 1961-1965 to 1973-1975. Costa Rica and Honduras showed slight increases while Guatemalan production declined slightly.

In general, the economic impact of medfly appears to be relatively minor in all countries. In Belize, emphasis is on expanding the fruit processing industry where medfly is of no concern. Fresh exports are made to countries where fruit flies are not a problem because of climate. Costa Rican juice processors prefer to import concentrate for use in their domestic market because of favorable price differential. Due to numerous other difficult production and marketing problems, the medfly does not appear to be a priority concern for El Salvador. Guatemala has numerous citrus production and marketing problems which are considered more serious than medfly damage. There is greater concern in all CAP countries for coffee rust and various production and marketing problems than for medfly. In Honduras, export emphasis is on bananas and coffee, with minimal concern for citrus. Coffee rust is, however, a major concern! Solutions to various production and marketing problems would be required to realize production and export potentials for oranges, grapefruit and mangos. Since Panama produces mainly frozen orange concentrate, medfly damage is of minor concern.

Table 1

Orange and Grapefruit Production in Central America and Panama for the Period 1961-65 and 1973-75 (1000 Metric Tons)

Country	Average 1961-65	Percent Share 1961-65	1973	1974	1975	Percent Share 1973-75
Belize	37	15.5	55	52	53	14.7
Costa Rica	42	17.6	64	65	68	18.1
El Salvador	28	11.7	39	40	41	11.1
Guatemala	41	17.2	53	52	53	14.5
Honduras	19	7.9	39	45	44	11.8
Nicaragua	32	13.4	45	50	50	13.3
Panama	40	16.7	58	60	62	16.5
Total:	239	100.0	353	364	371	100.0

Source: FAO Production Yearbook, Vol. 29, 1975.

Price fluctuations in the fresh market are of greater concern to the grower than medfly damage.

It therefore appears that medfly is only one problem in a series of interrelated production and marketing problems for medfly host fruits. More study on medfly in CAP countries would provide a better basis for appropriate corrective action. Before major investments are made in suppression efforts, more knowledge of the fruit production system including pest management, varieties, climate, management and marketing problems is needed. Research programs are much less costly and would provide a basis for effective action. Action without adequate research support would probably be wasteful, if not harmful.

CHAPTER 2

RECOMMENDATIONS

Several studies of the Mediterranean Fruit Fly (medfly) situation in CAP countries have been made for various reasons. Although this team may not be the first to recognize that medfly is a bio-ecological, economic and social problem, our studies and observations indicate that these factors are interrelated and can best be dealt with together rather than independently. We have therefore developed a comprehensive approach in our evaluation.

The biology of the insect has been worked out by entomologists. The ecology of the medfly is understood, but complete information is lacking in the CAP countries on the distribution of the insect, phenology of host plants, and interactions with Anastrepha spp., parasites and predators. It was observed that the relatively few large commercial fruit growers generally make an effort to control pests and diseases. Small scale growers and door-yard and patio fruit plantings constitute important breeding sites in the ecology of the medfly. Fruit from these sources often does not enter commercial channels, so its impact on fruit fly populations is difficult to evaluate. Likewise, losses due to medfly and Anastrepha spp. infestations are unknown. The team felt that export value of fruit grown in small commercial plantings was minimal, but its value to producers and the economy of the country was significant. Culturally and socially, the growing of fruit trees is of major importance to the people of CAP countries.

The scope of this study was to gather and evaluate data on the impact of medfly and Anastrepha spp. on CAP countries and to make recommendations or to suggest alternate solutions and appropriate action against insect pests to decision makers.

Medfly and Anastrepha spp. are presently considered minor pests in CAP countries because they cause very little economic impact. Under these conditions, medfly detection and control programs are being conducted at a relatively low level in CAP countries. It was concluded that an Integrated Pest Management Program would strengthen the present efforts and would be a more realistic and logical approach commensurate with the importance of the medfly problem in CAP countries. For such a program to be successful, considerable basic biological, ecological and economic information is needed to develop, plan and coordinate a fruit fly suppression program. The Team recommends an Integrated Pest Management Program of Fruit Fly Suppression including the following measures, not in priority order:

1. Technical Assistance: There is a need for technical assistance with experienced fruit fly researchers working with CAP country personnel to demonstrate and train people in the necessary procedures and philosophies of an integrated pest management program. There is a shortage of technical personnel in all countries and a training program is of high priority.

2. Standardizing of trap data: Several countries have an on-going fly trapping program, but data cannot be used for comparisons between different regions within a country, between countries or between years. Trap data should be recorded as the number of flies per trap day (FPTD) using the following formula:

$$FPTD = \frac{F}{T \times D}$$

F - the number of flies trapped
T - the number of traps
D - the number of days the traps were in operation

3. Fruit Infestation Data: Systematic host fruit collections are needed to obtain fruit fly infestation rates, identify minor fruit hosts, rate of parasitization, host fruit phenology, and to secure information on competition between fruit fly species. This can be accomplished by making fruit collections and holding fruit until pupation occurs and recording the emerging adult flies and parasites.

4. Detection of fruit flies: Most of the countries are utilizing the sticky (Jackson) traps baited with trimedlure. This lure is not uniformly effective or attractive under all conditions. Fermenting liquid protein lure in McPhail or plastic tub traps should be used in conjunction with sticky traps to capture female medfly and *Anastrepha* spp. Traps with negative catches should be moved to other areas where preferred host fruits occur. This would increase the area covered by survey and detection programs and make more effective use of traps available.

5. Biological Control: Several countries which have introduced and released parasites have not carried follow-up programs to determine if beneficial insects have become established. More effective bio-control can be achieved by releasing parasites in areas known to be infested with medfly and obtaining additional species of parasites and predators which may prove more effective. The recent tactic of making periodic inundative releases of a few species of parasites should be discontinued in favor of releasing smaller numbers of a greater diversity of medfly parasites with the aim of permanently establishing new natural enemies. Data must be secured to determine if establish-

ment of the released parasite has been achieved. Beneficial insects are of great value to the small farmer or home owner who has a single tree in his patio and cannot afford the costs of equipment and chemicals. Establishment of additional medfly parasites in coffee would reduce a major source of medfly in CAP countries.

6. Biological Control Quarantine Facility: An urgent need for CAP countries is a central quarantine facility to allow the importation of natural enemies of agricultural pests. Presently, only pure stocks of primary parasites can be safely handled in CAP countries. A quarantine facility would allow the expansion of classical biological control. This encompasses not only importing primary parasites, but also host material suspected of containing parasites and which could also include hyperparasites that need to be screened. Furthermore, potential predators could also be tested in this facility. The quarantine laboratory should be located adjacent to the central mass rearing insectary.

The person in charge must be a trained entomologist specialized in biological control and with experience in handling foreign shipments.

7. Malathion-bait Sprays: Chemical control is a component of integrated pest management programs. Individuals in many CAP countries report using malathion-protein bait sprays in fruit fly control programs. Applications of protein bait sprays should be applied to alternate rows of trees to insure survival of possible parasite populations. The bait sprays must include protein and an acid or enzymatic hydrolysate, since molasses-malathion mixture is not as attractive and effective.

8. Citrus Cultural Practices: Allowing mature fruit to remain on the tree or ground encourages the build up of fruit fly populations. Whenever possible, fruit should be picked when mature and fallen and damaged fruit buried. Even though it was required by law in some countries to bury fallen citrus, many fallen fruit were observed. Individuals should be encouraged to bury damaged and fallen fruit.

9. Taxonomic Aids: There is a need of a publication in English and Spanish containing keys to larvae of the important fruit fly species in CAP countries. This publication would be of regional and worldwide importance in areas where fruit flies occur. A practical method of separating the puparia of *Ceratitis* from *Anastrepha* should be included.

10. Economic Analyses: It is recommended that individuals participating in the Integrated Pest Management Program include economists spending sufficient time to secure data on host fruit production, operational costs, crop losses and number of plantings in order to make a more thorough analysis of the impact of fruit flies in CAP countries.

11. Program Center: For an Integrated Pest Management Program to be effective in the CAP countries, there should be an organization or center composed of experienced, qualified fruit fly specialists and economists to advise and coordinate operations. Perspectives of the organization must be international in scope, knowledgeable about the best insecticides for fruit fly control, the effect of pesticides on non-target organisms in a tropical environment, the importance of biological control agents in the ecosystem, the population dynamics of the fruit flies, host fruit phenology, etc. The organization must be an independent entity, but still be assured of support and cooperation from all CAP countries.

12. Strengthening the Quarantine Programs in CAP Countries: The best way to increase the effectiveness of a quarantine program is to increase the competence of the personnel through training. The U.S. Department of Agriculture has maintained for many years a Plant Quarantine Training Center where USDA inspectors as well as foreign nationals can be trained in plant quarantine procedures and related scientific specialties. The careful selection of quarantine personnel from CAP countries to attend training at the USDA Agricultural Training Center is recommended. More information on the facilities and program can be obtained by writing to Animal and Plant Quarantine Inspection Service, U.S. Department of Agriculture, Hyattsville, Maryland, 20782.

13. Postentry Quarantine Facility: The impact of the coffee rust on CAP countries could result in the need for resistant varieties of coffee. The introduction of such material requires that it be grown in postentry quarantine prior to being shipped to CAP countries or that such a facility be established in Central America. In addition to coffee varieties which could be screened in this facility, new varieties of the other crops grown could receive similar screening to assure that they are pest free. Such a facility could be established in conjunction with the recommended Program Center.

CHAPTER 3

ACKNOWLEDGEMENTS

Members of the UC/AID Medfly Team acknowledge and express their appreciation to the many administrators, agriculturists, farmers, exporters, educators, and scientists who gave so freely of their time. Your kind cooperation, candid opinions, frank discussions and helpful information furnished were extremely helpful in completion of our report.

In Appendix III, all of the individuals with whom we conferred are listed by country. In addition, we wish to acknowledge especially those organizations which were particularly helpful, including OIRSA, MOSCAMED, CATIE, ROCAP and USAID and the various Ministries of Agriculture.

USAID Rural Development Officers assisted us greatly in planning the best utilization of our time. Every farmer, exporter and processor cited personal experiences and helped us in evaluating the impact of the medfly and related fruit flies on fruit production in countries visited.

The managerial and secretarial staff of the UC/AID Pest Management Project, Berkeley, California, were most helpful and cooperative during both the planning and final stages of our assignment.

To all of you our grateful thanks.

Dr. Wallace C. Mitchell
(Team Leader)
Department of Entomology
University of Hawaii
Honolulu, Hawaii 96822

Dr. Chris O. Andrew
Food and Resource Economic Dept.
Institute of Food & Agricultural Science
University of Florida
Gainesville, Florida 32611

Dr. Kenneth S. Hagen
Department of Entomological Sciences
University of California
Berkeley, California 94720

Dr. Richard A. Hamilton
Department of Horticulture
University of Hawaii
Honolulu, Hawaii 96822

Dr. Ernest J. Harris
California-Hawaii-Nevada Area
Hawaiian Fruit Flies Laboratory
Honolulu, Hawaii 96804

Mr. Kenneth L. Maehler
4 Donald Place
Moraga, California 94556

Mr. Robert H. Rhode
Agricultural Research Service
USDA
Weslaco, Texas 78596

CHAPTER 4

INTRODUCTION

The UC/AID Medfly team was selected to provide a multidisciplinarian approach for an on-site investigation and evaluation of the medfly and other fruit flies (*Anastrepha* spp.) on fruit production and the economy of the CAP countries. The seven members reflect expertise in medfly and fruit fly ecology, biological control, mass rearing of parasites and fruit flies, chemical control, agricultural economics and plant quarantine.

The investigational scope was to gather and evaluate data and information and make field observations so that recommendations could be made to CAP policy makers indicating the most appropriate course to follow. The options considered when developing these recommendations were: no action; suppression; and eradication. Institutional capacity and economic losses due to medfly were to be evaluated in all CAP countries. Seven countries were visited during the period March 6 through April 3.

It was concluded that the medfly was a minor pest of minor crops and caused relatively small economic losses in CAP countries. While coffee was the main host, the presence of the larvae caused insignificant damage to production and quality. This opinion was shared by scientists, agriculturists, exporters, administrators and farmers with whom we talked.

The presence of the medfly is characterized by population fluctuations. There is always the possibility that under certain conditions medfly could cause economic damage to a particular citrus grove. However, in the 22 years it has been present in Costa Rica, it has not proved to be a significant economic pest. Its deterrent effect on potential fruit production is minor compared to other factors.

The presence of the medfly in CAP countries as a threat to Mexico and the United States was also considered. The quarantine data based on USDA records of interceptions indicate that Hawaii is an appreciably greater source of medfly introductions.

A theoretical economic analysis of medfly potential destructiveness should it reach the United States is covered in Chapter 6. It is based on the best available information on crop production, climate limitations of the medfly and a sliding-scale of percent losses related to host susceptibility. Such projections are at best "guesstimates" because there are so many variables involved.

There have been other studies which tried to estimate eradication costs. These estimates have steadily increased. The USDA/ERS Field Report 21 goes into considerable detail in trying to establish possible cost parameters. These estimates could be updated, but we did not verify their validity. It became increasingly obvious as the team made its field observations that the medfly in CAP countries did not cause economic damage that could possibly justify the expenditure of millions of dollars in an eradication program. Accordingly, information was gathered to support a realistic approach to the medfly problem.

Biological and economic interrelationships encompassing the environment indicate that the medfly cannot be considered alone, but an integrated pest management program for fruit flies must consider other insect pests as well. The team's assessment presented here should be considered as a prelude to in-depth research on fruit flies and other pests of fruit production in CAP countries to establish a data base to support a realistic integrated suppression program.

The interrelated range of agricultural problems for the small farmer in any country goes beyond our ability to generalize. Medfly needs to be considered in its proper priority with other fruit production and marketing problems. Pest management problems may appear to be specific, but our limited knowledge of the varied integrated, ecological, environmental and economic issues involved suggests that the medfly problem in CAP countries is quite complex and cannot be considered as a single entity to be resolved without regard to other species of fruit flies.

Problem identification ranged from concern to apathy. Groups and individuals have different resources, income and cultural backgrounds and therefore are not equally concerned about pest damage as related to production and marketing. Accordingly, the medfly calls forth different responses limiting the involvement of various groups or individuals. For example, field observations indicate that during drought conditions, water is more significant in causing fruit drop than medfly.

Our investigation attempted to determine the impact of the medfly on individual CAP countries. The mere presence of medfly does not make it a problem. Medfly losses must be of sufficient magnitude relative to other problems and loss of income to the grower to clearly demonstrate that it is a serious problem.

Personal and family needs may substantially influence the farmer's behavior and concern for the medfly. Growing of fruit around the home is common practice. As long as there is sufficient fruit for their use, the fruit destroyed by insects, birds, or animals may not be important. Data on these losses are not

available. Commercial growers are concerned with anything that reduces production. However, it is only when observable loss is present that the medfly becomes a problem. The level of concern depends upon the individual, group, or agency and their motivation. This report probably will not be able to completely answer these questions, but at least the intent was to place the medfly in a realistic perspective.

The medfly has many commercial and non-commercial host fruits in CAP countries. Two primary commercial crops infested are coffee and citrus. Oranges are more likely to be infested if grown adjacent to coffee. The presence of medfly in coffee has not been shown to cause any reduction in quality or production. Oranges and other citrus at present can only be considered minor crops. However, there is a preliminary proposal being considered by USAID and CENTA in El Salvador to try and increase fruit production (primarily oranges) to supply local needs. It is certain that the medfly will continue to be viewed differently by those involved in citrus production.

Medfly's greatest impact could be in its quarantine implications. Its presence usually results in restrictions that add to the marketing costs. It is indeed an international pest. Its presence in South America, Africa, Australia, Hawaii and Israel may offer ideas on how they have adjusted to its presence. Perhaps growers in CAP countries will have to make similar adjustments, mostly on an individual basis.

CHAPTER 5

COUNTRY PROGRAMS

1. GUATEMALA

5.1.1 Introduction

Guatemala has an area of approximately 42,000 sq. miles and a population estimated at 4.8 million. It is bordered on the north and west by Mexico, on the south by the Pacific Ocean, on the southeast by El Salvador, and on the east by Honduras and the Caribbean Sea. Much of the country is made up of highlands created by two major mountain ranges extending from east to west. The highest mountains are in the west central part sloping eastward to the Pacific coast.

The border with El Salvador and Honduras is mostly mountainous. Petén, in the north, is mostly a sparsely populated lowland, tropical, hardwood forested province. The mountains in the northern part slope gradually to the "littoral," the name given to the level coastal plain along the Pacific coast. This variation in topography gives rise to microclimates ranging from hot and humid in the lowlands to relatively cold in the highlands where frosts are not uncommon. Variation in altitude and climates make it possible to cultivate almost any crop that can be grown in the western hemisphere. Most of the people live in the highlands where 65% of the labor force is engaged in agriculture and related activities. The principal export crops are coffee, cotton and sugarcane. Other products grown, largely for domestic use, are bananas, corn, rice, beans and a variety of fruits and vegetables. Production of citrus on a commercial scale is small. There are, however, many orange trees in dooryard plantings, mixed fruit plantings with coffee and other tree crops and small commercial plantings.

5.1.2 Organization and Personnel

There is one Ph.D. entomologist in Guatemala on the faculty of the University of San Carlos, the National University for Guatemala. He teaches and is presently doing research on interplanting various vegetable crops to reduce insect/plant disease transmission and mite and whitefly populations.

The Agriculture College offers the Ingeniero Agrónomo degree in agriculture, plant science, animal husbandry and social economics. A general course in entomology is part of the curricula in agriculture, plant science and animal husbandry. In 1977, 1,600 students were enrolled in agriculture. About 427 new students enter college each year. A graduating class of about a hundred is expected this year. There is no major in entomology

or related sciences. No research on fruit flies is being conducted at this time. Training programs for entomological technicians are lacking.

There is no research, administrative or organizational structure to do basic research on fruit flies in Guatemala.

Guatemala and Mexico have developed a well coordinated, cooperative program of medfly prevention and control (MOSCAMED) on a limited scale. Ministry of Agriculture (MAG) personnel direct the medfly survey, detection, quarantine and bait spray applications within Guatemala. MAG personnel also conduct periodic training programs for technicians and trappers. OIRSA has provided support for the program in the form of vehicles, trimed lure, stickem and other supplies.

5.1.3 Detection and Chemical Control

The medfly appears to be a low priority problem in agricultural production in Guatemala. Although medfly infests coffee, citrus, mango and other fruits, specific controls are not applied directly for the control of fruit flies on small farms. There is a "we can live with it" attitude. A few large commercial producers may sometimes use single bait spray applications.

The Ministry of Agriculture (MAG) is committed to a cooperative medfly detection, prevention and control program with Mexico (MOSCAMED). MAG personnel are eager for assistance and information to better understand the behavior, population dynamics, and natural control agents of all fruit fly species in Guatemala.

The country is divided into four work sectors: Eastern, Southwestern, Central, and Northern. Detection and chemical control activities are underway in three of those sectors. No work is being carried on at present in the Northern sector which comprises the Departments of Huehuetenango, Totonicapán, Alta Verapaz, Quiché and Petén. The amount of fruit fly host material in much of the Northern sector has not been surveyed. The province of Petén, about 1/3 of the national territory, consists of low tropical rain forest, interspersed with savannas. The isolated, undeveloped nature and sparse population of Petén are factors which might limit the development of persistent fruit fly populations.

A network of 3,300 sticky traps is currently in operation in an area of 47,000 square kilometers in 3 of the 4 sectors. The traps are baited with a 5% w/w mixture of trimed lure (summer grade) in Tanglefoot. Workers assigned to operational centers in each sector service the traps and carry out required spray operations. The majority of traps are inspected twice a month.

In areas with high medfly populations, traps are examined weekly. In spite of widely dispersed trap locations, one worker equipped with a vehicle can inspect 200 traps per week.

Host fruit plantings close to traps which register medfly trap catches receive several applications a season of a protein malathion bait mixture. MOSCAMED supervisors were aware of the harmful effects of insecticides on beneficial insect populations. To protect the ecological environment of coffee plantings, alternate rows of trees are partially sprayed at a rate of 50 gallons/hectare. The spray materials are applied with pumps from 55 gallon drums mounted on the bed of pickup trucks and/or with motorized backpack sprayers.

The highest medfly populations throughout the country are presently found in the Department of Escuintla. Although attacks by Anastrepha spp. are reported to be more severe than those of medfly, no McPhail traps are in operation. No data concerning parasites, infestation intensities and host range of the medfly and Anastrepha spp. are available. In addition, precise observations are not available on the occurrence of host fruit competition between medfly and Anastrepha spp.

At the farm level, MOSCAMED supervisors provide the growers with information on fruit fly control and suggest burying of fruit to reduce fly population. OIRSA is providing material assistance to the MOSCAMED program in the form of three 4-wheel drive vehicles, 1 Volkswagon, gasoline, lubricants, carton traps, trimed lure/Tanglefoot mixture, insecticides, miscellaneous equipment and publications on prevention, detection and control of medfly.

5.1.4 Biological Control

Since the medfly has only recently been discovered in Guatemala (April 1975), natural enemies have not yet been introduced to combat this new pest. There is an interest in developing biological control programs, and plans to begin introductions of four hymenopterous parasites: Biosteres longicaudatus, Opius concolor, Pachycrepoideus vindemiae (Rondani) and Aceratoneuromyia indica in June 1977. These are being cultured by OIRSA in Costa Rica. Parasite releases by the MOSCAMED team will probably be concentrated in the citrus/coffee areas adjacent to El Salvador.

Several natural enemies are present and working against pests of citrus, such as cottonycushion scale, Icerya purchasi, and citrus blackfly, Aleurocanthus woglumi. MOSCAMED workers, therefore, are employing an integrated pest management against the medfly, applying protein bait sprays to alternate rows of citrus and coffee to minimize disruption of natural control organisms.

5.1.5 Quarantine

Guatemala's maritime ports and anchorages on the Pacific and Caribbean are vulnerable to pest invasion at many points. The quarantine inspection staff is presently deployed at border crossings with El Salvador at San Cristóbal and Pedro de Alvarado, and with Mexico at La Mesilla and El Carmen. The most important border crossings are San Cristóbal and La Mesilla on the Pan American Highway. These border inspection points have two agriculture inspectors. Pacific maritime ports are Champerico and San José, each staffed with two inspectors. The Caribbean port of Puerto Barrios has similar staffing. Puerto Barrios is a railway terminal and the railroad proceeds north to Mexico with branches to the Pacific ports of Champerico, San José and south to La Unión in El Salvador.

Aurora International Airport in Guatemala is the main airport for the country. There are also numerous smaller airports and landing strips. Airlines servicing Aurora International Airport include PAA, SAHSA, TACA, MEXICANA and AVIATECA. They provide service and interconnecting flights to Miami, Mexico City, Los Angeles, San Francisco, Washington, D.C., and New Orleans and south to Panama and South America.

Aircraft passenger compartments and cargo pits can carry hitchhiking pests. Air cargo, freight, mail and passenger baggage can also carry host material infested with fruit fly larvae. Agricultural quarantine at Aurora International Airport depends on the Customs service to intercept restricted plant material. Inspections observed were reasonably thorough, but do not preclude host material being smuggled.

The Agricultural Quarantine staff includes:

25 administrative and support personnel
7 supervisors
32 inspectors
36 spray operators

The budget was estimated at $350,000 annually for Quarantine Services. Quarantine inspectors work closely with Customs inspectors at ports of entry and restricted agricultural material is confiscated and incinerated.

Vehicles entering and departing Guatemala are sprayed with DDVP to prevent adult flies from being carried north. Drivers are charged for this treatment. The risk of transporting medfly is largely from larvae in host fruit, and it is doubtful if vehicle treatment can be justified from a biological standpoint.

Aerosol treatment of aircraft observed on several Central American flights was performed in a casual, perfunctory manner. It is of doubtful value and probably not justified. USDA records for ten years on pest interceptions, including about 50,000 hitchhikers on aircraft, recorded medfly adults intercepted only twice, once in 1968 and once in 1971.

5.1.6 Field Observations

Guatemala has a diverse range of microclimates depending on elevation, rainfall, wind and sunshine. The precipitation varies from 500 mm to 6,000 mm and the temperature from freezing to 35°C. The country has dry and rainy seasons. The dry season may last from 3 to 6 months. The amount of rain received is greatly influenced by elevation. The terrain is diverse with lowlands, highlands, mountain peaks and coastal plains. The climate of Guatemala may be divided into three major climatic zones based on the potential for the development of horticultural crops: the hot zone, the temperate zone and the cold zone. The hot zone extends from sea level to 1,200 meters in elevation and most of the bananas and some coffee grow within this zone. The temperate zone extends from 1,200 to 2,400 meters in elevation. Oranges, avocados and some deciduous fruits grow within this zone. The cold zone extends above 2,400 meters and is too cold and foggy for most fruit crops. The hot and temperate zones may be further divided into humid and dry regions.

In the temperate zone, the following tropical and subtropical fruits are grown: coffee, peaches, plums, avocados, cherimoyas, guavas, loquats, cashews, mangos, bananas, papayas, jocotes, chicozapotes, mamey zapotes, and star apples. Medfly and *Anastrepha* spp. are found in many of the areas where these fruits are grown. Fruit flies can potentially become established in all of the fruit growing areas.

Much of the sparsely populated humid northern part of the country is partially forested with conifers and mixed hardwoods. Most of the temperate area where fruits are grown is on the heavily populated Pacific side.

Medfly and *Anastrepha* spp. are distributed from the El Salvador border to the Mexican border, mostly in the temperate area. Preferred hosts for medfly are coffee and citrus, whereas the preferred hosts for *Anastrepha* spp. are reported to be mandarins, mangos and grapefruit. Tropical and subtropical fruits are grown throughout Guatemala wherever the climate is favorable. No information was available on phenology of host plant fruiting or competitive interaction between the medfly and *Anastrepha* breeding in the same fruit. Studies should be initiated to obtain this information. The temperature, humidity and evapotranspiration

tolerances of fruit flies may be within the limits of tolerance of tropical fruits grown in the temperate zone. Development of both fruits and fruit flies may be under stress during the dry season. Changes in fruit production and fruit fly infestation within and between years support this view.

The trapping program operated by MOSCAMED showed that medfly is present on the Pacific side of Guatemala from the district of Jutiapa, west to the district of Quezaltenango. Sticky traps were being used to detect and monitor medflies. This program needs to be extended to cover the entire country, including the northern region and Petén. The trapping program should be augmented by the operation of McPhail or plastic tub traps to catch male and female medflies and Anastrepha to evaluate population changes. Trap captures should be recorded in flies-per-trap-day so that comparisons may be made between different areas and years. Systematic fruit sampling should also be done in areas where traps are operated to obtain data on fruit fly infestation, host fruit phenology, medfly and Anastrepha spp. competition and parasitization. This information could be obtained through minor adjustments in current survey effort.

The degree of fruit infestation, seasonal abundance and distribution of fruit flies varies with host sequence. Many kinds of fruit are grown on small farms in rural areas and by home owners in urban areas. Some of this fruit is consumed by the growers and the surplus sold in the market. The damage caused by fruit flies may be ignored or taken for granted. These infested fruits are important in the ecology of fruit flies and should be sampled in the survey program. These locations are reservoirs of flies because fruits are frequently left on the ground under the trees.

The medfly was first reported in Mexico near the Guatemalan-Mexican border in February 1977. Intense bait spray treatments were made in an attempt to eradicate the fly in this area. APHIS hopes to establish a barrier zone in the Tehuantepec area of Mexico. Various methods will be used to suppress the medfly and deter its northward spread. Basic ecological information on fruit flies in Guatemala is needed to prevent adverse effects on the environment.

Current practices to control medfly in Guatemala involve spot applications of bait sprays in both coffee and citrus. This approach is safer and ecologically acceptable in minimizing adverse effects on nontarget organisms.

5.1.7 Economic Impact

General Agricultural Situation

Guatemala's agriculture consists largely of small farms, many of them producing basic grains. These small farms are

integrated to varying degrees into the market economy. Fruit and vegetable production comes primarily from small units, with local and home consumption most prevalent. Sales are made largely in local markets, but some fruit products are also exported. Exports are primarily to other Central American countries. Due to data limitations, meaningful statistics on production, value and percentage of various agricultural products are not presently available. Current estimates of value and share of various products relative to production in Guatemala's agricultural sector were unavailable. The forthcoming census will substantially amplify this base.

Fruit Production and Trade

Agricultural production represented about 27% of Guatemala's gross domestic product from 1974 through 1976. The agricultural sector has traditionally maintained a trade surplus. In 1975, agricultural exports were $441,370,000 and exceeded imports by $370,680,000 (Table 2).

Fruit exports by Guatemala in 1975 were mostly to nearby countries, primarily El Salvador (52%). Fruit exports rank 12th and represent only 0.41% of Guatemala's total agricultural exports. Coffee exports ranked first with 36.59% of the total value of agricultural exports. Oranges represented about 10% of all fruit exports from Guatemala in 1975 and were almost entirely to El Salvador (Table 3). The limited role of fruits in Guatemala's trade situation is common throughout Central America.

Production data are not presently available for citrus in Guatemala. The tentative production estimate for oranges is about 2,800,000 kilograms, valued at approximately $100,000. The value of oranges is relatively minor compared to the gross domestic agricultural product of the country.

Medfly Economics

It is difficult to evaluate the economic impact of the medfly on Guatemala's agricultural income. Crop damage and demand estimates needed to accurately predict price movements are not available. Even with suppression or eradication of fruit flies, the addition in potential product marketed would probably not be fully realized because of serious post-harvest handling and marketing problems. Without a medfly management program, economic impact in Guatemala will probably be minimal. Substantial economic benefits may or may not result from a control program. The export and domestic value of agricultural crops not affected by medfly overshadows those which are fruit fly hosts.

Table 2

Guatemala: Value of agricultural exports and product shares, 1975 (FOB in thousands of dollars).

Commodity group	Rank	Total FOB value	Export share %
Coffee and products	1	165,947	36.59
Sugar	2	115,558	26.18
Cotton and products	3	78,512	17.79
Beef and meats	4	21,262	4.82
Bananas and plantains	5	17,596	3.99
Cardamon	6	10,068	2.28
Tobacco leaf and products	7	7,119	1.61
Vegetables and products	8	5,588	1.27
Seeds and nuts	9	3,872	0.88
Cereal preparations	10	3,025	0.69
Lumber	11	2,365	0.54
Fruit products 1/	12	1,868	0.42
Honey	13	1,826	0.41
Cut flowers	14	1,553	0.35
Molasses	15	1,188	0.27
Essential oils	16	1,000	0.23
Other		3,003	0.68
		441,370	100.00%

1/ Fruit products included oranges, grapefruits, etc.

Source: Dirección General de Estadística, Guatemala.

Table 3

Guatemala: Exports of oranges[1/]

	Kilograms	Dollar value	Cents/Kilogram
First Quarter:			
El Salvador	271,854	10,860	4.0
USA	150	33	22.0
Canada	15	3	20.0
England	12	2	16.7
	272,031	10,898	4.0
Second Quarter:			
Third Quarter:			
El Salvador	59,776	2,304	3.9
Fourth Quarter:			
El Salvador	519,210	18,425	3.5
TOTAL	851,017	31,627	3.7

1/ A knowledgeable group of economists preparing the agricultural sector analysis for USAID has stated that these estimates may be low by as much as 30%.

Source: INDECA, "Comercio Internacional y Noticias de Mercado Interno de Productos Agrícolas," Dirección Técnica, Sección Noticias de Mercado, Instituto Nacional de Comercialización Agrícola, Guatemala, 1°, 2°, 3° and 4° Trimestres, 1975.

This does not mean that the medfly is unimportant in some situations, since growers of high quality fruit and potential exporters may be disadvantaged. A broad country level statement tends to overlook this point. For example, Guatemala presently exports honeydew melons to the United States, but faces additional costs due to U.S. Quarantine 56 requiring shipments to be bonded in Miami for delivery only to Baltimore or points north. This requirement reduces the competitive position of Guatemalan honeydews. El Salvador and Honduras face similar restrictions in melon exports.

2. EL SALVADOR

5.2.1 Introduction

El Salvador, the smallest country of Central America, is also the most densely populated with approximately 3.5 million inhabitants. The central and northern parts of the country are mountainous, sloping down to the relatively flat littoral plain extending along the Pacific Coast. El Salvador is bounded on the west by Guatemala, on the north and east by Honduras and on the south by the Pacific Ocean. Coffee is grown intensively in the mountainous interior section of the country and cotton is grown in the eastern section of the littoral plain.

Although El Salvador is the smallest country in Central America, it is the third largest exporter of coffee in the western hemisphere, being exceeded only by Brazil and Colombia.

Corn is the most important food crop. Rice, beans and cooking bananas are also grown. The country is not self-sufficient in fruit production and supplementary imports of oranges, bananas and other fruits and vegetables are necessary, mainly from Guatemala and Nicaragua.

Because of its population density, El Salvador has a large work force available for labor intensive work, such as coffee and cotton picking. In spite of this, the country has such a large acreage of coffee that every year large numbers of migrant laborers from adjacent countries come to El Salvador for the coffee harvest.

5.2.2 Organization and Personnel

Higher education in El Salvador is provided by the National University of El Salvador and José Cañas University. The National University has a curriculum leading to the degree of Ingeniero Agrónomo. Only one general course in entomology is offered. There is one Ph.D. entomologist in El Salvador, who is a member of the faculty and also conducts entomological research for CENTA.

The main agricultural research organization in El Salvador is CENTA in Santa Tecla. CENTA entomologists are conducting research on major crop pests. A reference collection of economic insect pests, including fruit flies, is located there. Fruit fly research, which has relatively low priority, emphasizes survey, trapping and biological control studies. Parasites shipped from Costa Rica, Mexico and Hawaii have been released, but to date only *Biosteres longicaudatus* has been recovered.

The Coffee Institute of El Salvador, ISIC, located in Santa Tecla, conducts research on coffee. Entomologists there have conducted research to determine whether or not medfly causes any loss in yield and quality of coffee. They have concluded that the medfly caused no reduction in yield or quality.

OIRSA Regional Headquarters, which administers animal and plant protection programs on a regional basis, is located in San Salvador.

5.2.3 Detection and Chemical Control

Extensive trapping operations in 1975 disclosed the presence of medfly in 9 of 14 departments encompassing an area of 11,000 km^2. National medfly activities at present are centered within three principal coffee and citrus areas: Ahuachapán, San Juan Opico and Coatepeque. A group of ten trained workers are implementing a program designed to advise the growers on the prevention, detection and control of medfly. This extension type work is offered as a result of a Presidential Order which obligates coffee and citrus growers to exercise control measures against medfly.

Anastrepha spp. are a problem in El Salvador with seven species attacking mangos, citrus, guava and other tropical fruits. It was reported that these fruit flies create more widespread damage than the medfly. One citrus grower near San Salvador is attempting to suppress *A. ludens* populations by intensive trapping operations. However, no data are available concerning the effectiveness of 1,000 McPhail traps baited with fresh fruit juices and placed in the 50-acre grove.

5.2.4 Biological Control

A parasite release program directed against the medfly in El Salvador was started in July, 1975. Over one million *Biosteres longicaudatus* were shipped to El Salvador from the OIRSA insectary in Costa Rica and released in 10 different medfly infested areas. From 90,000 to 120,000 *B. longicaudatus* and *Opius concolor* were released weekly from August to November 1975 in citrus, coffee and mango plantings on a 102 acre farm near Quezaltapeque. Citrus and mango fruit collections were checked to determine if any impact had been made by the parasites released. No parasitism of either *Ceratitis* or *Anastrepha* was detected. Approximately 22,618,000 *B. longicaudatus* and 1,518,000 *O. concolor* were sent from the OIRSA insectary in Costa Rica to El Salvador for release from July to December 1976. About 1,000 *B. oophilus* were sent from the USDA Fruit Fly Laboratory, Honolulu, Hawaii, to El Salvador in 1976 for release. According to MAG technicians, it was estimated that about 3 percent of medfly examined were parasitized by *B. longicaudatus*.

Technicians involved in the biological control program were interested in biological control of medfly, but lacked the manpower and facilities to study the impact of natural enemies of C. capitata and Anastrepha spp.

5.2.5 Quarantine

For such a small country (8,260 sq. miles), El Salvador has a rather complex border situation. It is bordered by Guatemala and Honduras on the north and faces the Pacific on the south. The Gulf of Fonseca separates it from Nicaragua. It is the only country in the isthmus without a coastline on the Caribbean Sea.

The quarantine staff of 32 Agricultural Inspectors is deployed as follows:

Guatemala/El Salvador Border	
Puente José Arce	3
Las Chinamas	3
San Cristóbal	2
Anguiatú	2
El Coco	1
Pacific Maritime	
Puerto Acajutla	3
Cutuco	3
La Libertad	2

Honduras/El Salvador Border	
El Poy	1
Puente Goascorán	3
Nicaragua/El Salvador Ferry	
Punta Ruca	1
San Salvador	
Ilopango I. Airport	7
Post Office	1
TOTAL:	32

Vehicles entering and leaving El Salvador are treated with DDVP and the driver charged for the treatment which is intended to prevent the movement of medfly. As previously mentioned, such treatments are of doubtful value because the chance of adult medflies riding on the outside or even the inside of vehicles is rather remote. Medfly is much more likely to be transported as larvae in host fruit or possibly as puparia in a truck bed that has been hauling fruit. Quarantine officials should evaluate pest entry potential and concentrate on those avenues most likely to carry the fly rather than dissipating funds and manpower on "wheel spinning operations," sometimes created for psychological reasons. In this case, careful search for fruit is apt to be more productive.

They are using plastic tarp fumigation chambers 16' x 14' x 6' to fumigate vehicles carrying commodities suspected of being infested. Methyl bromide is used at 2.5 - 3 pounds per 1,000 cu.ft. with an exposure period of two to three hours. These temporary structures, cheaply made of plastic and a supporting wood frame, provide an excellent method of fumigating truckloads of produce. Permanent structures of cement or steel are very expensive. However, one limitation to the plastic chambers is that vacuum fumigation is not possible.

El Salvador's principal exports are coffee and cotton. Their greatest concern is that they will be infected with coffee rust from Nicaragua. Unfortunately, quarantine is not very effective against wind-blown spores and it is very likely that El Salvador will shortly be faced with yet another serious pest problem. The Ministry of Agriculture's Annual Report for 1973 showed the following figures on inspection activities:

Station	Baggage	Vehicles	Aircraft	Ships	Packages
Ilopango Airport	85,991		4,286		
Puerto Acajutla				472	
La Libertad				151	
Cutuco				175	
Post Office					7,736
José Arce		31,350			
Las Chinamas		25,550			
San Cristóbal		9,027			
Puente Goascorán		4,965			
Anguiatú		8,328			

5.2.6 Field Observations

El Salvador is located entirely on the Pacific Coast side of Central America. The climate is temperate, hot or dry except for a narrow land strip on the coastal plain where it is hot and humid or hot and dry. The rainy season occurs from about May to October and the temperature varies from 10° - 38°C. The varied terrain consists of lowlands and highlands with many volcanoes and mountain peaks. Main export crops are coffee, cotton, and sugar, grown in the hot dry climatic zone. Tropical and subtropical fruits grown include coffee, mangos, citrus, bananas, avocados, peaches, mombin, papayas, sapotes and cashews. Both medfly and *Anastrepha* spp. breed in these tropical fruits. Coffee and sweet orange are the preferred medfly hosts.

Anastrepha spp. are found in *Spondias* spp., star apple, mango, chicozapote and grapefruit. The medfly occurs in mandarins, sweet oranges, rose apple and tropical almond. The fruit fly, *Toxotrypana*, infests papaya.

A limited trapping program for medfly was in operation. This should be augmented by using McPhail or tub traps to catch fruit fly males and females. Fruit samples should be collected to determine fruit fly larval infestation levels, host preference, and competition.

Trap studies have shown that Anastrepha spp. reach their highest population levels in the fall and medfly is most numerous in spring. Coffee is widely distributed in El Salvador and so is medfly. Seven species of Anastrepha have been identified and they may cause more damage to fruits than the medfly.

The relative abundance of fruit flies and the damage they cause to tropical fruits in El Salvador is highly variable, depending on the phenology of fruiting, temperature, and rainfall. The growers frequently tolerate injury and fruit losses without any attempt at control. When control measures are applied, they are in the form of localized treatments with bait sprays applied by ground sprayers.

5.2.7 Economic Impact

General Agricultural Situation

El Salvador's agricultural sector is best depicted as one of numerous very small farms with dependence on basic grain production. Concern within the country is with the high population density and the need for labor intensive production. Agriculture's share of gross domestic product is about 27%, but more than 50% of the population is rural. In 1970, nearly 49% of the farms were less than one hectare in size, and 92% were under ten hectares.

Large farms are most involved in production of major export crops including coffee, cotton and sugar (see Table 4). For the five year period from 1967 to 1972, agricultural exports accounted for about 65% of total exports. Also, agricultural exports were five to six times greater than agricultural imports for the same period. Coffee alone accounted for about 70% of agricultural exports or 45% of total exports.

Fruit Production and Trade

In El Salvador, numerous fruits are produced for domestic consumption, but imports, primarily from Guatemala, are necessary. The volume of fruit production from about 5,600 hectares reached 47,000 tons in 1970. Land suitable for fruit production is estimated to be about 20,000 hectares. Presently, because of the import situation and the availability of suitable lands for fruit production, CENTA is considering an expanded fruit research and extension program with emphasis on some of the fruits most infested by medfly.

Among the fruits grown in El Salvador, citrus is most important, and oranges represent about 85% of citrus production. The greatest number of farms, 75%, producing oranges are under ten hectares, but 72% of the production is on farms of greater than ten hectares. A greater proportion of large farms are involved in orange production than small farms (Table 4).

Table 4

El Salvador: Total farm, coffee farm and orange farm size distribution, 1970/71.

Farm size (has)	Total number of farms	Number of farms producing coffee	Number of farms producing oranges	Production in 100,000's of fruit	Percent of total farms producing	
					coffee	oranges
0 to 0.9	132,464	14,771	1,709	285	11.2	1.3
1.0 to 9.9	118,075	19,798	3,435	1,460	16.8	2.9
10.0 to 49.9	16,150	4,737	1,129	2,086	29.3	7.0
50.0 to 199.9	3,341	1,194	404	1,354	35.7	12.1
200.0 or more	838	279	151	1,019	33.3	18.0
TOTAL:	270,868	40,779	6,828	6,204	15.1	2.5

Source: Dirección General de Estadística y Censos, Tercer Censo Nacional Agropecuario 1971, San Salvador, El Salvador, Enero 1975.

Medfly Economics

While fruit imports have been in excess of $1,000,000 per year (Table 5), the impact of the medfly and related fruit flies on the need to import appears to be minimal. Peaches, oranges and mangos are imported where only a reduction in orange imports would make a marginal impact. Peaches, while affected, are limited in production for climatic reasons more than for pest reasons. Mango imports are quite small. Thus, even with self-sufficiency in orange production stimulated by fruit fly control and other production advances, the value of the fruit import deficit would decline by only about 5%.

Again, as in Guatemala, the economic impact of fruit fly control on the agricultural sector and the economy as a whole appears to be negligible without major export opportunities. The farm level impact of the medfly, however, may be very significant for some producers. In El Salvador, where other crops command major positions in the country's domestic and international import and export markets, the expected economic gains from fruit fly control programs may not be sufficient to stimulate priority concern. Potential gains in the international market are quite conjectural.

Table 5

El Salvador: Value of all fruit and orange imports and exports from 1969-74.

Year	Imports		Exports		Net Trade		Orange % share of all fruit
	All fruits	Oranges	All fruits	Oranges	All fruits	Oranges	
1969	1,533,675	55,848	106,111	3,257	1,427,564	52,591	3.7
1970	1,279,236	55,265	31,225	3,380	1,248,011	51,885	4.2
1971	1,532,126	105,617	28,455	2,212	1,503,671	103,405	6.9
1972	1,391,372	86,105	30,404	6,855	1,360,968	79,250	5.8
1973	853,488	56,756	41,778	5,532	811,700	51,224	6.3
1974	1,368,444	47,671	13,900	7,892	1,354,544	39,779	2.9

Source: Calculated from "Anuario de Estadísticos Agropecuario, El Salvador, 1974/75," Ministerio de Agricultura y Ganadería.

3. COSTA RICA

5.3.1 Introduction

Costa Rica, with a population of about 2 million, has a relatively low population density. It has boundaries with Nicaragua on the north and Panama to the east. It is a mountainous country with both Pacific and Caribbean coastlines. Two mountain ranges make up most of the central part of the country.

Leading export crops are coffee and bananas. Coffee is the major export crop grown in the mountainous central part of the country. It is grown mostly at elevations ranging from 609 to 1371 meters. Bananas are also an important export crop in both Pacific and Caribbean lowlands. Other important crops include beans, rice, cacao, African oil palm and peach palm. Flower seeds and foliage plants are minor export crops. Domestic fruit crops include oranges, papayas and mangos. Some fruit is presently imported from Nicaragua and Panama.

The livestock industry of Costa Rica is relatively well developed, especially in beef and dairy cattle, which are among the best in Central America. Breeding stock is exported to other Central American countries.

5.3.2 Organization and Personnel

The University of Costa Rica, Faculty of Agronomy, offers three academic programs: plant production, animal production and agricultural economics. Of the total enrollment of 25,000, about 2,000 are in agriculture. There is a 5 year curriculum, plus a thesis, leading to the Ingeniero Agrónomo degree. Approximately 50 students per year graduate in plant production.

Graduate programs leading to the Master of Science Degree are available in Plant Production, Animal Production and Forestry. CATIE at Turrialba cooperates in the training and graduate programs of the university.

Professional entomologists on the faculty of Agronomy and CATIE form the nucleus for teaching and research. Most of their staff entomologists have received their doctorate and/or M.S. degrees abroad.

It appeared to us that entomology in Costa Rica had better research facilities, a more adequate library and more trained personnel than any of the other CAP countries. Research programs in entomology included systematics, ecology, biology and integrated control of insect pests of edible crops.

5.3.3 Detection and Chemical Control

No activities associated with fruit fly control, other than the methyl bromide fumigation of fruit entering from Nicaragua, are being conducted by MAG. Personnel with medfly experience report that present populations of this pest are much lower than those found during the first years following the introduction of the medfly in 1955. MAG believes that in part the complex of parasites released in Costa Rica could account for the lowered population densities. It was also observed by CATIE workers that medfly populations fluctuate from year to year as well as within the yearly cycle of wet and dry seasons. Medfly was not considered a problem in Turrialba, probably because of the prolonged wet season. They also reported that wormy oranges in the markets were not commonly found. On the other hand, guavas infested by *Anastrepha* are heavily attacked. At Guadaloupe, a suburb of San José, OIRSA has retained the fly rearing laboratory (built with USAID assistance) which was active in the UNDP/OIRSA/IAEA medfly study. Present OIRSA activity concerns the routine maintenance of stock populations of medfly and its parasites, some of which also attack *Anastrepha* spp. This is essentially a holding operation and any future mass rearing and release of parasites will depend on OIRSA's funding ability.

5.3.4 Biological Control

The most extensive biological control effort made against the medfly in CAP countries has been in Costa Rica. The initial biological control approach employed was a classical one in which attempts were made to establish the following imported parasites:

Biosteres longicaudatus compensans Silvestri
Biosteres longicaudatus Ashmead (= *O. formosanus* Fullaway)
Biosteres longicaudatus var. *novocaledonicus* Fullaway
Biosteres longicaudatus taiensis Fullaway
Biosteres tryoni (Cameron)
Biosteres vandenboschi Fullaway
Opius incisi Silvestri
Dirhinus giffardi Silvestri
Trybliographa daci Weld

During the early 1970's, the biological control laboratory at San José introduced additional medfly parasites and began to mass culture and release four parasite species throughout the year in such numbers that the approach shifted from the classical to an inundative periodic colonization approach. Large numbers of the four parasitic species were also sent to other CAP countries.

By 1971-72, the Costa Rica insectary was effectively mass culturing *Biosteres longicaudatus* and *Pachycrepoideus vindemiae*, but had difficulties in mass culturing the pupal parasite,

Dirhinus giffardii. During July and August 1971, the insectary received Opius concolor var. siculus from Palermo, Italy and began to mass produce this solitary larval-pupal parasite. In September, the insectary received Aceratoneuromyia indica Silvestri (= Synthomosphyrum indicum Silvestri) from Mexico, and mass culture of this gregarious larval-pupal parasite of tephritids and flesh flies was initiated.

The numbers of the four parasitic species mass cultured and released in Costa Rica are shown in Table 6. Many parasites of the four species produced were distributed to other countries (see under respective countries). Also, 14,246 Dirhinus giffardii were produced, and 4,050 were released in Costa Rica.

Evaluation of the impact of the parasite releases based on collecting, and holding fruits and flies trapped from eight release areas indicated a reduction of fruit flies. In 1971-72, Anastrepha occurred most commonly from May to September and medfly from October to March. Medfly puparia recovered were never greater than one per pound of fruit which is a low population. The parasites recovered in 1971-72 fruit collections indicated that medflies were parasitized from 8-30% by B. longicaudatus, 2-14% by P. vindemiae, but no apparent parasitism by A. indica or D. giffardii. The highest total medfly parasitism was 35%. Anastrepha was parasitized from 16-30% by A. indica in mango and guava, from 18-37% by B. longicaudatus, and between 4-45% by P. vindemiae. Dirhinus giffardii was not recovered from Anastrepha. From 12-30% of Anastrepha spp. were parasitized.

In 1974, fruit samples, mainly citrus, made from January to June, showed from 6-60% of the medfly to be parasitized by B. longicaudatus, from 1-27% by A. indica and from 1-14% by P. vindemiae. The highest total parasitization was 60.2%. One Anastrepha sample from mango showed 12% parasitization by B. longicaudatus, 5% by A. indica and 0.6% by P. vindemiae, a parasitization total of about 18%.

From July 1975 to June 1976, over 21 million B. longicaudatus, O. concolor and P. vindemiae were released in 2 to 7 areas in Costa Rica. Citrus fruit samples collected from 1 to 5 release areas during August 1975 to June 1976 showed from 0-43% medfly parasitized by B. longicaudatus, from 0-3% parasitized by A. indica, and from 0-33% parasitized by P. vindemiae. From 6 fruit samples containing Anastrepha, 12-30% were parasitized by B. longicaudatus. Parasitism by A. indica or P. vindemiae, and O. concolor was not reported from any area.

In 1977, the OIRSA insectary at San José reduced the parasite mass rearing program to a maintenance level. Even at this reduced level, sufficient parasites are being reared for release in new areas in CAP countries where it is desired to establish them. However, a greater diversity of parasitic species should be released.

Table 6

Number of fruit fly parasites produced and released in Costa Rica by OIRSA from May 1971 to May 1976 1/

	Biosteres longicaudatus 2/	Opius concolor	Acert. indica	Pachy. vindemiae
		1971-1972		
Produced	14,835,436	1,037,589	101,070,774	13,539,348
Released (C.R.)	5,213,000	-	45,661,000	6,349,000
		1974-1975		
Produced	159,092,142	20,194,066	163,825,553	5,047,742
Released (C.R.)	61,659,530	5,221,000	44,834,280	1,328,500
		1975-1976		
Produced	84,253,554	12,588,136	-	4,736,741
Released (C.R.)	17,088,630	3,358,750	-	605,800

1/ Data from: OIRSA Report 1973
OIRSA XXIII Meeting Report 1975
OIRSA XXIV Meeting Report 1976

2/ Fischer (1971) recognizes the genus Biosteres which now includes a group of species formerly placed in the genus Opius (see Appendix VIII).

5.3.5 Quarantine

Costa Rica, bordered on the north by Nicaragua and on the east by Panama, has a 360 mile coastline on the Pacific and a similar stretch on the Caribbean Sea with numerous small harbors and anchorages. Small craft that use these are difficult to monitor. The principal exports are coffee, bananas, sugar and meat. The main quarantine concern is not medfly damage, but the distinct possibility that Costa Rica may soon be infested with the coffee rust from Nicaragua.

The Department of Quarantine deploys its 32 Inspectors as follows:

Border Crossing Nicaragua		Border Crossing Panama	
Peñas Blancas	7	Paso Canoas	3
Pacific Ports		**Caribbean Sea Ports**	
Puntarenas	2	Limón	2
Golfito	1		
Airports		**Central Office**	
Sta María, San José	7	San José	6
El Grande	2		
Tobias Bellows	2		

The Ministry of Agriculture and Livestock Annual Quarantine Report for 1976 showed:

	Inspected	Treated	Cert. Issued
Vehicles with cargo	9,575	552	
Vehicles	51,906	3,762	
Aircraft	3,378	3,447	
Ships	1,307	31	
Phytosanitary certificates			5,505

5.3.6 Field Observations

Costa Rica has a long coastline on both the Pacific and Caribbean. Climates vary according to altitude. Most of the population lives in the temperate climate in the upland plateau known as Meseta Central which ranges in elevation from 457-1524 meters. The climate and topography of the country are diverse, ranging from hot coastal lowlands to cold mountain peaks. A series of three mountain ranges flanked by lower hilly sections which bisect the country from northwest to southeast is partially responsible for the different coastal climatic conditions. The mountains block the northeast trade winds, causing heavy rainfall along the Caribbean coast. The Pacific coast receives its rain from May through October. Because of the complicated topography

of the Pacific coast many microclimates are found in this area.

The climate of Costa Rica is divided into three major divisions: hot, temperate and cold. On the Pacific side, the hot zone extends from sea level to about 457 meters with daytime temperatures of 29° to 32°C. The temperate zone, with daytime temperatures of 24° to 27°C, extends from 457 to 1524 meters. The cold zone comprises the land above 1524 meters with daytime temperatures of 24° to 27°C and night temperatures from 10° - 13°C, down to freezing. Because of high rainfall on the Atlantic side and the warmer waters of the Caribbean, the temperate zone extends to higher altitudes on the Caribbean side than on the Pacific.

Many tropical and subtropical fruits including coffee, mangos, citrus, bananas, avocados, peaches, figs, plums, guavas, rose apples, mombins, papayas, sapotes and cashews are grown in temperate areas of Costa Rica. Tropical almonds and bananas grow in the hot zone. Medflies are present in fruit growing areas in the temperate zone, but their distribution in the hot zone on the Caribbean has not been determined. Anastrepha oviposits in mangos and guavas and ripe fruit are frequently infested.

There is presently no fruit fly trapping program in Costa Rica. Consequently, information on current fruit fly population trends is not available.

5.3.7 Economic Impact

General Agricultural Situation

Costa Rica's economy is dependent upon the agricultural sector. In 1975, agriculture's share of gross domestic product was 20%, and in 1973, it was estimated that 57% of all industry was agriculture. In 1973, 65% of the country's exports were agricultural, and 35% of the population was employed in the agricultural sector. There has been rapid growth in the agricultural sector, primarily through exports of coffee, bananas, sugar and beef. Coffee, bananas and sugar accounted for 57% of total exports in 1975.

In contrast to El Salvador, there are a greater proportion of small farms in coffee production than large farms (Table 7). Of nearly 77,000 farms in Costa Rica, 42% are engaged in coffee production while 18% produce oranges.

Table 7

Costa Rica: Total farm, coffee farm and orange farm size distribution, 1973.

Farm size (has)	Total no. of farms	No. of farms prod. coffee	No. of farms prod. oranges	Prod. in 100,000s of fruit	% oranges consumed on the farm	% of total farms producing	
						coffee	oranges
0 to 0.9	14,413	7,897	1,927	25	28.0	54.8	13.4
1.0 to 9.9	29,925	15,431	5,201	149	17.4	51.2	17.4
10.0 to 49.9	21,213	6,870	4,630	149	19.5	32.4	21.8
50.0 to 199.9	8,723	1,804	1,981	101	15.8	20.7	22.7
200.0 or more	2,724	348	466	83	4.8	12.8	17.1
TOTAL	76,998	32,350	14,205	507	16.2	42.0	18.4

Source: Calculated from Censo de Población, 1973.

Fruit Production and Trade

Fresh citrus fruit exports in 1973, consisting primarily of oranges, were valued at $26,426 while imports of lemons and mandarins totaled $4,172. Orange juice is a major import item with a volume of 450,000 kilos, 95% of which is divided about equally between Guatemala and Honduras. Specific and ad valorem duties have recently been assessed on orange juice imports to provide a stimulus for increased use of domestic fruit by the three orange juice processors.

Production of oranges in Costa Rica is not high relative to other CAP countries. Farms of less than 50 hectares grew 64% of the oranges produced in 1973. Small farms use nearly 30% of their production for home consumption. Of total orange production in 1973, slightly more than 4% of the 16% was consumed at the farm level (Table 7).

Medfly Economics

Presently, orange production and prices in Costa Rica do not entirely meet the needs of the orange juice industry. Medfly and other production and marketing difficulties contribute to increased unit costs at the processor level. Control of the medfly will not resolve this problem. A concerted attempt to remove production and marketing barriers is needed, but these attempts are hampered by priorities given to other crops. Recently imposed import duties may or may not be sufficient to stimulate local production. As the juice industry uses more of the local product, fresh oranges will become scarce. Presently, juice processors have the capacity to utilize 50% of the domestic fresh oranges going to market.

4. PANAMA

5.4.1 Introduction

Panama has borders with Costa Rica on the west and Colombia on the east. It forms the narrowest portion of the isthmus which links North and South America. A central range of mountains and hills form the continental divide. The mountains are highest at the Costa Rican border and become progressively lower as they extend eastward toward the canal where they almost disappear before rising again to moderate heights near the Colombian border. The entire country lies between 7° and 10° N latitude. Temperatures and humidity are uniformly high except for highland areas and on the Pacific side of the continental divide. Nearly 30% of Panama's 29,208 square miles is in agriculture related use, but only about 6.6% is used for crop production. Almost 16% is in pasture while the remaining agricultural land is used for miscellaneous purposes or left fallow. Panama's principal exports are bananas, sugar, beef and shrimp. Other important products grown largely for internal consumption are coffee, beans, tobacco, citrus and other fruits and vegetables. The population of Panama is 1.4 million (1970), and 40% of the economically active segment of the population is engaged in agriculture and related activities.

5.4.2 Organization and Personnel

The leading academic institution in Panama is the University of Panama with 30,000 students. The Faculty of Agronomy has one professional entomologist with a doctorate degree, who teaches and conducts research on economic and insect pest problems.

Branches of the University are located in several of the provinces. Schools of agriculture, located in David and Panama City, offer curricula in plant sciences and animal husbandry. The student body in the agricultural program is approximately 850 and there are about 50 graduates per year in plant production.

General and Applied Entomology are the only entomological courses offered. Additional entomological training is possible only through the selection of an entomological research problem for the undergraduate thesis. Graduate training in entomology is not available in Panama.

Entomological research is being conducted by the faculty. The major emphasis is on determining the economic injury levels of insect pests of beans, corn, rice, sugarcane and other crops. Research on medfly is of low priority.

As in other CAP countries, there is a shortage of trained entomologists and technicians in Panama.

5.4.3 Detection and Chemical Control

Approximately 600 sticky traps are currently deployed in medfly detection programs carried out by MIDA personnel in the provinces of Chiriquí, Veraguas, Coclé and Herrera. The last three provinces are situated in the low, semi-arid central portion of the country. No medfly captures have been reported outside the province of Chiriquí. Traps are scheduled to be placed in Los Santos province where there is a large production of melons for export. Trapping operations in Chiriquí are largely confined to the Boquete Valley. Sporadic trapping is also being done at the Government operated orange plantings of Cítricos de Chiriquí. El Valle and similar inland locations are favorable for fruit flies, but little trapping is being done. No trapping has apparently been carried out in Panama City and environs.

Anastrepha spp. are considered to be a problem in production of mango, guava, papaya, avocado and passion fruit in the central provinces. Toxotrypana curvicauda, a serious pest of papaya, is reported to be particularly troublesome.

No trapping or control operations are being carried out against Anastrepha spp. Some spraying against medfly in Cítricos de Chiriquí is done during November and December when medfly populations increase to higher levels. Spray operations are initiated when trap catches average 1.5 flies/trap/day. A mixture of molasses and malathion is applied to the foliage of trees in every other row throughout the block of trees in which flies were captured and also in adjacent blocks. At times, 2-3 spray applications at weekly intervals are needed to reduce medfly populations. No data are available concerning amount or degree of fruit infestation.

MIDA reports that about US $200,000 is devoted annually to their medfly program. This covers personnel, vehicles, trapping and per diem.

5.4.4 Biological Control

According to an OIRSA 1973 Report, 717,000 medfly puparia parasitized by Biosteres longicaudatus and 60,000 puparia parasitized by Pachycrepoideus vindemiae were released in the Boquete area during 1971. During 1974, nearly 45 million B. longicaudatus, 21 million Opius concolor, 164 million Aceratoneuromyia indica, and over 5 million P. vindemiae were released at Volcán, Potrerillos, Boquete, Chiriquí, David, Algarrobos, Sortova, Bugavita, Santa Marta, Las Lomas and El Calvario. Apparently, no evaluation has been made as to establishment or impact of the parasites released.

A MAG technician observed parasites stinging puparia of fruit flies in and under fallen fruits near Boquete. The species involved may be P. vindemiae since this species has been released. This species (under the name P. dubius Ashmead) was found in Panama in 1940 and sent to Puerto Rico for establishment against Anastrepha species there (Bartlett, 1941). P. vindemiae is probably already well established in CAP countries as a parasite of Anastrepha spp. and may also be attacking medfly.

5.4.5 Quarantine

Panama is a long narrow country oriented in an east-west direction. It is bordered on the west by Costa Rica and to the east by Colombia. The Pacific Ocean lies to the south and the Caribbean Sea to the north. While it has minimal land borders, Panama has a proportionately long coastline with many small ports which aggravate plant quarantine problems.

The Quarantine staff is deployed as follows:

Panama (39 Insp, 2 Supvr)

Tocumen	22
Almacentro	1
Chiriquí	1
Terminales Panamá	1
Tumba Muerto	1
Paitilla	3
Central P.O.	1
Curundú	1
Balboa	1
Air Express	1
Muelle Fiscal	4
INTERTRADE	1
Cargas Movibles	1

Colón (8 Insp, 2 Supvr)

Muelle-3	4
Folks River	1
Cristóbal	2
Bahía Las Minas	1

Coclé (1 Insp)

Puerto Aguadulce	1

Chiriquí (13 Insp, 1 Supvr)

Pt. Armuelles	1
Paso Canoas	3
Malek Airport	2
Risacua	6
Guabalá	1

Bocas del Toro (1 Insp)

Almirante	1

Total:	Inspectors	62
	Supervisors	5

Panama can truly be considered a crossroads of the world and accordingly could be the recipient of pests from all over the world. Aircraft flights from many North and South American cities pass through the Tocumen International Airport. Most of South America is infested with medfly and these flights are a continual source of medfly infestation. Interestingly enough Panama officials consider that the medfly is restricted to the province of Chiriquí. It is the major agricultural province and the center for banana, coffee and citrus production. More intensive surveys are needed and should be carried out to detect possible

infestations in other parts of the country. Another unusual aspect of this country is the ship traffic through the Panama Canal. Although ship transient time is short, there is adequate opportunity for pests to leave or board transiting vessels. Because of this, Panama could logically be the recipient of pests from distant places which could establish themselves if ecological conditions permitted.

From a quarantine standpoint, Panama is unique in having a pest entry potential problem greater than any other CAP country.

5.4.6 Field Observations

A dominant feature of the country is the central range of mountains of volcanic origin. These are highest near the Costa Rican frontier and become progressively lower eastward toward the canal. Panama has a warm tropical climate with a distinct dry and rainy season. Temperatures in much of the country are high without marked seasonal variation. The mean temperatures range from 22°-29°C. Temperatures seldom exceed 32°C. Rainfall varies from less than 1270 mm to more than 3048 mm, with the greater precipitation from April through October. The climate in Panama is variable.

Major export crops are bananas, sugar, coffee and oranges. Coffee, citrus, avocados, cashews, mangos, papayas, jocotes, guavas and plums are also grown. Damage to fruits from medfly is reported to be confined to Chiriquí Province which is the major agricultural and fruit growing area. In this province, medfly breeds principally in coffee and oranges.

El Valle and similar inland valleys, as well as residential locations in urban and rural areas, should be studied in detail to confirm whether or not they are free of medfly. It is possible that climatic factors limit the seasonal abundance of fruit flies, but normally we would expect the fruit fly population to be correlated with host abundance and periodicity.

5.4.7 Economic Impact

General Agricultural Situation

The agricultural sector accounted for 20% of Panama's gross national product in 1970. From 1968 through 1972, agricultural exports represented 65% of total exports and 8% of the imports. Agriculture does assist Panama's significant trade deficit which was 38.5 million dollars in 1972. The major agricultural export commodity group with 82% is vegetables, bananas and oranges.

Farms engaged in production of various products range from 5,767 for cacao to 50,401 and 51,311 respectively, for bananas and oranges (Table 8). Banana farms tend to be much larger than those of oranges and cacao.

Fruit Production and Trade

The government operated firm, Cítricos de Chiriquí, produces about 99% of the processed orange juice on a 3,950 ha plantation. From 350,000 fifteen year old trees, about 800,000 ninety pound boxes of oranges processed each year yields nearly 400,000 kilos of 65 Brix frozen concentrate orange juice. About 75% of the juice concentrate is exported. Less than 1% of the oranges processed is purchased from local growers. Attempts are underway to expand this supply source.

Medfly Economics

Marketing problems challenge expansion of the frozen concentrate orange juice industry. Lack of adequate infra-structure, storage and forward contract opportunities limit the government's ability to achieve potentials. Fresh market price instability with fluctuations of 500% discourage expansion of the commercial fresh orange market. Small growers depend on other income sources. Control of the medfly may not improve the fresh supply markedly and for the juice industry, the medfly is of little concern.

Table 8

Panama: Number of Farms, Plants and Total Production for the Primary Agricultural Products, 1970-71.

Crop	Number of Farms	Number of Plants		Production	
		Total	In production	Unit	Quantity
Coffee	30,742	21,555,295	16,390,955	100 pounds	97,799
Bananas	50,401	22,690,874	19,741,552	bunch	22,917,369
Platain	36,274	6,275,360	4,255,156	100 fruit	1,840,767
Coconut	38,765	1,739,350	659,306	fruit	7,802,015
Oranges	51,311	2,452,148	1,558,434	100 fruit	3,030,920
Cacao	5,767	945,028	806,662	pounds	983,154
Avocado	40,299	433,298	233,445	fruit	15,789,262
Papaya	18,009	198,756	110,785	fruit	878,268
Pineapple	31,220	4,959,680	3,152,214	fruit	1,860,525
Lemon	31,078	239,732	175,274		not available
Guayaba	21,861	362,282	286,847		not available
Marañon	36,012	406,877	293,402		not available
Mango	44,195	205,518	135,986		not available
Tomato	3,090	2,237ha			not available

Source: Censos Nacionales de 1970, Panama

5. NICARAGUA

5.5.1 Introduction

Nicaragua is a nation of 2.2 million people, the majority engaged in some form of agriculture or agriculture related pursuit. Coffee, cotton and livestock are the major sources of income. Oranges are grown for domestic use and some for export to nearby countries, principally El Salvador. Other tropical and subtropical fruit crops and vegetables play a part in the subsistence and local economy. The population of the country and most of the agriculture is concentrated in the dry/wet tropical and dry/wet temperate areas along the Pacific slope. The eastern province of Zelaya, which is more than half of the total area of the country, is low-lying, hot and humid, sparsely populated and with very few roads. The concentration of cities, roads, wealth, population, crops, and livestock is in the temperate highlands and littoral along the Pacific coast and is similar and comparable to that of corresponding areas of El Salvador, Guatemala and Costa Rica.

Export of coffee as well as certain fruits and vegetable crops to the United States and nearby countries play an important role in the economy of the country. There is adequate land and a labor pool which would permit expansion of export production of these crops. The presence of coffee rust in the country and the fear and uncertainty aroused in nearby coffee producing countries has adversely affected trade relations. The medfly is an additional complicating factor since it is found in all of the Departments which would logically be involved in new plantings for export. The combination of coffee rust, together with accompanying internal and external quarantine measures and the presence of various fruit flies, constitutes a potentially damaging factor to export possibilities.

5.5.2 Organization and Personnel

In Nicaragua, as well as in other CAP countries, there is a shortage of adequately trained entomologists and technicians needed to conduct an effective medfly suppression program.

Pest management has received much attention and limited success in certain specific areas. The major effort has been in developing an integrated pest management system for cotton insects. This program is a combined effort of FAO, MAG, BNN and UNAN. Through this program, insecticide applications have been reduced from 35 to about half this many per season. Professional entomologists conducting the program were trained in Europe and/or the United States. Studies on medfly have received a very low priority.

The National School of Agriculture and Animal Husbandry (ENAG) has a 5 year curriculum leading to the Ingeniero Agrónomo degree. Approximately 200 students are enrolled with about 18 graduates per year. Basic courses in general and economic entomology are offered. No graduate work or specialized training in entomology is available, however.

The National Autonomous University of Nicaragua (UNAN) offers training in biology and animal husbandry. A course on the principles of ecology and the philosophy of pest management is sometimes offered. Specialized training in entomology is not available.

Graduates of the schools in the Ingeniero Agrónomo curriculum would require additional specialized training in entomology to be effective participants in a fruit fly control program.

5.5.3 Detection and Chemical Control

The Government of Nicaragua, in a cooperative program with OIRSA, is carrying out some control and detection activities against the medfly. About 360 sticky traps are currently in operation in the Departments of Ocotal, Somoto and Chinandega which border on Honduras.

Some coffee and citrus are grown in these Departments, but yearly medfly trap catch data indicate low population densities. An area with a radius of 25 meters around traps which register medfly catches, is sprayed with malathion EC 57% at a rate of 15cc/gallon of water. The trees are given a full coverage treatment using a small trailer mounted power spray rig. Periodic samples of medfly host fruits are taken to verify established infestations. No detection or control work is being done with *Anastrepha* species. It is noteworthy that following the discovery of coffee rust in Nicaragua, the five man OIRSA medfly team was reduced to one man in order to meet the demand for trained personnel to assist MAG in its control campaign against coffee rust.

5.5.4 Biological Control

During 1970-1971, Rainer Daxl (FAO Ecology Officer) made an ecological study of the medfly and *Anastrepha* spp. at two fruit farms, "A" and "B", near Concepción, Nicaragua.

A weekly survey of medflies trapped from August 1970 to March 1971 was made, as well as fruit collections, to determine the numbers of medfly, *Anastrepha* spp. and parasites which emerged from fruits collected. Both farms grew a mixture of various tropical and subtropical fruits including coffee and oranges, but more coffee was grown at farm "B".

At farm "B" the medfly population was twenty times higher than at farm "A", based on adult trap records. Medfly adults peaked in January at farm "B" and in March at farm "A". Phenology of medfly hosts showed a mixture of coffee and oranges to be ideal for medfly population build up.

From 1420 medfly larvae and puparia collected from coffee berries in July and August, three Opius emerged. Forty three Opius and 35 Zaeucoila (Cynipidae) emerged from Anastrepha puparia collected from rose apple in June.

The Opius reared by Daxl from medfly are presently being identified to species.

According to 1973 OIRSA Report, 5,500,000 Aceratoneuromyia indica (=Synthomosphyrum indicum) were released in April and May 1972 at farm "A" where a variety of medfly host fruits was grown. No follow-up was made to determine the establishment or impact of the releases.

5.5.5 Quarantine

Nicaragua, bordered on the north by Honduras and to the south by Costa Rica, has many sea ports and anchorages on both the Pacific side and on the Caribbean. Twenty-nine such small harbors and anchorages were noted on the map. The border areas with Costa Rica and Honduras are sparsely populated with few roads and in many places foot crossings are common and unsupervised.

With a total staff of 26, Agricultural Quarantine assigns inspectors to the following stations:

Headquarters Office

Central Office Managua

Pacific Ports

Potosí
Corinto
Puerto Somoza
San Juan del Sur

Costa Rican Border

Peñas Blancas*

Airports

Las Mercedes International
Waspán
Puerto Cabezas
Bluefields

Post Office

Managua P.O.

Atlantic Ports

Puerto Cabezas
Bluefields
Corn Island

Honduran Border

El Espino*
Guasaule
Las Manos

Customs House

Managua

The inspectors are mostly graduates of Zamorano and Turrialba with little or no specialized training in entomology, plant pathology or other related sciences, or in quarantine procedures. Some have had several years of experience and on the job quarantine training.

The Annual Report of the Department for 1976 showed the following quarantine activity:

Stations	Vehicles	Aircraft	Ships	Baggage	Packages
Custom's House					142
Post Office					58
Las Mercedes		4,228		92,883	
El Espino	8,998			67,158	
Peñas Blancas	44,319			200,525	
San Juan del Sur			48		
Corinto			477	934	
Puerto Somoza			84		
Bluefields		140		2,387	
Puerto Cabezas	29		55		
Potosí	4,970		846	29,516	
Guasaule	22,068			77,714	
Las Manos	4,196			8,825	
Corn Island			80	9	

In addition to the exterior quarantine, Nicaragua has an interior quarantine against the spread of the coffee rust. This consists of 12 check points around a 10,000 manzana quarantined area near Carazo staffed with 40 inspectors, and reinforced with military personnel. All vehicles leaving are sprayed with a copper fungicide on the wheels and undercarriage, but no attempt is made to spray the upper part of the vehicle where rust spores might logically settle. The fact that the spores are wind-borne, suggests that these attempts to contain the disease with road checks are costly and futile.

The practice of treating vehicles with DDVP (Dichlorovinyl-dimethyl phosphate) at both the Costa Rica and Honduras border for medfly is not justified since the fly occurs in both countries.

5.5.6 Field Observations

Nicaragua lies between Costa Rica on the south and Honduras to the north. It is characterized by 4 regions: 1. the heavily populated Pacific highlands, 2. the Central highlands along the frontier with Honduras, 3. the sparsely populated forested areas of the eastern highlands and 4. the lowland coastal plain along the Mosquito coast of the Caribbean Sea.

There are 3 principal types of climate in the country: temperate, tropical wet and dry, and wet tropical. The temperate areas where coffee is grown lie mostly on the Pacific slope. These areas are smaller in extent than in most of the other countries with the exception of Panama and Belize. The tropical wet and dry climatic areas lie to the west of the mountains which form the continental divide. The wet tropical zone has a definite dry period, but is mostly warm and humid. Except for the highland areas, mean temperatures in most of the country are about 21°C. Temperatures rarely exceed 32°C.

Medfly host fruits found in the temperate climatic zone include coffee, avocados, bananas, mombins, rose apples, white sapotes, papayas, red sapotes, and various kinds of citrus fruits. Fruit fly larvae are frequently found in host fruits growing in coffee areas.

Two farms growing several different medfly host fruits were visited by the team. Medfly infested fruits were found on both farms. The medfly detection program is presently not well organized or active, but medfly is reported to be established from the Honduras border, south to Carazo in the coffee rust area. The government of Nicaragua is obviously more concerned with the coffee rust problem than with medfly.

5.5.7 Economic Impact

General Agricultural Situation

Economic activity in the agricultural sector represents about 30% of the gross national product. Agricultural exports have traditionally exceeded imports by a large margin and assist the country in maintaining a favorable balance of trade. In 1972, agricultural imports and exports totaled $24.7 and $190.7 million dollars respectively. From 1968 through 1972, agricultural imports averaged 10% of total imports while agricultural exports were 77% of total exports. In 1972, livestock (20%); coffee, tea and spices (17%); and sugar (8%) were the major contributors to agricultural exports with fruit and vegetables accounting for only 3%. Fruit and vegetable imports and exports from 1969 through 1972 were about equal.

Fruit Production and Trade

A major goal of the Nicaraguan government is to diversify agricultural production into fruits and vegetables with emphasis on both domestic and export markets. About 57% of the sector's labor force is employed in production of export products. Expansion in fruit and vegetable production, as in several other CAP countries, is viewed as a means of creating employment as well as generating foreign exchange.

The Central Bank of Nicaragua has been responsible for several farm management, production and marketing cost, and general feasibility studies on fruit and vegetables. The fruit export feasibility work focused on the U.S. market and revealed a ranking as follows: high: coconut, mango, lemon; medium: papaya, pineapple; limited: mandarins; none: grapefruit and cooking bananas.

Medfly Economics

Citrus exports do not appear feasible for Nicaragua and probably would not become feasible with eradication of the medfly. Various internal production and market problems, other than medfly, must be addressed to fully realize present production and export potentials.

6. HONDURAS

5.6.1 Introduction

Honduras has a 400 mile coastline on the Caribbean Sea and is bordered on the south by Nicaragua, on the southwest by El Salvador and on the west by Guatemala. Its 77 mile Pacific coastline is on the Gulf of Fonseca. It is the second largest country (43,300 square miles) in Central America with a population of over 2.5 million. Over 70% of the population make their living in agriculture, and agriculture related pursuits.

About 55,000 acres are devoted to bananas, the most important crop in the country. Commercial cultivation of bananas is limited to a strip of land 60 - 70 miles wide along the north coast. Many banana plantations were attacked by sigatoka disease in 1930 and some of the banana acreage was replanted to sugarcane. Coffee, the second crop in importance, is produced mostly on small plantations in the northwest. Farmers also grow corn, beans, rice, tobacco and oil palm.

Over 80% of the land is mountainous, but there are many small, fertile valleys and plateaus which could provide isolated pockets of medfly infestation and make an extensive control campaign difficult.

5.6.2 Organization and Personnel

The National University at La Ceiba has a 5 year curriculum leading to the Ingeniero Agrónomo degree. There is, however, no specialization in entomology other than the general entomology course offered. There is no research program underway in entomology.

The Pan-American School of Agriculture (EAP) at Zamorano is an excellent private school offering a 3 years diploma course in practical agriculture. EAP emphasizes practical training and in addition to classroom studies, provides good basic training in pest control as well as course work in the identification, physiology, morphology and control of insects. EAP is an international school, but about one-fourth of the students are from Honduras. In addition, Honduras supports an agricultural school at Catacamas patterned after EAP.

5.6.3 Detection and Chemical Control

Personnel of the Ministry of Natural Resources report that the lack of funds, equipment and materials necessary to carry out trapping operations has brought the medfly detection and chemical control program to a virtual standstill. During 1976, the trapping program was extensive with about 3,000 traps in operation.

Medflies were detected in the Departments of Copán and Ocotepeque, Lempira and Intibucá, and in El Paraíso. No medfly catches were reported from the northwest coast of Honduras. The highest medfly populations were recorded in El Paraíso. Spray crews applied a full coverage treatment of molasses and malathion to the coffee trees in the infested areas. In certain locations, soil treatments with Aldrin granules were applied. Fallen fruits were collected and placed in pits, then compacted and covered with Aldrin.

5.6.4 Biological Control

According to Ministry of Natural Resources technicians, no medfly parasites have been released in Honduras and no evaluation is being made of natural parasitism in medfly and *Anastrepha* spp. *Anastrepha* spp. are reported to cause more damage than the medfly on mango, guava, citrus and avocado.

5.6.5 Quarantine

Honduras is bordered on the west and southwest by Guatemala and El Salvador and on the south by Nicaragua. It has a long Pacific and Caribbean coastline. Its most important exports are bananas and coffee. The Plant Quarantine Service provides inspection coverage at Amapala on the Pacific. On the Caribbean side the ports are Puerto Cortés, La Ceiba, Tela and Roatán. The main International Airport is Toncontin, but there are smaller airports at Villeda Morales, San Pedro Sula and Golosón. The border crossing with El Salvador is at El Amatillo. The Honduras/Nicaragua crossings are located at Guasaule, El Spino and Las Manos. The border with Guatemala has entry points at Aqua Caliente and Florida. There are 32 inspectors deployed to cover these fourteen stations.

Vehicles entering and leaving Guatemala and Nicaragua are treated at border crossings with DDVP by OIRSA spray crews. Each vehicle operator is charged the equivalent of about US $1.00 for this treatment. Many complaints by tourists have been registered with the Ministry. Susceptible fruit are confiscated and burned or buried and cargo vehicles fumigated with methyl bromide. Internal quarantine stations are located at Sinuapa and Sensenti in the Department of Ocotepeque and at Güinope in El Paraíso. Host fruits are also seized and vehicles sprayed or fumigated at these points.

5.6.6. Field Observations

The following medfly tropical and subtropical host fruits are grown in Honduras: coffee, citrus, mangos, avocados, peaches, mombins, plums, cashews, green sapotes, and white sapotes. Bananas are grown in the hot areas near the coast. Medfly and

Anastrepha spp. are found in some locations of the temperate zone. Medfly infests mangos, citrus, guavas and avocados. Anastrepha spp. is a pest of grapefruit on the Caribbean coast and does more economic damage than medfly. The distribution of fruit flies is highly variable, depending upon the weather and fruiting cycle of the host plants.

Sticky traps are being used to detect and monitor medfly population trends. Trapping operations have shown that the medfly is present in five departments. Cultural control is occasionally practiced by collecting and burying cull and windfall fruit.

5.6.7 Economic Impact

General Agricultural Situation

The general economy of Honduras relies upon the agricultural sector for about one third of its gross national product. The country depends heavily on agricultural exports, but has experienced a trade deficit in recent years. From 1968 through 1972, agriculture's share of imports and exports averaged 11 and 74%, respectively.

The primary export commodities for Honduras are bananas and coffee, valued at $98.4 and $87.5 million dollars, respectively, in 1976. These two commodities account for about 80% of the country's agricultural exports and 60% of total exports. International price instability for these two commodities, accompanied by adverse weather conditions, have contributed to the country's deficit problem.

Fruit Production and Trade

Fresh orange, grapefruit and other citrus exports represent less than 1% of Honduran agricultural exports. A major part of the total $779,000 in exported fresh citrus was grapefruit shipped to West Germany and Belgium (Table 9). Fresh citrus exports from Honduras are shipped mainly to countries where medfly cannot survive.

For the 1973-74 season, production and yield characteristics for citrus in Honduras were estimated as follows:

	Has	Metric Tons	Metric Tons/ Ha
Oranges	2,925	24,425	8.34
Grapefruit	610	29,917	48.94
Other Citrus	217	16,362	75.5

Approximately 5, 30 and less than 1% of total production of oranges, grapefruit and other citrus, respectively, is exported.

Table 9

Honduras: Fresh Citrus Exports by Value and Receiving Market Share, 1975.

Product and country	Dollar value	Percent
Oranges and Mandarins:	$ 79,619	10.2
Guatemala	3,960	0.5
Nicaragua	75,521	9.7
Colombia	138	0.0
Grapefruit:	599,205	76.9
West Germany	386,260	49.6
Belgium	212,945	27.3
Other Citrus Fruit:	100,530	12.9
United States	38,920	5.0
Guatemala	350	0.0
Colombia	30	0.0
West Germany	10,800	1.4
Holland	50,430	6.5
Total:	$779,354	100.0

Source: Commercio Exterior de Honduras, Exportación, 1975.

There is a desire to increase exports of the fresh fruit that cannot be marketed domestically. The domestic market for grapefruit is narrow in Honduras because many consumers have not developed a taste for grapefruit. One plant is processing grapefruit juice.

Medfly Economics

Medfly does not present a serious economic problem in Honduras. Emphasis is on coffee and bananas while citrus exports are minor. The coffee rust situation is of major concern to the government and it appears that pest management priorities lie in that direction.

7. BELIZE

5.7.1 Introduction

Belize is a small country with an area of approximately 8,866 square miles. It faces the Caribbean Sea and is bordered on the north and northwest by Mexico and on the south and west by Guatemala. The physical features are made up of coral reefs and atolls along the coast, flat and dry coastal plains and a mountainous interior which rises to 1122 meters. The country is in the hurricane belt and the climate is hot and muggy, tempered by the sea breezes along the coast. The average annual rainfall is 1270 mm in the north to over 3810 mm in the south. The wet season extends from May through October.

Belize, with a total population of 130,000, has a population density of 14 persons per square mile, the lowest in Central America. About a third of the people live in Belize City.

The main sources of income are from agriculture, forestry products and fishing. Primary products are sugar, fish, rice, oranges, grapefruit, and mangos. Exploitation of its rich forests was the only significant economic activity up through the early part of the 20th Century. Since then, the supply of accessible timber has diminished, and agricultural pursuits such as sugar and citrus have replaced forest products as principal exports.

Belmopán, established in 1970, is the capital and administrative center of the country. The former capital and commercial center is Belize City.

5.7.2 Organization and Personnel

There is a shortage of entomologists and technicians with the knowledge and experience to carry on a program of medfly research or pest management in Belize. Academic training for entomologists is not available in the country. Several of the large commercial agricultural firms have trained individuals on their staffs in the use of pesticides for control of insects and diseases.

5.7.3 Detection and Chemical Control

The Ministry of Agriculture and Lands reports that medfly traps are in operation along the Mexican and Guatemalan borders at Stann Creek Valley, the major fruit producing area, and at the International airport, nine miles outside of Belize City. No insecticide treatments of vehicles for medfly is done at the international crossings.

To date, no medflies have been caught in Belize. A cooperative work agreement with APHIS/USDA has been developed which will provide for a more intensive medfly detection program.

Trapping for Anastrepha ludens is done at Stann Creek Valley where this pest attacks citrus and causes premature fruit drop, particularly in grapefruit plantings. Ultra-low-volume treatment of malathion/protein bait mixtures are applied by air when population levels of A. ludens reach a critical level. Other species of Anastrepha are also pests of mango, guava and other tropical fruits.

Several species of parasites received from Trinidad and Mexico have been released, but apparently have not become established.

5.7.4 Biological Control

Since the medfly has not been found in Belize, obviously no biological control has been directed toward the medfly. However, Department of Agriculture officials said that two species of parasites from CIBC in Trinidad during 1970/71 were released in Belize against Anastrepha spp. attacking citrus. It is not known if these parasites have become established.

5.7.5 Quarantine

Belize (British Honduras) is a small Caribbean country with a long coastline situated in the northeast part of Central America and bordered by Mexico and Guatemala. Belize City is the main maritime port. Other ports are Punta Gorda and Big Creek. There is a Mexican border crossing at Santa Elena and a Guatemala crossing at Benque Viejo. In addition, the International Airport at Belize City handles traffic from CAP countries to New Orleans.

There is no interior quarantine program in Belize.

5.7.6 Field Observations

One day was spent in the field traveling to Belmopán from Belize City. The area visited was a low plain with a few papaya, orange and mango trees planted around homes. Time did not permit a visit to commercial plantings of oranges, grapefruit, bananas and mangos located in Stann Creek.

5.7.7 Economic Impact

Citrus is produced in Belize mostly by members (294) of the Citrus Grower's Association. Approximately 9,500 acres were devoted to citrus production, of which 7,000 were oranges and 2500 grapefruit.

Agriculture is the primary industry in Belize. The agricultural sector's share of total exports and imports was 74% and 29%, respectively, in 1970. Fruit and vegetables accounted for 27% agricultural exports in that year while 69% were attributed to sugar (Table 10).

Frozen orange concentrate accounted for 46% of export sales in 1975 followed by 17.5% for grapefruit (Table 11). Over 15% of the country's orange concentrate was exported to Canada. England imported 43% of Belize's citrus, mainly fresh grapefruit and canned segments.

Fresh citrus exports are probably not hampered either presently or potentially by the medfly since emphasis is on processing. Because of this, the possible economic impact of medfly would probably not be significant. The Mexican fruit fly is, however, considered a problem in production. The citrus marketing system is reasonably well organized in Belize.

Table 10

Belize: Export Value and Volume for Sugar and Citrus, 1974[a] and 1975[b].

Product	1974 Metric Tons	1974 Dollars	1975 Metric Tons	1975 Dollars
Sugar	83,725	$ 28,250,000	not available	not available
Fresh oranges	none	none	66	$ 1,328
Fresh grapefruit	1,103	218,009	2,017	412,139
Orange juice	1,549	214,953	1,367	144,208
Grapefruit juice	714	90,791	324	59,320
Orange Concentrate	4,281	1,492,196	3,144	1,271,207
Grapefruit concentrate	387	138,272	1,133	493,187
Grapefruit segments	2,470	755,737	998	380,015
Orange oil	683	247,156	21	31,849
Grapefruit oil	3	5,208	3	3,482
Total Citrus	11,190	$ 3,162,322	9,073	$2,796,735

Source: [a] Annual Report, Department of Agriculture, Belize, 1974.
[b] Agricultural Attaché, 1976.

Table 11

Belize: Percentage Distribution of Citrus Exports from Belize in 1975 by Country of Destination.

Country	Fresh		Processed							Total
			Orange			Grapefruit				
	Oranges	Grapefruit	Juice	Concentrate	Oil	Juice	Concentrate	Segments	Oil	
Belgium	*	-	-	-	-	-	-	-	-	-
Canada	-	-	0.3	15.4	-	-	8.2	-	-	23.0
Caymans	-	-	-	-	-	-	-	-	0.1	0.1
Guatemala	*	-	-	-	-	*	-	-	-	*
England	-	14.7	2.8	7.1	0.1	1.9	1.7	13.6	0.6	42.6
France	-	-	-	-	-	-	-	-	0.4	0.4
Holland	*	-	-	2.7	-	-	0.3	-	-	3.0
Jamaica	-	-	2.1	11.3	-	0.1	0.2	-	0.1	13.8
Mexico	-	-	*	-	-	*	-	-	-	*
Trinidad	-	-	-	3.0	-	-	0.6	-	-	3.6
United States	-	-	-	5.9	-	-	4.5	-	-	10.4
West Germany	-	-	-	0.3	-	-	2.0	-	-	2.3
Total	*	14.7	5.2	45.7	0.1	2.0	17.5	13.6	1.2	100.0

* less than 0.1%

Source: Calculated from data taken from an unpublished report by the U.S. Agricultural Attaché, November 3, 1976.

CHAPTER 6

POTENTIAL IMPACT OF MEDFLY ON U.S.

Potential Zones

Studies conducted by Messenger and Flitters [1954,1957] and Flitters and Messenger [1965] indicate that four fruit fly species (Mediterranean fruit fly, oriental fruit fly, melon fruit fly and Mexican fruit fly) may survive winter conditions in the Continental U.S. in areas where the average year exhibits no more than a 60-day period with an average temperature below 14°C. This area roughly includes all of Florida south of the 30th parallel, the lower delta of Louisiana, the lower Rio Grande Valley in Texas, a coastal strip along the Gulf of Mexico from Brownsville to Galveston, Texas, the Imperial Valley of California, and the Yuma and Lower Gila River areas in Arizona. A fifth fruit fly, the Caribbean fruit fly, is already established as a pest in Florida, but its potential range in southern United States has not yet been determined.

Areas with more than a 60-day period but less than a 90-day period with an average temperature below 14°C appear to be marginal for fruit fly reproduction and immature stage development. In the U.S., this zone includes an Atlantic coastal strip extending from the 30th parallel north to Charleston, South Carolina, other parts of Florida north of the 30th parallel, extensive areas in southern Georgia, Alabama, Mississippi, Louisiana, and Texas, the Greater Gila and Salt River valleys of Arizona, including the Phoenix area. The Death Valley and Coachella Valley regions of southern California, and the lower Colorado River Valley area inland as far south as the southern tip of Nevada are also included.

Excessively hot, dry summer conditions may be expected to inhibit build up of damaging infestations of Dacus spp. A map [Messenger and Flitters, 1954, p. 754] delineates the "potential" and "marginal" zones of infestation.[1/] Harris [1975] reported that the Mediterranean fruit fly strain in Tunisia is an exception and reaches the highest levels during the hottest and driest part of the year.

Zone lines on the cited map were extrapolated onto a large U.S. map showing counties in each state. Counties were used as the

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1/ "Potential" is used to describe the zone with no more than a 60-day period with average temperatures below 14°C. "Marginal" is used to describe the zone with more than 60 but no more than 90 days with average temperatures below 14°C.

basic unit for which data were collected to estimate production losses for various infestation levels. A county was included in the potential zone if any part of the county was crossed by the zone line. Similarly, any county was included in the marginal zone if any part of the county was crossed by the zone delineating the marginal zone from areas thought to have temperatures which makes infestation improbable.

Florida is the only state in which all counties fall into either one zone or the other. Forty-seven southern Florida counties were grouped into the potential zone with 20 northern counties remaining in the marginal zone. South Carolina, Georgia, Alabama, and Mississippi have 5, 66, 18, and 24 southern counties respectively, in the marginal zone. Louisiana has 14 parishes in the potential zone and 29 parishes in the marginal zone. Texas counties number 44 and 72 respectively, in the potential and marginal zones. Three California counties have areas covered by both the potential and marginal zone so all were included in the potential zone. A similar technique placed three Arizona counties in each zone.

Loss Rates

Definite infestation rates from which to project losses are not available. Loss rates in this report are assumed over a range from 10 to 75 percent. These loss rates are assumed to occur in the potential zone. Based on Messenger and Flitters [1954, p. 761], it appears that five successive generations per year of the oriental fruit fly are produced under conditions typical of the potential zone. Between two and three generations reproduced under conditions typical of the marginal zone. In order to derive total loss estimates across zones in this report these data were used to make the assumption that losses would occur in the marginal zone at one-half the rate of the potential zone.[2/]

Data Base

County data on agricultural production were used to develop zone production data where entire statewide production did not fall within a zone. Average production for 1972-75 was used to derive an average annual production base rate for citrus and peaches. Use of a three-year average modified the influence of abnormal production years. Price data for 1975 were used.

2/ Loss rate or infestation rate notation in this report similar to 10/5 percent can be interpreted as a 10 percent loss in the potential zone accompanied by a five percent loss in the marginal zone.

Production and Value Losses

Citrus

Four states produce all the citrus in the U.S. All or parts of these states are in the potential zone. Florida, Texas, Arizona, and California produced a total 1972-75 average of 328,786,000 boxes of citrus. Eighty-one percent of this production is in the probable zone. All the limes, tangelo and temples produced in the U.S. are in the potential zone (Table 12). Grapefruit, tangerine, orange and lemon production in the U.S. occurs at the rate of 98, 83, 81 and 31 percent, respectively, in the potential zone. California is the only state where citrus production occurs outside the probable and potential zones. Only 13 percent of production in California occurs inside these zones.

Estimated volume of losses at various damage rates are given in Table 12. At a 10/5 percent rate a total of 26,681,000 boxes of citrus would be lost in the U.S. Of this loss, percentage shares for oranges and grapefruit would be 68.5 and 23.5 percent, respectively, for a total of 92.0 percent. Florida would suffer 85.7 percent of the total loss followed by Texas, Arizona, and California with 6.1, 4.7 and 3.5 percent, respectively. Loss estimates for rates ranging from 20/10 percent to 75/37 percent are also given in Table 12.

The value of projected production losses at 1975 prices and the 10/5 percent rate would be $70.1 million in the U.S. (Table 13). The loss in oranges would be $46.6 million or 66.4 percent and in grapefruit $16.11 million or 23.0 percent of the total. Florida would suffer the greatest loss at $60.0 million or 85.6 percent of the total. These potential loss figures are estimates at the farm level.

Estimates of losses at the retail level would be much greater because of marketing margins. Retail loss estimates for oranges and grapefruit are given in Table 14. Estimated total retail loss at a 10/5 percent infestation rate for oranges is $159.9 million. This would occur at $118.0, $15.5 and $26.4 million in frozen concentrate, fresh and all other orange markets, respectively.

Losses in grapefruit at the farm level from a 10/5 percent infestation rate would be $16.11 million. Loss in the retail market would be $58.81 million. The retail market loss would be allocated to the frozen concentrate, fresh and all other markets at the rate of $7.1, $28.7 and $23.0 million, respectively.

Production declines would be expected to cause an increase in prices. Consumers will pay more to purchase the commodity as it becomes less available. Price flexibilities relating the percentage change in product price to a percentage change in quantity make possible mroe accurate estimates of the total loss from a possible production decline.

Table 12

Projected citrus fruit production losses for Florida, Texas, Arizona, California and the U.S. for a series of assumed damage rates that might occur as a result of fruit fly infestation.4/

Crop	1972-75 Statewide Average 1/ 1,000 boxes	Percent in 2/ Probable Zone	Percent in 2/ Marginal Zone	Projected Losses at Various Damage Rates 3/					
				10/5%	20/10%	30/15%	40/20%	50/25%	75/37%
				1,000 boxes					
						Florida			
All Oranges	169,000	100	0	16,960	33,920	50,880	67,840	84,800	127,200
Grapefruit	46,033	100	0	4,603	9,260	13,809	18,413	23,016	34,524
Limes	1,083	100	0	108	216	324	433	541	812
Tangelos	3,833	100	0	383	766	1,149	1,533	1,916	2,874
Tangerines	2,966	100	0	296	593	889	1,186	1,483	2,224
Temples	5,233	100	0	523	1,046	1,569	2,093	2,616	3,924
Total	228,748	100	0	22,873	45,807	68,620	91,498	114,372	171,558
						Texas			
All Oranges	6,313	100	0	631	1,262	1,893	2,525	3,156	4,734
Grapefruit	9,933	100	0	993	1,986	2,979	3,973	4,966	7,479
Total	16,246	100	0	1,624	3,248	4,872	6,498	8,122	12,213
						Arizona			
All Oranges	4,480	100	0	448	896	1,344	1,792	2,240	3,360
Grapefruit	2,488	100	0	249	498	747	995	1,244	1,866
Lemons	4,900	100	0	490	980	1,470	1,960	2,450	3,675
Tangerines	607	100	0	61	121	182	243	304	455
Total	12,475	100	0	1,248	2,495	3,743	4,990	6,238	9,356
						California			
All Oranges	45,867	5	0	229	459	688	917	1,147	1,720
Grapefruit	5,717	74	0	423	846	1,269	1,692	2,116	3,173
Lemons	18,233	12	0	219	438	656	875	1,044	1,641
Tangerines	1,500	42	0	63	126	189	252	315	473
Total	71,317	33	0	934	1,869		3,736	4,622	7,007
						Total U.S.			
All Oranges	226,260	81	0	18,269	36,537	54,806	73,074	91,343	137,015
Grapefruit	64,171	98	0	6,269	12,537	18,805	25,074	31,342	47,014
Limes	1,083	100	0	108	216	324	433	541	812
Lemons	23,133	31	0	709	1,418	2,126	2,835	3,544	5,316
Tangelos	3,833	100	0	383	593	889	1,186	1,483	2,224
Tangerines	5,073	83	0	420	841	1,261	1,681	2.102	3,152
Temples	5,233	100	0	523	1,046	1,569	2,093	2,616	3,924
Total	328,786	81	0	26,681	53,188	79,780	106,376	132,971	199,457

1-Source: Computed from [Messenger et al. 1957]
2-Based on county data taken from [Purcell et al. 1972]
Delineated into zones based on maps in [Harris. 1975].
3-Losses in marginal zone calculated at one-half the rate in the potential zone.
4-Totals may not add exactly due to rounding error.

Table 13.--Projected citrus fruit farm value losses for Florida, Texas, Arizona, California, and the U.S. for a series of assumed damage rates that might occur as a result of fruit fly infestation.

Crop	1975 Average Price	Projected Losses at Various Damage Rates					
		10/5%	20/10%	30/15%	40/20%	50/25%	75/37%
	dollars per box	millions of dollars					
					Florida		
All Oranges	2.56	43.418	86.835	130.253	173.670	217.089	325.632
Grapefruit	2.66	12.244	24.488	36.732	48.979	61.22	91.833
Limes	7.22	.833	1.667	2.501	3.343	4.177	6.269
Tangelos	2.36	.904	1.808	2.712	3.618	4.522	6.783
Tangerines	4.84	1.433	2.870	4.303	5.740	7.178	10.764
Temples	2.31	1.208	2.416	3.624	4.835	6.043	9.064
Total		60.040	120.084	180.125	240.185	300.229	450.345
					Texas		
All Oranges	1.91	1.205	2.410	3.616	4.823	6.028	9.042
Grapefruit	2.30	2.284	4.568	6.852	9.138	11.422	17.202
Total		3.489	6.978	10.468	13.961	17.450	26.244
					Arizona		
All Oranges	2.67	1.197	2.393	3.588	4.785	5.981	8.971
Grapefruit	2.10	.523	1.046	1.569	2.090	2.612	3.919
Lemons	3.30	1.617	3.234	4.851	6.468	8.085	12.128
Tangerines	4.73	.288	.572	.861	1.149	1.483	2.152
Total		3.625	7.245	10.869	14.492	18.116	27.170
					California		
All Oranges	3.24	.742	1.487	2.229	2.971	3.716	5.573
Grapefruit	2.51	1.061	2.123	3.185	4.247	5.311	7.964
Lemons	4.03	.883	1.765	2.644	3.526	4.409	6.613
Tangerines	3.92	.247	.494	.741	.988	1.235	1.854
Total		2.933	5.869	8.799	11.732	14.671	22.004
					Total U.S.		
All Oranges	--	46.562	93.125	139.686	186.249	232.814	349.218
Grapefruit	--	16.112	32.225	48.338	64.454	80.265	120.918
Limes	--	.833	1.667	2.501	3.343	4.177	6.269
Lemons	--	2.500	4.999	7.495	9.994	12.494	18.741
Tangelos	--	.904	1.808	2.712	3.618	4.522	6.783
Tangerines	--	1.968	3.364	5.044	6.728	8.413	12.618
Temples	--	1.208	2.416	3.624	4.835	6.043	9.064
Total		70.087	139.604	209.400	279.221	348.728	523.611

Table 14

Estimated U.S. losses in oranges and grapefruit sales with a 10/5 percent infestation rate.

Price Conditions	Farm Value	Retail Value			
		Frozen Concentrate	Fresh	All Others	Total
	Million dollars				
			Oranges		
1975 Prices	46.56[a]	117.96[c]	15.52[d]	26.39[e]	159.87
Price adjusted with flexibilities. U.S. market assumed	39.92[b]	101.13[c]	13.31[d]	22.62[e]	137.06
			Grapefruit		
1975 Prices	16.11[a]	7.11[g]	28.72[h]	22.98[i]	58.81
Price adjusted with flexibilities. U.S. market assumed	14.13[f]	2.83[j]	17.99[k]	15.79[l]	36.61

[a]From Table 13.

[b]Given price flexibility equal to -.22 and 1975 price of $2.71 per box.

[c]Given 76 percent allocated to frozen concentrate market and farm value representing 30 percent of retail value [USDA Agr. Stat. (1976)].

[d]Given 7 percent allocated to fresh market and farm value representing 21 percent of retail value [USDA Agr. Stat. (1976)].

[e]Given 17 percent allocated to all others and farm value representing 30 percent of retail value [USDA Agr. Stat. (1976)].

[f]Given price flexibility equal to -.14 and 1975 price of $2.58 per box.

[g]Given 19 percent allocated to frozen concentrate.

[h]Given 41 percent allocated to fresh market and farm value representing 23 percent of retail value.

[i]Given 41 percent allocated to all other uses and a 1975 equivalent price of $9.80 per box.

[j]Given price flexibility equal to -.67.

[k]Given price flexibility equal to -.42.

[l]Given price flexibility equal to -.42.

Total losses using slightly higher prices resulting from production declines are also shown in Table 14. Original farm level losses at the 10/5 percent loss rate were $46.6 million at 1975 prices of $2.71 per box. Losses for oranges with adjusted prices were $39.9 million. This estimate was obtained by first calculating total U.S. value of all orange production at $2.71 per box. Using the price flexibility of -.22, the change in price from a 10/5 percent decrease in production resulted in a new price of $2.76 per box. This adjusted price was then multiplied by production levels reflecting the 10/5 percent loss. The difference between total production at 1975 prices and production adjusted for a 10/5 percent loss at the adjusted price then made up the estimated loss of $39.9 million. Retail value losses were then estimated to reflect the slight price increase at lower production levels to arrive at a total retail loss of $137.1 million. This compares to a retail loss estimate without price adjustment of $159.9 million.

Loss estimate adjustments due to price increases are also shown for grapefruit (Table 14). Losses at the farm level using 1975 prices were $16.1 million. After slight price increases due to lower quantities produced, the estimated loss is revised downward from $58.8 to $36.6 million.

Retail level losses for lemons, limes, tangelos, tangerines, and temples are not given. Market data necessary to make comparable estimates to oranges and grapefruit are not available. Farm level losses for these commodities are given in Table 13.

Peaches

Nine states produce peaches which are in potential and/or marginal zones. Together these states produce an average (1972-73) of 2.2 billion pounds annually which accounts for 81 percent of U.S. peach production. However, only a relatively small part of this production occurs within the designated zones. Florida, Texas, Arizona and California all have part of their production in the potential zone and some in the marginal zone (Table 15). Florida has the greatest potential for loss because all production is in either the potential or marginal zone. South Carolina and California are the leading states in peach production, but potential losses are relatively small because most of these states' production is outside of the potential or marginal zones.

Estimated volume of losses for infestation rates of 10, 20, 30, 40, 50 and 75 percent for the probable zones are calculated in Table 15. For a 10/5 percent loss rate an estimated 5 million pounds of peaches will be lost. Estimated losses increase proportionately until a 25.0 million pound loss is estimated for 50/25 percent infestation rates.

Table 15.--Projected peach production losses for South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arizona, California and the U.S. for a series of assumed damage rates that might occur as a result of fruit fly infestations.[4]

State	1972-75[1] Average Production	Percent in Probable Zone [2]	Percent in Marginal Zone [3]	Projected Losses at Various Damage Rates[3]					
				10/5%	20/10%	30/15%	40/20%	50/25%	75/37%
				million pounds					
South Carolina	22.33	0	1.0	.11	.22	.34	.45	.56	.84
Georgia	80.0	0	12.0	.48	.96	1.44	1.92	2.40	3.60
Florida	38.5	8.0	92.0	3.85	7.69	11.53	15.38	19.23	28.84
Alabama	7.7	0	2.0	.01	.02	.02	.03	.04	.06
Mississippi	8.0	0	4.0	.01	.02	.05	.07	.08	.12
Louisiana	5.3	0	4.0	.01	.02	.03	.04	.05	.08
Texas	16.3	.9	39.0	.34	.67	1.00	1.33	1.67	2.50
Arizona	.2	12.0	8.0	0	0	.01	.01	.01	.03
California	1,867 6	.1	0	.19	.37	.56	.75	.94	1.40
Total	2,771.9[5]	.2	2.0	5.00	9.97	14.98	19.98	24.98	37.46

[1] Source: Computed from Messenger et al. 1957; and Purcell et al. 1972.

[2] Based on county data taken from Purcell et al. 1957.
Delineated into zones based on maps in Harris, 1975.

[3] Losses in marginal zone calculated at one-half the rate in the potential zone.

[4] Totals may not add due to rounding error.

[5] Total U.S. production.

Value of projected production losses at current (1975) prices are presented in Table 16. Florida, because of the relatively large projected volume losses and because of favorable state prices, is estimated to have the largest dollar loss. Total estimated U.S. loss to producers ranges from $1.1 million for a 10/5 percent infestation rate to $8.6 million for a 75/37 percent infestation rate. These projected losses are for peach farmers since prices in Table 16 represent farm-gate prices for 1975.

Estimates of losses at retail are relatively higher because of marketing margins (Table 17). Estimated value of retail losses in canned peaches is $0.8 million at 1975 prices with a 10/5 percent infestation rate. This estimate assumes that the current allocation of the crop will be maintained at 54 percent to canned peaches. U.S. retail prices of fresh peaches are approximately twice the U.S. average farm price [Florida Canners Association, 1975; and Purcell et al., 1972]. Given that the remaining 46 percent of production is consumed fresh, estimated retail loss of fresh peach sales is $1.1 million for a 10/5 percent infestation rate (assuming that farm prices in the affected area are one-half retail prices). The total estimated retail loss at 1975 prices is $1.9 million (Table 17).

A decrease in production can be expected to raise prices due to the inverse demand relation of price and quantity. Price flexibilities relating percentage change in price to percentage change in quantities are required for precise prediction of changes in total value. The price flexibility for California canned peaches is estimated to be -.4820 [Hoos and Kuznets, 1973]. Price elasticity for retail fresh peaches in Georgia is estimated to be -1.90 [Purcell, et al., 1972] which results in a price flexibility of -.51. Price flexibilities or elasticities are not available at the farm level. However, other market relationships allow for an estimate for the farm level.

After price adjustments for retail canned peaches are included, the projected loss is $0.4 million (Table 17) which is approximately one-half the projected loss at 1975 prices. Retail fresh peach sales are estimated to be down by $0.5 million which again is approximately one-half of the projected loss using 1975 prices. The basic procedure for these estimates was to calculate the percentage loss in the U.S. market for a 10/5 percent infestation rate. Given this percentage loss, percentage change in price was estimated using the estimated price flexibilities. Total value of U.S. fresh sales were then estimated. The difference between these estimated sales and actual 1975 sales provided the estimated losses of $0.4 and $0.5 million in Table 17.

Estimates of dollar losses at the farm level are less precise. From 1974 to 1976 farmers received a relatively stable 24 to 26 percent of the retail value of canned peaches [USDA, 1976]. Using this to imply a constant percentage margin gives a price flexibility

Table 16

Projected value of peach production losses for South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arizona, California, and the U.S. for a series of assumed damage rates that might occur as a result of fruit fly infestation.

State	1975 Average Price	Projected Losses at Various Damage Rates					
		10/5%	20/10%	30/15%	40/20%	50/25%	75/37%
	Cents per lb.[a]	Million Dollars					
South Carolina	16.2	.018	.030	.055	.073	.091	.136
Georgia	23.8	.114	.229	.343	.457	.571	.857
Florida	23.3	.897	1.792	2.687	3.584	4.481	6.720
Alabama	22.7	.002	.005	.005	.007	.009	.014
Mississippi	19.0	.002	.004	.010	.013	.015	.023
Louisiana	20.5	.002	.004	.006	.008	.010	.016
Texas	22.0	.075	.147	.220	.293	.367	.550
Arizona	17.5	0	0	.002	.002	.002	.005
California	17.5	.033	.065	.098	.131	.165	.245
U.S. Total:		1.143	2.282	3.426	4.568	5.711	8.566

[a] Derived from Messenger et al. 1957. Florida estimated as average of Alabama and Georgia. Arizona price assumed equal to California.

Table 17

Estimates of U.S. dollar losses in peach sales with a 10/5 percent infestation rate.

Price Conditions	Farm Value	Retail Value		
		Canned	Fresh	Total
		Million Dollars		
1975 Prices	1.143[a]	.806[b]	1.050[c]	1.856
Price adjusted with flexibilities. U.S. market assumed	.343[d]	.418[e]	.516[f]	.934
Price adjusted with assumption of special market[g]	.656	.077	1.024	1.101

[a]From Table 16.

[b]Given 54 percent allocated to the canned market with a 1975 price equal to 29.85 cents per pound [USDA Agr. Stat. (1976)].

[c]Given 46 percent allocated to the fresh market with a 1975 price equal to 45.72 cents per pound [USDA Agr. Stat. (1976)].

[d]Assuming price flexibility equal to -.482 and prices equal U.S. averages before and after the loss.

[e]Given 54 percent to the canned market, 5 million pound loss and price flexibility equal to -.482.

[f]Given 46 percent to the fresh market, 5 million pound loss and price flexibility of -.51.

[g]Assumed separate market for affected market. Given initial farm weighted average price equal to 22.85 cents per pound. Assumed 90 percent allocated to fresh market. Price flexibility given in footnotes e and f.

at the farm level equal to the flexibility at retail (-.482). Given this assumption and using the same procedure used for estimating retail losses, the estimated loss at the farm level is $0.3 million.

The estimated loss at farm level is probably low for several reasons. The zoned area produces 41.28 million pounds. The 5 million pound loss at the 10/5 percent infestation rate is a reduction of 12 percent. A 12 percent reduction in supply in the affected area would produce a 5.78 percent increase in price. Using the new price in the affected area results in a crop value of $8.8 million after the loss compared to a crop value in 1975 of $9.4 million for a loss of $0.7 million. This consideration of the affected areas as a separate market is somewhat justified since the weighted average price is $0.2285 per pound compared to only $0.109 for the U.S. total market. This suggests a superior product. Thus, the estimated effect at farm level after price adjustments is between $0.343 (Table 17) and $0.7 million (separate market).

Given a separate market for affected area peaches, the percentage going into the fresh market is likely to be higher than the U.S. average of 46 percent assumed in Table 17. This would increase the loss estimates for the fresh and total retail markets since dollar value is higher in fresh form than processed form. For example, if 90 percent of affected area peaches moved into the fresh market, the estimated losses in the retail fresh market would be $1.024 and $0.08 million in the canned retail market for a total of $1.1 million. The last two rows in Table 17 should be viewed as a range in estimates with price adjustments. The range is less than estimates assuming 1975 prices.

International Considerations

The previous analysis of physical crop loss provided estimates of farm losses. In addition, estimates were also given for major commodities at the U.S. retail level, assuming the crop losses would be totally absorbed by the domestic market. However, both fresh peaches and citrus are exported by the U.S. and export losses are also possible because of fruit fly infestation. A lack of demand parameters, complete export statistics and market relationships make precise estimates of market effects difficult. Consequently, limited estimates are presented using rather simplifying assumptions. The international impact of export losses for fresh peaches probably are below the estimate shown because fresh exports are primarily destined to Canada where fruit flies represent no problem.

Peach - Trade Losses with Quarantine Restrictions on Exports 3/

During the 1972-74 period, U.S. exports of fresh peaches averaged 54.1 million pounds annually, canned peaches averaged 112.4 million pounds and other product forms averaged 41.0 million annually [USDA, Agricultural Statistics, 1976]. In total, peach exports averaged 207.5 million pounds annually which is approximately 7.5 percent of 1975 U.S. production.

The export market could absorb the total possible crop loss leaving the U.S. domestic supply unaffected. For example, a total loss in the potential zone and a 50 percent loss in the marginal zone would result in a crop loss of approximately 50 million pounds (Table 15). This is only 24 percent of the U.S. volume of exports. Twenty-six percent of U.S. peach exports were fresh and the remaining 74 percent were processed in 1974. Given the estimated export price of 38 cents per pound for fresh peaches,4/ export value of total fresh peach exports is estimated to be $20.6 million. A ban on fresh peach exports would cause an estimated loss of $20.6 million in export sales. However, assuming these fresh peaches could be sold in the U.S. domestic market, there would be an increase in supply of approximately 4.2 percent. Given a price flexibility of -.51 for fresh peaches, a price decline of approximately 2.14 percent could be expected. Retail fresh peach prices would be approximately 44.7 cents per pound, and the retail value would be approximately $522.6 million. Comparing this to the previous value of fresh domestic sales plus exports of fresh peaches ($530.1 million) suggests a loss of $7.5 million.

No treatment cost estimates were available for peaches to complete the economic analysis. Since peach exports move primarily to markets unconcerned about the medfly, this lack of information is not of major concern, nor in fact is the loss estimate expected to be realized.

3/ Some countries may prohibit susceptible host fruits and others may require treatment as a basis for entry. A ban is unlikely because treatment would undoubtedly be initiated. This analysis begins by assuming that no export would be possible without treatment and the estimates then provide a basis for a feasibility comparison with treatment costs.

4/ Canned peaches in export trade were valued at 25 cents per pound (computed from USDA, Agricultural Statistics, 1976 by dividing export canned value by export canned volume). Other prices were not available. Assuming the U.S. domestic market ratio (1.53) of fresh peach prices over canned peach prices, export price of fresh peaches is estimated to be 38 cents per pound.

Citrus - Trade Losses with Quarantine Restrictions on Exports[5/]

Exports of fresh oranges represent a relatively small proportion of the total production of oranges in the U.S. Average exports of fresh oranges for 1972-74 amounted to 9.6 million boxes annually [USDA, Agricultural Statistics, 1976]. This represents 4.24 percent of the U.S. production during the same period. A ban without a treatment program on fresh orange exports due to fruit fly infestation would increase the total supply on the domestic market by 4.24 percent. Using the price flexibility of -.22 (Table 14) for oranges at the farm level would mean that the 4.24 percent increase in domestic orange supply would result in a price decrease of .9328 of one percent. Total revenue in the U.S. at the farm level in 1975 as a result of orange production was $645.2 million with an average price per box of $2.71 [USDA, Agricultural Statistics, 1976]. With the previously exported production kept in the domestic market, price would have fallen in 1975 to $2.68 per box and total revenue would have been $638.7 million or a total revenue loss of $6.5 million due to increased supply on the domestic market. Total retail loss due to a 10/5 percent infestation rate was $159.9 million (Table 14) as compared to $46.6 million at the farm level. Retail loss was greater by a factor of 3.4336. Using this same factor would give a loss estimate of $22.2 million at the retail level in oranges due to losing the fresh export market. These estimates assume that previously exported oranges would enter the domestic U.S. market in the same use proportions as existing domestic supplies.

A complete ban and full realization of a potential $22.2 million loss in orange exports would not occur because treatment programs would be initiated. Based on fumigation treatment costs for grapefruit in Florida, the cost for treating the 9.6 million boxes exported would be $1,136,842[6/]. This estimate is a maximum treatment cost because not all countries receiving U.S. orange exports would quarantine for medfly. Given the value of fresh exports, treatment costs would represent 4 percent of the total export value. While this percentage may appear relatively low and possibly not significant on a cost basis, a 4 percent increase in price could cut into the competitive position of the U.S. fresh orange exports, resulting in a reduction in share of the world market.

Annual exports of grapefruit from 1972-74 averaged 6.2 million boxes. Most exports are of fresh fruit, but single strength juices, concentrates, blended juices and some sections are also exported. Fresh

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5/ See footnote 3.

6/ 9.6 million boxes is 864 million pounds of 22,737 truckloads at 38,000 pounds per truck and $1,136,842 for treatment costs where total costs per truck including facilities, labor and materials are $50 per truck.

grapefruit exports amounted to 4.7 million boxes or 76.4 percent of total grapefruit exports. Fresh grapefruit exports amounted from 1972-74 to 7.35 percent of the annual U.S. grapefruit production of 64.2 million boxes. Elimination of fresh grapefruit exports would increase total supply on the domestic market by 7.35 percent and lead to a price decrease of 1.029 percent as determined by the grapefruit price flexibility of -.14 (Table 14). Average 1975 grapefruit price was $2.58 per box with a total revenue of $158.3 million at the farm level. Assuming fresh exports would have remained in the domestic market, prices would have dropped to $2.55, and the resultant total revenue would have been $156.7 million. This would have represented a loss of $1.6 million at the farm level. Using the ratio of total retail value loss to farm value loss at 1975 prices, the 10/5 percent infestation rate (Table 14) would give an estimated retail loss of $4.1 million dollars due to keeping fresh exports on the domestic market. These estimates assume the same relative uses for grapefruit added to the domestic supply as those currently on the domestic market.

U.S. grapefruit exports are presently treated, and the cost, based on the 4.7 million box annual export average for the 1972-74 period, is $556,579. This cost represents 4.5 percent of the fresh export value and may affect the U.S. competitive position to some extent.

Other citrus fruit exported are lemons, limes and tangerines. Total annual amounts exported based on the 1972-74 average were 5.39, .07, and .28 million boxes annually for lemons, limes and tangerines, respectively [USDA Agricultural Statistics, 1976]. These export levels amount to 23.3, 4.7, and 5.6 percent of total U.S. production for these fruits. Projected losses of lemons, limes, and tangerines at the 10/5 percent infestation rate were 709, 108 and 420 thousand boxes, respectively. These losses are greater than average exports for limes and tangerines and amount to 13.2 percent of lemon exports. Adequate data are not available to estimate losses that might occur from an embargo on exports of fresh lemons, limes, and tangerines.

Additional Research Considerations

A possible embargo on fresh fruit exports of citrus and peaches could take several forms. Since citrus and peaches are produced in several states, an embargo might be placed on certain states or affected areas. Another possibility would be the banning of all U.S. exports of certain fruits, although only small areas and a small percentage of total production might be infested.

Estimating the effect of a fresh fruit export embargo on a certain state or area would require demand equations by state or area for the fruit. These equations are not available for some

fruit which would make a total evaluation of this embargo form impossible. Also lacking for this type of analysis are interstate movement data on fruit since export data by state are not available in adequate detail. Because of these shortcomings, the approach used to evaluate effect of fresh fruit embargos was to analyze the effects of a total embargo on the domestic market in the form of total revenue losses. This assumes that exported fresh fruit remained in the domestic market and caused price reductions. Seasonal prices and production patterns were not considered.

Summary

This report delineated certain areas of the U.S. into potential and marginal zones for infestation of four species of the fruit fly. County and statewide production data on citrus and peaches were analyzed to estimate production and value losses that would result from various fruit fly infestation rates. These rates ranged from a 10/5 percent rate upward to a 75/37 percent rate in the potential and marginal zones. Various losses at the 10/5 rate were discussed.

Total production losses at the 10/5 percent rate would amount to 26.7 million boxes of citrus and 5.0 million pounds of peaches. This would amount to $70.1 million in citrus and $1.1 million in peaches for a total of $71.2 million at the farm level using 1975 prices. The estimate of losses at the retail level for oranges, grapefruit and peaches was $220.5 million. Retail loss estimates were not possible for limes, lemons, tangelos, tangerines and temples. Total farm level losses for these five citrus fruits were $7.4 million of the $70.1 million total for citrus.

These estimates, using 1975 prices, were revised slightly downward due to the price effect of reduced production. As production losses occur, prices increase slightly for the remaining product. Slightly higher prices then moderate expected losses. Losses adjusted for increases in 1975 prices totaled $54.71 million at the farm level for oranges, grapefruit and peaches. This compares with 1975 original price loss estimate of $63.81 million. Retail loss estimates for these same three citrus fruits were reduced from $220.54 million to $174.77 million by price adjustments. These adjusted estimates more accurately reflect true value loss after consideration of price adjustments. Adequate data were not available to make price adjustments for lemons, limes, tangerines and tangelos.

In terms of export market losses, if fresh peaches were banned, a U.S. price reduction for fresh peaches would be 2.14 percent with a net loss of $7.5 million in sales. Since most peach exports are destined to areas where medfly is not a problem, the total amount of this loss would be considerably less. Fresh orange exports amount to 4.24 percent of total U.S. production. A ban on exports of fresh oranges would add 9.6 million boxes of oranges to the domestic supply. This would lead to lower prices and an annual

loss in grower revenue of $6.5 million. Losses of $22.2 million in total revenue would result at the retail level. Treatment costs to prevent this loss would be $1.1 million or 4 percent of the fresh export value. Grapefruit exports amount to 7.35% of U.S. production. Fresh exports are 76.4 percent of all exports, and an export ban would add 4.7 million boxes to U.S. supply. This would lead to losses in total revenue through reduced prices of $1.6 million at the farm level and $4.1 million at the retail level. To prevent these losses, present treatment costs are about $.5 million amounting to 4.5 percent of fresh export value. Lemon, lime and tangerine exports average 5.39, .07 and .28 million boxes annually. No loss estimates were possible other than general comparisons for the effect of a potential ban on exports of these fruits.

CHAPTER 7

EVALUATION AND DISCUSSION

7.1 Introduction

Limited field observations made by the UC/AID medfly team in the seven countries visited, literature review, reports of other investigations, and discussions with many knowledgeable people leads to the conclusion that medfly in CAP countries is a minor pest of minor crops, presently not inflicting any great amount of economic damage. The data on medfly and the crops it attacks is fragmentary and it is presently not considere a serious problem. It is viewed as one fruit fly among several species occurring in these countries. Its removal from the fruit fly complex would probably not cause any appreciable change in quarantine restrictions of the CAP countries involved. Furthermore, medfly does not appear to be as much of a deterrent to citrus production as irrigation water, citrus diseases, inferior varieties, harvesting problems, transportation, marketing and unstable prices which discourage capital and manpower investment in citrus ventures. An exception could be the processing of orange and grapefruit concentrate as done in Panama and in Belize, respectively.

If these conclusions regarding the lack of impact by medfly on CAP countries are correct, it seems logical to consider that expenditures of funds for research and control should be made in relation to the magnitude of the problem.

Perhaps the most valuable result of this survey would be to place the medfly in its correct perspective in relation to other fruit production problems in CAP countries. In estimating and assessing damage, it would be well to consider the predominant attitude and opinion, "that medfly causes no loss in production or quality of coffee." Estimating theoretical losses by assuming that medfly may cause 2-5% damage to the total coffee crop without experimental evidence is not realistic or justifiable.

Placing the medfly in its proper economic perspective and considering realistic estimates of damage provides a sound biological and economic basis to recommend appropriate action. In the beginning, three alternative types of action were considered: (1) no action, (2) eradication program, and (3) suppression.

1. No action: In spite of the worldwide notoriety that medfly has achieved and its presence in many countries, the observations of this team and the lack of concern by most of the scientists and producers interviewed, clearly indicate that medfly in CAP countries is presently considered a minor pest of minor crops causing very limited economic damage and therefore justifying only limited expenditures.

No action means that no nationally financed programs for fruit fly detection and control would be promulgated. The medfly might continue to develop and migrate northward through Mexico to the United States. It is estimated that the medfly could migrate into the U.S. within ten years providing no action was taken by Mexico or CAP countries to deter or slow the rate of migration.

Within the CAP countries, changes in agricultural policies and production of host fruit for export could result in increasingly serious problems if no action is taken. Medfly and Anastrepha spp. populations could increase and spread and therefore have an impact on future exports as well as locally marketed fruits and vegetables.

The team therefore does not recommend "no action."

2. Eradication: Present economic losses attributed to medfly and Anastrepha spp. in Central America and Panama to citrus and other minor crops does not justify the high cost of an eradication program which would have no assurance of success because of the difficult terrain, inaccessible areas and lack of precise information on extent of infestation. There is insufficient information on medfly host phenology, distribution, rate of parasitization, biology, ecology and population estimates on which to base an eradication program. In addition, it would probably be impossible for inter- and intra- country quarantine to keep the fly restricted and prevent reinfestation of so-called fly-free areas. The socio-economic and cultural aspects of the peoples make it difficult to apply quarantine and other control measures rigidly and effectively to individual host plants in backyards or patios of urban and rural communities.

The lack of trained personnel and of an adequate data base needed to plan and develop an eradication program and the low economic losses attributed to medfly and related species, does not justify the high cost of an attempted eradication program. In addition, there is the complicated problem of coordination of international operations which this highly sophisticated program would require.

The possibility of medfly being introduced into the continental United States from Central America and Panama cannot justify an eradication program in those countries when Hawaii remains the main threat for this introduction. Furthermore, the medfly is well established in most of South America and could also be introduced from this region as the U.S. is readily accessible and only hours away by air transport.

Assuming the medfly could be eradicated, the problem of Anastrepha spp. remains.

The team does not recommend "eradication."

3. Suppression: Having dismissed "no action" and "eradication" as inappropriate in the existing situation, the third option to be considered is suppression. Integrated pest management by growers and government agencies would allow the use of judgment to determine appropriate control efforts in individual situations. It would tailor action to the problem. In a citrus planting where medfly levels appear to be causing damage, bait sprays could be applied to reduce the population. Many field workers consider that medfly is not a difficult insect to reduce below the level which can cause economic damage.

In CAP countries, the large acreage of coffee provides the major host for medfly. This would be an area where parasites would work most effectively and economically. Reducing medfly build up in this major host would greatly reduce the spillover into other fruit hosts. The prospects for such a program is much greater than attempting, probably unsuccessfully, the eradication of medfly from CAP countries.

7.2 Organization and Personnel

The majority of countries visited had national and/or private educational institutions offering Ingeniero Agrónomo curricula in three or more areas: plant science, animal science, forestry, and agricultural economics. Plant and animal production curricula included a course in general entomology and economic or applied entomology plus an elective course in entomological methods. The Ingeniero Agrónomo program is a five year course of study requiring a thesis. Additional training in entomology is possible only if the student selects an entomological thesis problem. There were no formal academic programs specializing in scientific disciplines (entomology, plant pathology, weed science, etc.) at either the undergraduate or graduate level.

Entomology positions in faculties of universities and/or Ministries of Agriculture are occupied largely by professionals holding the title of Ingeniero Agrónomo. Some entomologists had advanced degrees (M.S. and/or Ph.D.) from Mexican, European or American universities. Those individuals with advanced degrees were, however, holding administrative positions with little opportunity for research.

Entomologists in most institutions were concerned with applied research on pests of major export crops such as cotton, coffee and sugarcane. Studies on medfly have been made in the past, but medfly research is presently practically non-existent. Entomologists with fruit fly research experience could form a nucleus for future medfly research, but knowledgeable, experienced personnel at all levels are scarce, lacking or otherwise employed.

Entomologists contacted by the team generally favored the integrated pest management philosophy. All were against large

scale intensive applications of pesticides over wide areas by aircraft or ground equipment.

Institutional library facilities for medfly research were modest to inadequate and often limited to personal reference collections. Reprint collections were scarce and inadequate. A proposed USAID program to establish an inter-regional informational center for plant pest and disease identification and control in El Salvador would be of considerable value to any entomological research or control program in CAP countries.

Reference insect collections were available in some of the countries visited. Important insect pests of exportable crops were well represented. Modest collections of fruit flies were also available. There was very little information on beneficial insects and their role as controlling agents, although several entomologists expressed strong interest in biological control.

Research facilities in most countries were modest to inadequate and lacked necessary equipment and technicians to carry on fruit fly research. Compound and dissecting microscopes, Schmidt boxes, cornell cabinets, petri dishes, dissecting instruments, microscope slides, etc. were in short supply. Many individuals complained of major difficulties in ordering and obtaining basic research supplies and equipment.

Laboratories in Costa Rica and Panama were fairly well equipped and modern. This was the exception rather than the rule in other countries visited.

In general, there is a real shortage of trained scientists and supporting technicians in all disciplines needed to develop the valid data base necessary to plan and develop an integrated pest management program against medfly and other fruit flies in Central America and Panama.

It is estimated that a minimum training program of 6-8 weeks would be necessary to adequately train Ingeniero Agrónomos to function effectively in a fruit fly research program.

Some qualified entomologists expressed an interest in doing basic research on medfly if financial and administrative support and an institutional structure were made available.

7.3 Detection and Chemical Control

With the exception of Costa Rica, field programs related to the detection and/or control of medfly are underway in all CAP countries. Objectives and scope of their respective programs, however, vary somewhat from country to country.

The MOSCAMED operation in Guatemala is the most efficient in the CAP countries. Field operations carried out by the MOSCAMED Commission are well organized and coordinated, work objectives are properly defined and the overall program is highly functional. The primary objectives of MOSCAMED are to detect and suppress medfly outbreaks, with particular emphasis given to the coffee and citrus area extending along the Pacific littoral to the Mexican-Guatemalan frontier. Supervisory personnel are aware of the dangers of indiscriminate insecticide applications to beneficial insect populations. Accordingly, only alternate rows of coffee are treated in suppressive spraying using protein bait/malathion. Several suggestions are offered to improve the effectiveness of their operations: (1) express medfly trap catches on a fly/trap/day basis. In this way, the dynamics of medfly populations existing within different ecological situations can be compared directly; (2) trap catch data is more meaningful if the trap density (number of traps/unit area) is similar in the areas under observation; (3) if traps placed in a host fruit area register no fly catches within a 2-week period, they should be moved to new locations. In this manner, a larger area can be surveyed more quickly; and (4) suppressive spraying should not be initiated only on the basis of a single fly capture. To determine whether or not a trap capture was the result of an established infestation or by transient fly movement, susceptible fruits found in the vicinity should be collected and the sample held in a protected manner over sand to determine pupal recovery. Additional traps should also be placed around original catch sites to delimit suspected infestations. If one or more of the traps continues to catch flies, an established infestation is indicated and control measures should be initiated.

In El Salvador, field activities relating to medfly are principally extension type. Trained technicians instruct progressive growers through field demonstrations on prevention, detection and control of fruit flies. This work undoubtedly is being done in response to a Presidential Decree directing growers to carry out control measures against medfly. These practical demonstrations are of immediate benefit to the farmer who bears most of the responsibility for learning how to deal most effectively and

economically with the fruit fly problem. To further reduce the cost of backpack sprayers and other equipment to the grower, Ministry technicians should consider other methods of applying protein bait/insecticide mixture to trees. One method is to dip a large paint brush into a pail containing the chemicals and then flick the solution onto the foliage in several spots around the tree. Rubber gloves and a long sleeved shirt should be used in this work.

It is hoped that funds to allow trapping and quarantine activities to résume in Honduras will soon become available. The mountainous terrain and relative isolation of many small valleys are natural barriers in restricting the voluntary movement of medfly. However, a concerted effort involving quarantine posts and prevention, detection and control programs would be required to delay the spread of medfly into citrus growing regions on the NW coast. The use of a protein bait instead of molasses will result in more efficient control of medfly. An inexpensive source of protein bait can possibly be found locally as a brewery by-product. Some breweries do not utilize the yeast sediment when cleaning out the fermentation vats. This material is rich in protein and can be mixed with the insecticide. Systematic collection and burial of fallen fruits by Ministry workers is commendable and this practice should be encouraged among growers. If done consistently, this relatively inexpensive operation can greatly inhibit increases in medfly populations.

In Panama, technical personnel are carrying out intermittent trapping operations in the plantings of Cítricos de Chiriquí. Steiner traps are being used, in spite of being subject to malicious damage by field workers, because sticky traps are considered inferior. Spray applications are initiated in an infested area when trap catches average 1.5 flies/trap/day. The Cítricos de Chiriquí plantings offer a unique opportunity to observe medfly populations in a monoculture situation throughout the year. The 350,000 orange tree planting extends over 3,950 hectares and is located at least 3 air miles from the coffee producing area in Boquete Valley. Medfly populations could be monitored at weekly intervals throughout the year at relatively low cost. The use of sticky traps baited with a 5% w/w mixture of summer grade trimedlure and an adhesive, such as Tack Trap, is indicated because of low cost and ease of handling. Replicated tests conducted near San José, Costa Rica under conditions similar to those at Cítricos de Chiriquí have consistently demonstrated the superiority of the sticky trap over the Steiner trap for detection purposes. When spray

applications become necessary to reduce increasing medfly populations, it is believed that a protein bait/ insecticide formulation will prove to be more effective than the molasses/ insecticide mixture now used. Also, here again a source of protein may be found at a local brewery.

Trapping for medfly in the Central Provinces, particularly El Valle and similar areas, should be intensified. It would also be desirable to determine if medfly infestations are present in Panama City, Colón and their environs.

The detection and control program in Nicaragua is a cooperative effort by MAG and OIRSA to suppress medfly populations in coffee producing areas adjacent to the Honduran border. The success of this operation is problematical, particularly since the majority of personnel involved in the project have been reassigned to the coffee rust campaign. If the present infestations are not dealt with properly, the spread of the medfly will outstrip OIRSA's ability to contain the pest. It is suggested that more effective results could be obtained if protein bait is added to the malathion currently being used.

From experience gained in carrying out suppressive measures against Mexican fruit fly, entomologists of the Ministry of Agriculture and Lands are technically prepared to deal with outbreaks of medfly which appear in Belize. A working agreement which is being developed with USDA/APHIS will assist Belize in expanding their capability to detect incipient outbreaks of this pest.

Several species of Anastrepha are found throughout the CAP region, with A. ludens reported particularly troublesome in Guatemala, El Salvador, Belize and Honduras. It is regrettable that, except for Belize, no comprehensive data are available on adult population dynamics and the degree of fruit infestation by A. ludens and other Anastrepha spp. prior to the appearance of medfly in these countries. Knowledge of the effects of any interaction between members of the two genera would be desirable so that medfly behavior could be anticipated when this pest invades areas dominated by Anastrepha. Now that medfly is well established in El Salvador, much needed information could be obtained by experienced CENTA personnel at little extra cost by:

1. Placing McPhail traps baited with fermenting or protein lure in areas where both A. ludens and C. capitata are present. Weekly observations should be made for at least one year.

2. Making systematic collections of host fruits of these fruit flies throughout the year. Hold the fruit samples over sand, recording number and species of pupae recovered. It would be interesting to observe if both genera of fruit fly larvae are present in the same individual fruit and the relative numbers of pupae of each species recovered.

3. Holding the pupae obtained from fruit collections, observing and recording the species and numbers of parasites emerging.

In countries other than Belize, control measures against Anastrepha spp. are not generally practiced, even though this species was acknowledged to cause more damage than medfly. An exporter of processed fruits in Guatemala reported that suppressive sprays were sometimes applied against A. ludens. It was also interesting to learn that a citrus grower near San Salvador, El Salvador is carrying out intensive trapping operations against A. ludens and medfly. Approximately 1,000 McPhail traps baited with fresh fruit juices are placed throughout this 21 hectare orchard. No data were available to assess the value of this intensive trapping as a control measure against these pests.

7.4 Biological Control

There is much interest in biological control of the medfly in all CAP countries. The first medfly parasites were imported into Costa Rica in the late 1950's. By 1975, the OIRSA insectary in Costa Rica was mass culturing millions of Biosteres longicaudatus, Opius concolor, Pachycrepoideus vindemiae and Aceratoneuromyia indica. All four species were released in Costa Rica and Panama, but only the first two species and only A. indica were released in El Salvador and Nicaragua, respectively. Several other parasite species were also imported and released against the medfly in Costa Rica and El Salvador. The quantity of the parasite species released in each of these countries is included under each country discussed in this report, and "all" parasite species reported to attack the medfly are listed in Appendix VIII.

At the outset, classical biological control was attempted. Several medfly parasites were imported for the purpose of establishing them against the medfly. Later, as mass culture of the above four parasite species increased, the biological control strategy apparently shifted to making many periodic releases of millions of parasites in several CAP countries. Thus, the inundative method of biological control was being attempted with peak production and release attained in 1975.

The ability of the OIRSA insectary to mass culture medfly parasites clearly indicates that the personnel and facilities are quite capable of providing ample numbers of parasites to all CAP countries with the classical biological control approach as an objective. The people responsible for the mass culture of medfly parasites are to be commended and strongly supported.

The evaluation of the impact of the parasite releases based on collection, and holding fruits and medflies trapped from at least eight parasite release sites in Costa Rica, indicated that a reduction in the fruit fly population was apparently achieved. One medfly pupa per one pound of fruit was obtained in 1971-72 from 1,832 pounds of fruit (oranges, mangos and guavas).

Biosteres longicaudatus, P. vindemiae and A. indica were recovered from both medfly and Anastrepha spp. in the release areas of Costa Rica. The highest total medfly parasitism recorded from infested fruits was 35%. Coffee fruits were not sampled. It is imperative that further fruit collections be made in all CAP countries, not only to determine degrees of various fruit infestations including coffee, but also to obtain base lines as to what parasites are present and their impact on both medfly and Anastrepha spp.

Since the cosmopolitan pupal parasite, Pachycrepoideus vindemiae, has been known to be in Panama at least since the early 1940's and attacks both medfly and Anastrepha spp. puparia in fruit and soil, it may already be having an impact on medfly populations in Central America and Panama. It will be important to evaluate fruit fly puparia from sifted soil to determine the impact of fruit fly puparia parasites.

Apparently a small number of Biosteres tryoni and B. oophilus has been released in Costa Rica, and the latter species was also released in El Salvador. There is no record of either of these species becoming established in CAP countries. It is recommended that these two species be reintroduced and released in all CAP countries where medfly attacks coffee. The record of these parasites attacking medfly in coffee in Hawaii is outstanding. Over a 50% reduction of medfly was attained in Hawaii. Since coffee is the major host of medfly, any reduction in population achieved by parasites would be important.

Pupal parasites of the diapriid genus Psilus should also be introduced to parasitize both medfly and Anastrepha spp.

Presently, only pure stocks of primary parasites can be handled. Therefore, a central quarantine facility should be established in one CAP country to handle foreign shipments of insects that include parasites. At least one trained entomologist with experience in screening for hyperparasites should be sought and placed in charge of the quarantine facility. Not only could fruit fly puparia be received and parasites screened, but these countries would also have the capability of importing natural enemies of other introduced pests.

7.5 Quarantine

An evaluation of the medfly threat and its entry potential into the United States should logically consider the principal sources of introduction. Table 18 compiled from the USDA annual reports, "List of Intercepted Pests," shows that over a period of nine years (1964-1972) the medfly was intercepted a total of 2,097 times by inspectors at U.S. ports of entry and during predeparture inspection in Hawaii. These were larvae in hosts from all over the world.

Hawaii was the principal source of these interceptions in predeparture air passenger baggage inspection. Of 1,221 Hawaiian medfly interceptions, which is 60% of the total for all U.S. ports, 993 were intercepted as larvae in coffee cherries carried by tourists in their baggage, purses and pockets. A common explanation given was, "to show their friends on the mainland what coffee looks like."

In 1910 the medfly arrived in the Hawaiian Islands from Australia. Since that time, it has probably been introduced into the continental United States from Hawaii thousands of times, most likely as larvae occurring in coffee berries brought in by tourists. From 1964 to 1972 (Table 18), medfly was intercepted over a thousand times. When the Matson Navigation Company operated the Lurline and her sister ships between Hawaii and San Francisco and Los Angeles, medfly was frequently found in Hawaiian fruit during the inspection of passenger baggage at these west coast ports. Since this passenger service has been discontinued, most tourist traffic to Hawaii is by aircraft and the volume of passenger baggage has increased tremendously. In 1976, the volume of baggage carried on 30,000 aircraft from Hawaii was over nine million pieces. Complete inspection of this amount of baggage is impractical so the medfly, as well as other fruit flies, will undoubtedly continue to be introduced in the the United States mainland from Hawaii in passenger baggage.

Table 18

MEDFLY INTERCEPTIONS AT U.S. PORTS OF ENTRY

AND PREDEPARTURE INSPECTION IN HAWAII

Years:	1964	1965	1966	1967	1968	1969	1970	1971	1972	Totals
Hawaii										
Coffee	54	42	52	23	89	260	292	123	58	993
Other Hosts	43	22	23	23	32	29	27	23	6	228
TOTALS:	97	64	75	46	121	289	319	146	64	1221
All U.S. Ports*	199	128	184	212	142	269	397	336	230	2097

* including Hawaii

Addendum: From FY 1973 to April 18, 1977, the USDA reported the following medfly interceptions:

Hawaii Ports	510
All U.S. Ports*	377

The records demonstrate that Hawaii has been a greater source of medfly introductions into the continental United States than CAP countries. Table 19 shows the few medfly interceptions that have been made from CAP countries. Anastrepha spp. intercepted at U.S. ports are recorded in Table 20.

Although medfly introductions from Hawaii have been numerous, incipient infestations have been very few. This indicates that there is considerable environmental resistance in the continental United States to the establishment of this species.

Historically, man's commerce has been responsible for the spread of pests throughout the world. Natural movement plays a part once an incipient infestation becomes established, but natural spread is seldom responsible for the initial introduction. When the medfly invades the continental United States again it will more likely be carried by aircraft, ships or surface vehicles long before it could possibly arrive from CAP countries or Mexico through natural movement.

Air transportation is important in moving pests associated with hosts quickly from one part of the world to another. A less likely means is in passenger compartments or cargo pits of aircraft. During the population peak of the Oriental fruit fly, Dacus dorsalis in Hawaii, USDA inspectors found a total of 134 adult flies in aircraft from 1948 to 1956.

1948 - 47	1953 - 4
1949 - 60	1954 - 1
1950 - 10	1955 - 8
1951 - 0	1956 - 1
1952 - 3	

These 134 Oriental fruit flies were found during the inspection of 119,932 planes leaving Hawaii for the U.S. mainland. The Oriental fruit fly population dropped drastically after the initial population explosion and only three D. dorsalis flies were found on 250,000 aircraft inspected from 1956 through 1970. A high population level in and around airports obviously increases the possibility of adult fruit flies getting on aircraft. The medfly, which is normally not numerous around airports in Hawaii, was only found once on aircraft during a similar period. In 1960, one adult medfly was found in a cargo aircraft that had been sitting in a nose hanger for several days.

Table 19

SUMMARY OF MEDFLY INTERCEPTIONS

TAKEN AT U.S. PORTS OF ENTRY

FROM HOSTS FROM CENTRAL AMERICA & PANAMA

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Belize										
Costa Rica	x									
El Salvador										
Guatemala										
Honduras										
Nicaragua						x				x
Panama									x	

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Belize											
Costa Rica			x	x	x		x				
El Salvador				x							x
Guatemala											x
Honduras							x	x			x
Nicaragua											
Panama				x	x		x				

Data from USDA. An "x" indicates at least one interception.

Table 20

FRUIT FLY INTERCEPTIONS AT U.S. PORTS OF ENTRY

FROM CENTRAL AMERICA AND PANAMA

	1964	1965	1966	1967	1968	1969	1970	1971	1972
BELIZE									
MEDFLY									
ludens			x	x		x		x	x
mombin.						x		x	
striata									
serpentina									
COSTA RICA									
MEDFLY	x			x	x	x		x	
ludens									
mombin.	x	x	x	x	x	x		x	x
striata									x
serpentina									
EL SALVADOR									
MEDFLY					x				
ludens				x	x	x	x		
mombin.	x	x	x	x	x	x		x	x
striata			x		x				
serpentina					x	x			
GUATEMALA									
MEDFLY									
ludens	x			x	x	x	x	x	x
mombin.	x	x	x	x	x	x		x	x
striata	x				x				
serpentina		x		x	x		x	x	x
HONDURAS									
MEDFLY								x	x
ludens					x		x	x	x
mombin.	x	x	x	x	x	x			x
striata									
serpentina				x					
NICARAGUA									
MEDFLY	x								
ludens						x	x		
mombin.	x	x	x	x	x	x		x	
striata	x	x							
serpentina								x	
PANAMA									
MEDFLY					x	x			x
ludens					x				
mombin.		x		x	x	x		x	
striata									
serpentina									

USDA Data. An "x" indicates at least one interception.

Fruit fly adults are not apt to be found on aircraft. Aerosol spraying for these adults inconveniences passengers, wastes time and materials and, as usually administered, is probably ineffective.

Records show that fruit fly larvae in hosts are the most frequent source of introductions into the United States. A good example is the Los Angeles International Airport which averages over 100,000 passengers per month. Table 21 shows the fruit fly species intercepted at this airport and their origin.

To evaluate the impact of Agricultural Quarantine on CAP countries, each of the five different quarantine programs, together with their specific objectives, need to be considered separately. These quarantine programs are:

(1) Internal Quarantines
(2) Exterior Quarantines
(3) Mexican Quarantines against Central America and other countries infested with the medfly.
(4) U.S. Quarantines against Central American countries and other countries where medfly occurs.
(5) Other non-infested countries' quarantines against countries where medfly occurs.

While all of these quarantine programs interact to some degree, they must be considered individually because of:

(1) Economic justification.
(2) Staff resources and funds.
(3) Biological considerations.
(4) Practical Quarantine Enforcement Aspects.

Considered together, they provide an indication of the economic justification and likelihood of success.

Response to an insect problem includes the following: 1) ignoring it, 2) learning to live with it, 3) a suppression effort when economic damage seems imminent, and 4) an all out effort at eradication. Likewise, a quarantine effort may range from free movement, a paper quarantine (regulations but little enforcement effort), an active inspection and treatment program to a virtual embargo on host material.

The intensity and thoroughness of enforcement efforts usually depend on the importance of the crop or product being protected and seriousness of the pest.

Table 21

FRUIT FLY LARVAE IN HOST MATERIAL INTERCEPTED AT THE LOS ANGELES INTERNATIONAL AIRPORT 1/

1942 - 1970

Species	Origin
Dacus cucurbitae Coq.	Hawaii
Anastrepha ludens (Loew)	Guatemala, Honduras, Mexico, Nicaragua, Panama
A. mombinpraeoptans Sein	British Honduras, Brazil, Columbia, Costa Rica, El Salvador, Ecuador, Guatemala, Mexico, Nicaragua, Panama, Peru, Venezuela
A. serpentina Wied.	Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Peru
A. striata Schin.	Costa Rica, Mexico, Nicaragua, El Salvador
A. fraterculus Wied.	Nicaragua
Ceratitis capitata Wied.	Brazil, Costa Rica, Hawaii, Italy, France, Malta
Dacus oleae (Gmelin.)	Italy
D. dorsalis Hendl.	Hawaii, Guam
Rhagoletis cerasi L.	Austria, England, France, Germany, Hungary, Italy

1/ USDA records based on 2,000 fruit fly interceptions. An interception may be one or a "lot" of infested host material and may include one to many larvae.

Consideration of the five different quarantine programs and their justification and success potential, leads to the following conclusions:

(1) Internal Quarantine within a country involves stopping the flow of host material at all highways, roads, trails, paths, and negotiable terrain whether in aircraft, vehicles, ships, boats, horseback or hand carried material.

It involves interfering with people's usual method of transport and trade. They may question or fail to understand quarantine procedures.

The traveler on the road, the farmer bringing his products to market, the exporter anxious to move his shipments to the ports, the consumer who comes to market expecting to find something to buy,are all involved. It is difficult to justify such interference for an insect which does not seriously damage any major crop in CAP countries and is only one of a number of fruit fly species which oviposit in and occasionally infest certain host fruits.

Even if all of these avenues could be effectively blocked, which is doubtful, adult flies can fly or be blown over check points and become established beyond the quarantine area. These new infestations, if detected, involve changing check points, expanding the quarantined area and result in increased public opposition and apathy. Perhaps those in charge of the quarantine program may eventually conclude that doing nothing would cause fewer problems. "When the cure prescribed is worse than the problem, it may be time to change doctors."

Considering the extent and degree of medfly infestation, the terrain involved, the lack of effective barriers in most areas, the mobility of the fly, and the likelihood that host fruit will be carried regardless of quarantine regulations, it is very unlikely that internal quarantines would be effective. The cost to staff such an operation would probably exceed the medfly damage to minor crops.

(2) Exterior Quarantine: For CAP countries infested with medfly, there is little logic or justification in attempting to prevent medfly movement back and forth across national borders. The treatment of vehicles and charging the driver tends to be counter-productive as far as getting good plant quarantine support for the overall program and may jeopardize other basically sound procedures.

An exterior quarantine across national boundaries is more easily enforced than an interior one because of the support and assistance of the Customs service and laws which provide the right of search and seizure of prohibited items. In order to be effective, however, it must cover all points of entry. These include aircraft, wheeled vehicles and maritime craft, as well as cargo, freight, mail, passenger baggage and personal effects.

Most material picked up at check points is usually confiscated and destroyed because of insufficient time for treatment. Confiscation of prohibited material also has a deterrent effect on attempts to carry prohibited items.

Arriving commercial shipments may have phytosanitary certificates indicating treatments which may or may not be acceptable. If a treatment is required, it can be provided in a fumigation chamber or under tarps at the entry point or the material may be put under bond and allowed to proceed to destination for treatment.

Properly enforced, exterior quarantines serve as an effective deterrent to those who may wish to bring restricted items into a country. A large percentage of prohibited material is intercepted, thereby reducing the probability of new pests becoming established. However, no quarantine is 100% effective. A certain amount of smuggling is inevitable, the amount depending on how desirable the smuggled item may be.

(3) Mexican Quarantine Against Central America and Panama: Mexico has ample justification for trying to prevent or delay the arrival of another species of fruit fly to add to those already present. Medfly has certain hosts not presently infested by fruit flies in Mexico. Tomatoes, for example, are a commercial crop which would probably require treatment as a basis for entry, if grown in medfly infested areas. Whether or not Mexico can prevent the movement of medfly across the long Guatemala border and up the Pan American Highway is problematical, but establishment of a barrier, plus quarantine enforcement, should delay the movement north.

In Mexico, there is a treatment facility and a road station at Benjamen Hill where vehicles are checked to prevent the northern movement of *Anastrepha* spp. from southern Mexico. This facility could also be modified to reduce the possibility of medfly moving north.

(4) U.S. Quarantine Against Medfly Infested Countries: The production of commercial quantities of fruit in California, Florida and southern border states where medfly could conceivably survive is good reason for the United States to be concerned with and to try to prevent the establishment of medfly within its borders. Medfly has been recorded from over 90 countries and is intercepted at U.S. ports of entry hundreds of times every year, mostly as larvae in host material in passenger's baggage. This is discussed in Chapter 6 and the data are presented in Tables 18 and 19.

There are many avenues by which the medfly could reach the United States. These include passenger baggage, mail, cargo, express, or as adult hitchhikers. Records indicate that, while many avenues are available, the major source of medfly interceptions is larvae in host material in air passenger baggage, mostly from Hawaii. Adult medflies have very rarely been intercepted in aircraft, ships or vehicles. However, the presence of medfly in CAP countries offers an opportunity for gradual movement northward. Vehicular traffic along the Pan American Highway could result in rapid movement north of the medfly as larvae in hosts carried by tourists and others.

The history of plant quarantine and pest introduction in the United States clearly demonstrates that pest introductions follow trade routes through major seaports and airports. Introductions are usually correlated with volume of traffic. A classic example is Guam, a major port of call for many years, which has many introduced pests, while Yap, an island in the Western Carolines off the trade routes, has mostly endemic insects and rather few of these.

While it is possible that medfly could gradually move northward and eventually reach our border, it seems much more likely that some of the hundreds of thousands of tourists visiting Hawaii would introduce medfly larvae in smuggled coffee cherries. Accordingly, any effort at suppression would logically be most productive in Hawaii which is the source of most of the recorded interceptions.

The United States presently employs a quarantine type of barrier south of San Diego to discourage the entry of *Anastrepha ludens*. This consists of sterile flies released along the barrier whenever *A. ludens* activity is detected or suspected. If this ever becomes necessary, sterile medfly releases could be added to this program.

There are a number of inspection stations along the U.S.-Mexico border where vehicles, cargo and baggage are inspected. Special attention is given those proceeding from or originating in southern Mexico. These existing inspection stations could, of course, become increasingly vigilant if medfly becomes established in Mexico.

The medfly has been established in Costa Rica since 1955 and during the past 22 years it has not caused any great economic losses in either major or minor host fruits. Medfly has gradually extended its range into other CAP countries. It has not been reported to have moved very far into Mexico, although it has recently been trapped on both sides of the Mexican-Guatemalan border. While this ubiquitous insect has a bad reputation and occurs in over 90 countries, people have learned to live with it. Some of these countries export fruit with prescribed treatments to the U.S. Perhaps the villian's reputation has been both overstated and overrated!

(5) Non-infested Countries have quarantine regulations which range from entirely ignoring the medfly, to requiring treatment of susceptible hosts, to prohibiting entry of suspected host material. Concern is tempered by their type of agriculture, whether medfly host fruits are produced and whether their climate would permit the medfly to exist. Of an estimated 150 countries which have some sort of formal agricultural quarantine regulations, many refer to the medfly as one of the pests they are anxious to exclude. Since introduction of a new pest can have serious consequences, it is understandable that countries are generally more fearful of pests they do not have than those they already have. In many cases, obtaining food is more important than any pests which may be associated with it.

7.6 Field Observation

An ecological overview of medfly and *Anastrepha* spp. in CAP countries reveals interesting similarities and differences between countries. The physical features of the countries are the structure upon which their ecology is based. These countries are volcanic in origin with more than 30 volcanos, most of which are inactive. Periodic earthquakes occur in the area, sometimes causing severe damage and loss of lives. The active and inactive volcanos form mountains, lakes, valleys, craters, plateaus, highlands, and lowlands. Differences in physical features of the land result in elevation and temperature differences, differential rainfall patterns and formation of lakes and streams.

Climates of the CAP countries are similar, with the same major divisions: hot, temperate and cold. The major climatic divisions may be subdivided into hot or dry. All countries have Pacific or Caribbean coastlines or both. Mountains are located inland and the prevailing winds cause distinct wet and dry seasons on the Pacific slope. On the Caribbean side, rainfall is more evenly distributed throughout the year. Temperatures in CAP countries range from near freezing to about 38°C. Annual rainfall ranges from less than 1270 mm to more than 4064 mm. There are many microclimates in the CAP countries. These microclimates create favorable environments in certain locations for tropical and subtropical fruit production as well as for many insects, including fruit flies.

The temperate zone highlands are ecologically favorable for growing coffee, citrus, avocados, plums, peaches, guavas, cherimoyas, sapotes, etc. The area under cultivation and the varieties of fruit grown vary from country to country. Most of the inhabitants of CAP countries live in the temperate zone and grow fruits as dooryard trees. Most of the temperate zone on the Pacific side of Central America suitable for fruit culture could be infested by fruit flies. However, fruit flies were found in only a portion of the favorable areas in Central America and Panama. Of all the CAP countries, Guatemala has the greatest area with a temperate climate and the largest fruit production. Guatemala exports some fruit, chiefly bananas and oranges, to nearby Central American countries. Fruit flies were found on the Pacific side of Guatemala from the El Salvador border to the Mexican border. Panama is located predominately in a hot zone and is reported to have fruit flies only in the temperate area of Chiriquí Province on mountain slopes near the Costa Rican border. The status of fruit flies in the inland valleys and urban areas needs to be studied to make certain that small self-sustaining populations do not exist. Fruit flies, in general, and the medfly in particular, are found mainly on the Pacific side of the CAP countries. Exceptions are found in certain locations on the Caribbean side of Honduras, Nicaragua, and Costa Rica where the climate is humid and tropical.

A long dry season imposes severe stress on both fruit trees and fruit flies. Fruit tends to shrivel on the trees and fruit flies are not present, except in the most favorable situations. Locations where fruit flies were found near the end of the dry season are probably sites with self-sustaining medfly populations existing throughout the year. Similarly, sites where fruits come into production in sequence throughout

the year are favorable for self sustaining populations of medfly. Whenever possible, fruit fly traps should be located in all such areas.

For detection of medflies, the Jackson sticky trap is effective in covering large areas. Because of the ecological complexity of CAP countries, the McPhail or tub trap should also play an important role in detecting and monitoring the medfly and Anastrepha spp. complex. Systematic biometric sampling of fruits and rearing out the insects in them is the one tool which can provide the most complete information on the fruit fly situation and their natural enemies in these countries. The fruits themselves are the ultimate source of information on the preferred hosts of medfly and Anastrepha spp., competition between fruit fly species, and natural enemies attacking fruit fly eggs, larvae and pupae.

Studies should be conducted by an experienced fruit fly entomologist to obtain baseline information on seasonal population levels of medfly in the Pacific highlands and Caribbean lowlands, host preferences, host phenology, competition and natural enemies. The development of such baseline ecological information should be independent of current fruit fly programs. Information developed can be fed into detection, integrated control, and biological control programs. In conjunction with the development of basic biological information, an economist should conduct research to determine the impact of fruit flies on fruit production. This effort could include damage done to fruit crops by fruit flies and other insects as well as socio-economic factors important to fruit growers. The role of dooryard fruit trees in the ecology and economic impact of fruit flies is important and should be determined prior to any large scale control efforts.

7.7 Economic Impact

The interrelated range of agricultural problems of small farmers in any country goes beyond our ability to generalize. Medfly needs to be considered in its proper priority together with all of the fruit production and marketing problems. Pest management problems may appear to be specific, but our limited knowledge of the varied and integrated ecological, environmental and economic issues involved, suggests that the medfly problem in CAP countries is quite complex. It cannot be considered as a single problem to be resolved, disregarding other problems, including other species of fruit flies.

Problem identification may seem unnecessary, but groups and individuals experience different resources, income and cultural problems and are not equally concerned about pest damage as it relates to production and marketing. Accordingly, the medfly brings out different responses which limit involvement of groups and individuals.

In this investigation, it was hoped to determine the impact of medfly on individuals in CAP countries. Personal and family needs substantially influence the farmer's behavior and concern for medfly. Growing of fruit around the home is common practice. If it is intended only for home consumption, a sufficient quantity for home use may be the main concern. Fruit destroyed by insects, birds, or animals may not be important as long as enough remains for family use. Estimates of such losses are not made because they are relatively unimportant. If the grower intends to sell fruit, he will probably be concerned with anything that greatly diminishes production. It is only when an observable loss occurs that medfly becomes a matter of concern. The level of concern depends on the individual, group, or agency and their motivation. This report was not able to completely answer all these questions but was intended to place the medfly in perspective and indicate its priority compared with other problems.

The medfly has many hosts of commercial and non-commercial fruits in Central America and Panama. The two primary commercial crops infested are coffee and oranges. Oranges are especially likely to be infested if growing adjacent to coffee. The presence of medfly in coffee has not been proven to cause any production or quality loss so its presence is considered unimportant by coffee growers. Oranges at present can only be considered a minor crop. It is certain that medfly will continue to be viewed differently by those involved in citrus production including the CAP country producer, the U.S. producer, the producer for processing and the producer for local marketing, the producer for home consumption, and the government agencies involved.

The greatest impact of medfly could be on plant quarantine agencies and policies. Its presence usually results in restrictions which add to marketing costs. It is indeed an international pest. Its presence and impact or lack of impact in South America, Africa, Australia, Hawaii and Israel may offer worthwhile examples and ideas on how they have learned to adjust, control and live with this pest. Perhaps CAP country growers will need to make similar adjustments.

APPENDIX I

TEAM MEMBER ITINERARIES

Date	Hour	Persons	Airline	Airport	City	Country
Mar.	lv 1445	Mitchell	PAA 6	HIA	Honolulu	US
	ar 2150			LAIA	Los Angeles	
6	lv 0945	Rhode	Tex Inter 815	McAllen	McAllen, Tex	US
			PAA 501			
	ar 1640			Aurora	Guatemala	Guatemala
	lv 0745	Maehler	PAA 515	SFIA	SF	US
		Hagen				
	ar 1800			Aurora	Guatemala City	Guatemala
	lv 1215	Mitchell	PAA 515	LAIA	Los Angeles	US
		Hamilton				
	ar 1800			Aurora	Guatemala City	Guatemala
7	lv 2350	Harris	West 732	HIA	Honolulu	US
			PAA 515			
	ar 1800			Aurora	Guatemala City	Guatemala
12	lv 1820	Team	TACA 307	Aurora	Guatemala City	Guatemala
	ar 1845			Ilopango	San Salvador	El Salvador
18	lv 1718	Team	TACA 311	Ilopango	San Salvador	El Salvador
	ar 1900			Santa María	San José	Costa Rica
22	lv 1920	Team	TACA 311	Santa María	San José	Costa Rica
	ar 2130			Tocumen	Panama City	Panama
24	lv 0700	Team	COPA 101	Tocumen	Panama City	Panama
	ar 0800			David	David	Panama

APPENDIX I, Team Member Itineraries (continued)

Date	Hour	Persons	Airline	Airport	City	Country
Mar. 25	lv 0830	Team	COPA 102	David	David	Panama
	ar 0930			Tocumen	Panama City	Panama
27	lv 0800	Team	PAA 502	Tocumen	Panama City	Panama
	ar 0815			Las Mercedes	Managua	Nicaragua
30	lv 0700	Team	SAHSA 411	Las Mercedes	Managua	Nicaragua
	ar 0730			Toncontin	Tegucigalpa	Honduras
Apr. 1	lv 0815	Team	SAHSA 414	Toncontin	Tegucigalpa	Honduras
	ar 0945			Stanley	Belize City	Belize
2	lv 0740	Team	SAHSA 777	Stanley	Belize City	Belize
	ar 0900			Toncontin	Tegucigalpa	Honduras
3	lv 0900	Team	SAHSA 992	Toncontin	Tegucigalpa	Honduras
	ar 0945			Aurora	Guatemala City	Guatemala
	lv 1230	"	PAA 516	Aurora	Guatemala City	Guatemala
	ar 1510			LAIA	Los Angeles	US
	lv 1715	"		LAIA	Los Angeles	US
	ar 1815			SFIA	SF	US

APPENDIX I (continued)

Itinerary for Chris Andrew

Date	Hour	Person	Airline	Airport	City	Country
Mar. 17	lv 1133	Andrew	SO 215	McCoy	Orlando	US
	ar 1215			Miami Int.	Miami	US
	lv 1430	"	PAA 503	Miami Int.	Miami	US
	ar 1615			Aurora	Guatemala City	Guatemala
19	lv 0800	"	COPA 317	Aurora	Guatemala City	Guatemala
	ar 1130			Santa María	San José	Costa Rica
22	lv 1500	"	TACA 110	Santa María	San José	Costa Rica
	ar 1645			Ilopango	San Salvador	El Salvador
24	lv 1400	"	COPA 318	Ilopango	San Salvador	El Salvador
	ar 1440			Aurora	Guatemala City	Guatemala
26	lv 0900	"	AVIATECA 600	Aurora	Guatemala City	Guatemala
	ar 1300			Miami Int.	Miami	US
	lv 1545	"	EA 616	Miami Int.	Miami	US
	ar 1650			Gainesville	Gainesville	US

Itinerary for Richard Hamilton

Mar. 28	lv 1340	Hamilton	LANICA 410	Las Mercedes	Managua	Nicaragua
	ar 1550			Miami Int.	Miami	US
	lv 1830	"	Braniff 76	Miami Int.	Miami	US
	ar 2250			Stapleton	Denver	US

APPENDIX I, Itinerary for Richard Hamilton (continued)

Date	Hour	Person	Airline	Airport	City	Country
Mar. 31	lv 0845	Hamilton	Western 497	Stapleton	Denver	US
	ar 0950			Int. Airport	Salt Lake City	US
Apr. 3	lv 0130	"	Western 491	Int. Airport	Salt Lake City	US
	ar 0300			Oakland Airport	Oakland	US
9	lv 2000	"	PAA 841	SF Int. Airport	SF	US
	ar 2230			Honolulu Int.	Honolulu	US

APPENDIX II

ABBREVIATIONS AND ACRONYMS USED IN THIS REPORT

AID:	Agency for International Development (Agencia del Desarrollo Internacional)
ANACAFE:	Asociación Nacional del Café (National Coffee Association) (Guatemala)
ARS:	Agriculture Research Service (Servicio de Investigaciones Agrícolas)
BEPQ:	Bureau of Entomology and Plant Quarantine (Oficina de Entomología y Cuarentena Vegetal)
BNN:	Banco Nacional de Nicaragua (National Bank of Nicaragua)
CAP:	Central America and Panama (Centro América y Panama)
CATIE:	Centro Agronómico Tropical de Investigación y Enseñanza (Tropical Center for Research and Teaching of Agronomy) (Turrialba, Costa Rica)
CIRSA:	Comité Internacional Regional de Sanidad Agropecuaria (International Regional Committee for Plant and Animal Sanitation)
CENTA:	Centro Nacional de Tecnología Agrícola (National Center for Agricultural Technology) (Santa Tecla, El Salvador)
EAP:	Escuela Agrícola Panamericano (Pan-American School of Agriculture) (Zamorana, Honduras)
ENAG:	Escuela Nacional de Agricultura y Ganadería (National School of Agriculture and Animal Husbandry) (Nicaragua)
ERS:	Economic Research Service (Servicio de Investigaciones Económicas)

FAO:	Food and Agriculture Organization of the United Nations (Organización de las Naciones Unidas para la Agricultura y Alimentación)
IAEA:	International Atomic Energy Agency (Agencia Internacional de Energía Atómica) (Vienna, Austria)
ICAITI:	Instituto Centroamericano de Investigación y Tecnología Industrial (Central American Institute of Research and Industrial Technology) (Guatemala)
ICTA:	Instituto de Ciencias de Tecnología Agrícola (Scientific Institute of Agricultural Technology) (Guatemala)
IICA:	Instituto Interamericano de Ciencias Agrícolas (Interamerican Institute of Agricultural Sciences) (HQ, San José, Costa Rica)
INCAEI:	Instituto Nacional de Comercio Exterior y Interior (National Institute of Exterior and Interior Commerce)
INCAFE:	Instituto Nicaragüense de Café (Nicaraguan Coffee Institute)
INDECA:	Instituto Nacional de Comercialización Agrícola (National Institute of Agricultural Commercialization) (Guatemala)
INIA:	Instituto Nacional de Investigaciones Agrícolas (National Institute of Agricultural Research) (Mexico)
INTA:	Instituto Nacional de Tecnología Agropecuaria (National Institute of Plant and Animal Technology) (Nicaragua)
ISIC:	Instituto Salvadoreño de Investigaciones del Café (Salvadorean Coffee Research Institute)
MAG:	Ministerio de Agricultura y Ganadería (Ministry of Agriculture and Livestock)
MEDFLY:	*Ceratitis capitata* Wied., Mediterranean fruit fly, medfly (Same) (Mosca del Mediterráneo, moscamed.

MIDA:	Ministerio de Industrias y Desarrollo Agropecuaria (Ministry of Industry and Plant and Animal Development)
MOSCAMED:	Comisión Mixta Mexico-Guatemala, para la Prevención y Control de la Mosca de la Fruta del Mediterráneo (Mexican-Guatemalan Joint Commission for Mediterranean Fruit Fly Control)
OAS:	Organization of American States (Organización de los Estados Americanos)
OIRSA:	Organismo Internacional Regional de Sanidad Agropecuaria (International Regional Organization for Plant and Animal Protection) (Mexico-Central America-Panama)
OTS:	Organización para Estudios Tropicales (Organization for Tropical Studies) (San José, Costa Rica)
PASA:	Participating Agency Service Agreement (Contrato de Servicios entre Agencias Participantes)
SAG:	Secretaría de Agricultura y Ganadería (Secretariat of Agriculture and Livestock)
SIECA:	Secretaría de Integración Económica Centroamericana (Secretariat of Central American Economic Integration)
UC:	University of California (Universidad de California)
UC/AID:	University of California, Agency for International Development (Contract) Universidad de California, Agencia para el Desarrollo Internacional (Contrato)
UH:	University of Hawaii (Universidad de Hawaii)
UNAN:	Universidad Nacional Autónoma de Nicaragua (National Autonomous University of Nicaragua) (León, Nicaragua)
UNDP:	United Nations Development Programme (Programa de Desarrollo de las Naciones Unidas)

USAID: United States Agency for International Development (Agencia del Desarrollo Internacional de los Estados Unidos de America)

USDA: United States Department of Agriculture (Departamento de Agricultura de los Estados Unidos)

USDA/APHIS/PPC: United States Department of Agriculture/Animal and Plant Health Inspection Service/Plant Protection and Control (Departamento de Agricultura de los Estados Unidos/ Servicio de Inspección de Salud de Animales y Plantas/Protección y Control de Plantas)

APPENDIX III

PERSONS CONTACTED

Costa Rica (March 18-22, 1977)

Dr. Larry Boone
USDA/PASA/ROCAP/IICA
Data Systems for Central America, San José

Dr. Elemer Bornemisa
Jefe, Depto. de Suelos
Facultad de Agronomía
Universidad de Costa Rica, San José

Dr. Damon Boynton
Consultant Tropical Crops
CATIE, Turrialba

Dr. Gerardo Budowski
Jefe, Sección Forestal
CATIE, Turrialba

Ing. Edilberto Camacho
Sección de Recursos Genéticos de Plantas Económicas
CATIE, Turrialba

Ing. Rodrigo Castro
Director de Servicios Técnicos Básicos
MAG, San José

Mr. John Fasullo
Assistant RDO USAID, San José

Ing. Gilbert Fuentes
Laboratorio de Entomología
Facultad de Agronomía
Universidad de Costa Rica, San José

Sr. Alejandro Romero Garcia
Revista de Biología Tropical
Universidad de Costa Rica, San José

Ing. Tulio Gonzalez R.
Jefe, Programma Cooperativo de Control Biológico
OIRSA, San José

Mr. James E. Hawes
RDO/AID, San José

Mr. Richard C. Kraeitman
Agricultural Economist
USAID, San José

Dr. Jorge León
Jefe, Sección de Recursos Genéticos de Plantas Económicas
CATIE, Turrialba

Ing. Roger Lopez C.
Facultad de Agronomía
Laboratorio de Nematología
Universidad de Costa Rica, San José

Ing. Juan José May
Jefe de Cuarentena, MAG, San José

Ing. Everisto Morales
Jefe de Entomología, MAG, San José

Dr. Francisco Paniagua
Sub-Jefe Servicio Nacional
Erradicación Malaria, Ministerio de Salud, San José

Dr. William Ramirez B.
Laboratorio de Entomología
Facultad de Agronomía
Universidad de Costa Rica, San José

Dr. Luis Angel Salas
Laboratorio de Entomología
Facultad de Agronomía
Universidad de Costa Rica, San José

Dr. Pierre Sylvain
Emeritus, Head of Plant Science Department
CATIE, Turrialba

Ing. Isaac Solis
MAG, San José

Ing. Arturo Villalobos
Economista Agrícola
MAG, San José

El Salvador (March 12-18, 1977)

Ing. Armando Alas
Jefe de Cuarentena
OIRSA, San Salvador

Ing. Mario Apontes
Vice Director, CENTA, Santa Tecla

Mr. George H. Berg
FAO/UNDP/OIRSA, San Salvador

Mr. James Brock
Agricultural Attaché, US Embassy, San Salvador

Dr. Frank Calhoun
Suelos y Universidad de Florida
CENTA, San Salvador

Ing. Antonio Díaz Chávez
CENTA, Santa Tecla

Ing. Enrique Durón
Jefe de Sanidad Vegetal
OIRSA, San Salvador

Ing. Sebastián Rivera Garcia
CENTA, Santa Tecla

Ing. Mauricio Guzmán
Biólogo, Instituto Salvadoreño de Investigaciones del Café
Santa Tecla

Mr. Jack Lipes
APHIS/PPQ/USDA, Hyattsville, Maryland

Dr. Carlos Meyer A.
Director Ejecutivo, OIRSA, San Salvador

Ing. Miguel Muyshondt Yúdice
Director General, Instituto Salvadoreño de Investigaciones del Café
Santa Tecla

Ing. René Padoami R.
1a Av. 4-5-6, Santa Tecla

Jorge Peña
RDO/AID, San Salvador

Dr. José Rotillo Quesada
Entomólogo, MAG, Santa Tecla

Ing. Oscar Armando Ramirez
Técnico Entomólogo
Instituto Salvadoreño de Investigaciones del Café
Santa Tecla

Lic. Luis Sanchez
Director de Planificación
CENTA, San Salvador

Don Francisco de Sola
Presidente, H. de Sola e Hijos Succesores
San Salvador

Mr. Dwight Steen
Deputy RDO, USAID, San Salvador

Dr. Jesús A. Cutie Tula
Especialista Agrícola
Embajada Americana, San Salvador

Ing. Manuel Chávez Viaud
Jefe del Dept. de Defensa Agropecuaria
MAG, Santa Tecla

Ing. Thomas Vilanova
Encargado, Operaciones de Café (TACA), San Salvador

Mr. Boyd T. Whittle
RDO, USAID, San Salvador

Mr. David Zimet
Economista Agrícola, USAID/MAG, San Salvador

Guatemala (March 6-12, 1977)

Ing. Arturo Aguirre
Dirección General de Servicios Agrícolas
Guatemala City

Mr. Jeffrey H. Allen
Agric. Econ./AID/ROCAP, Guatemala City

Ing. C. Orlando Arjona
Fitopatólogo, Univ. San Carlos, Guatemala City

Ing. Mario A. Amézquita N.
Comisión MOSCAMED, Guatemala City

Ing. Servando Lopez Benítez
Agregado Agrícola de México
Comisión MOSCAMED, Guatemala City

Ing. Jorge Benítez Coronado
Jefe Ejecutivo, Comisión MOSCAMED, Guatemala City

Ing. Leonel Coronado
Secretario, Univ. de San Carlos, Guatemala City

Ing. Luis A. Casteñeda
Comisión MOSCAMED, Jutiapa

Ing. Rodolfo Estrada
Decano, Esuela de Agronomía, Universidad de San Carlos
Guatemala City

Mr. Don Fiester
Regional Rural Development Officer
ROCAP, Guatemala City

Ing. Estolfo Fumigali
Sub-Director General
Instituto de Ciencias Tecnológicas Agrícolas (ICTA)
Guatemala City

Ing. Ivan García M.
AID Agriculture Sector Analysis
and Agriculture Sector Loan
Guatemala City

Ing. Leoncio Zambrano García
San Antonio Suchitepequez
(INIA, Tapachula, México)

Mr. Lawrence Harrison
Director, ROCAP, Guatemala City

Dr. Peter E. Hildebrand
Director de Socioeconomía Rural y Asesor de la Fundación
Rockefeller, ICTA, Guatemala City

Sr. Norman Jiménez
Alimentos Naturales S.A., Guatemala City

Mr. Francis H. Jack III
Agricultural Attaché, US Embassy, Guatemala City

Dr. Doug Keaton
USAID, Asesor en Horticultura, ICTA, Guatemala City

Mr. Carl Koone
RDO, USAID, Guatemala City

Ing. Alvaro Klee
Comisión MOSCAMED, Guatemala City

Ing. Sergio Morales
Comisión MOSCAMED, Guatemala

Ing. Salvador Sánchez L.
Comisión MOSCAMED, Guatemala City

Ing. Oscar Nery Sosa Sandoval
Fitopatólogo
Universidad de San Carlos, Guatemala City

Mr. Barry Sidman
Deputy Director/ROCAP, Guatemala City

Dr. Howard L. Steele
ERS/USDA/PASA
Agriculture Sector Analysis and Agriculture Sector Loan
Guatemala City

Mr. Oscar Ufer
Alimentos Naturales S.A., Guatemala City

Dr. José de Jesús Castro Umaña
Director Departamento de Parasitología
Agrícola
Facultad de Agronomía
Universidad de San Carlos, Guatemala City

Sr. Edward Villagrán
Economista Agrícola, Ecotecnia, Guatemala City

Ing. Carlos Villatoro V.
Comisión MOSCAMED, San Antonio Suchitepequez

Dr. Robert Waugh
Asesor General de la Fundación Rockefeller, ICTA
Guatemala City

caragua (March 27-30, 1977)

Sr. Alfredo Arellano
Director de Desarrollo Agroindustrial
Banco Central de Nicaragua, Managua

Ing. Orlando Astacio
Supervisor, MOSCAMED, OIRSA, Managua

Sr. Rogelio Castro
Coffee and Citrus Grower, La Concepción

Dr. Rainer Daxl
Ecology Officer, FAO, Managua

Ing. Armando Gonzales
Liaison Officer/AID, Managua

Ing. Gustavo Hernández
Jefe, Departamento de Cuarentena, Managua

Dr. Oscar Hidalgo
Director de Investigaciones
INTA, Managua

Mr. Richard L. Hughes
RDO/USAID, US Embassy, Managua

Ing. Guillermo Otero
Director de Regulaciones y Controles Agropecuarios
MAG, Managua

Sr. Octavio Rosales
Coffee and Citrus Grower
Finca Santa Francisca, Masatepe

Ing. Liveo Saenz
Jefe, Dept. Sanidad Vegetal, MAG, Managua

Dr. Alvaro Sequiera
Sub-Director, Ciencias Agrícolas, INTA/MAG, Managua

Panama (March 22-27, 1977)

Sr. Cesario Alvarado
Coffee Grower and consultant, Boquete

Ing. Luis A. Botello
Depto. de Agricultura, Cítricos de Chiriquí, MIDA
David

Ing. Rafael Castrellón
Sub-Director Regional Chiriquí
MIDA, David

Ing. José del Rosario Concha B.
Dirección Nacional Producción Agrícola
MIDA, Panama City

Ing. Aquiles Cunningham
Sanidad Vegetal, MIDA, Panama City

Sr. Filiberto Gomez
MIDA, David

Sr. Albert Pérez Herréra
Gerente General, Cítricos de Chiriquí
Panama City

Dr. Lionel A. Jaén
Jefe, Sección Prevención de Fiebre Aftosa
OIRSA, Panama City

Ing. Eduardo Labrador
Horticultor, MIDA, Chiriquí

Ing. Carlos Landau
Coffee Grower, Boquete

Ing. Omar F. Lopéz
Adm. Cítricos de Chiriquí
MIDA, David

Dr. Diego Navas
Entomólogo
Facultad Universidad de Panamá, Panama City

Dr. Agapito Peralta
Jefe de la Dirección de Inspección Cuarentena Agropecuaria
Panama City

Dr. Alberto J. Perdomo
Facultad Univ. de Panamá
Desarrollo del Bayano, Panama City

Ing. Cesár A. Polanco S.
Jefe de Cuarentena Vegetal, MIDA, Panama City

Ing. Ruben D. Reyes
Horticultor, Facultad de Agronomía
Universidad de Panamá, Panama City

Mr. John Rodgers
Horticulturist, USAID, Panama City

Dr. Bernardo Ocaña Vieto
Dir. del Departamento de Projectos Internacionales
Ministerio Desarrollo Agropecuario, Panama City

Mr. Raymond E. White
USAID, Panama City

Honduras (March 30 - April 1, 1977)

Ing. Tomás Salgado
Jefe de Programas Nacionales
Ministerio de Recursos Naturales, Tegucigalpa

Mr. James O. Bleidner
RDO, AID, Tegucigalpa

Dr. Antal Borcsok B.
Secretario de Estado en el Despacho de Recursos Naturales
Tegucigalpa

Ing. Hernán R. Espinoza
Entomólogo, Ministerio de Recursos Naturales
Tegucigalpa

Ing. Mario Castro
Director, Instituto del Café, Tegucigalpa

Mr. Clements J. Weber
Assistant to RDO, AID, Tegucigalpa

Belize (April 2-3, 1977)

Mr. Eric W. King
Chief Agricultural Officer
Ministry of Agriculture and Land, Belmopán

Mr. Albert Navarette
Ministry of Agriculture and Land, Belmopán

APPENDIX IV

MEDITERRANEAN FRUIT FLY HOST LIST

Source:

A. USDA Bulletin No. 536. The Mediterranean Fruit Fly in Hawaii. 1/26/18.
B. USDA Bulletin No. 640. The Mediterranean Fruit Fly. 4/8/18.
C. California State Dept. of Agric. Monthly Bulletin. July 1929.
D. USDA Mediterranean Fruit Fly Project Report of Biological Research Division. April 1929 to Feb. 28, 1930. (Cage Experiments, Orlando, Florida)
E. USDA Fruit Fly Investigations in Hawaii Special Report No. 46. "The Chemistry of Mediterranean Fruit Fly Host Plants in Hawaii." By Donald Starr.
F. Proc. Hawaii. Entomol. Soc. VIII, No. 1, November 1932. "The Economic Importance of the Mediterranean Fruit Fly to Hawaiian Horticulture." By Arthur C. Mason.
G. Insects of Citrus and Other Subtropical Fruits by Henry J. Quayle. pp. 220-240.
H. USDA Agr. Res. Adm., BEPQ, Div. of Foreign Plant Quarantines Manual of Foreign Plant Pests for Fruit Flies. Jan. 30, 1950.
I. USDA Agr. Res. Serv., BEPQ. Unpublished Reports of Oriental Fruit Fly Investigations, and Inv. of Fruit Flies in Hawaii. (1949-1960)
J. USDA Annual Report Fruit Fly Investigations, Honolulu, Hawaii. (1936)
K. Hosts of Mediterranean Fruit Fly in India. (Furnished by Zvi Avidov)
L. Hosts of Mediterranean Fruit Fly in South Africa. (Furnished by Andre Myburg)
M. Proc. Hawaii. Entomol. Soc. 14(2):206. 1951.
N. Journal of Econ. Entomol. 61(1):339-340. 1968.

Group 1. Heavily or generally infested.
Group 2. Occasionally infested.
Group 3. Rarely infested.
Group 4. Laboratory infestations.

Source	Scientific Name and/or Common Name	Group
D	Acanthocereus. Acanthocereus. A. pentagonus (Cereus baxaniensis; C. pentagonus). Barbwire A. Dildoe. Cactus.	4
A,B,C,E,F,G H,K,L,M	*Achras sapota (A. zapota. Sapota achras; S. zapotilla). Sapodilla.	3
H,L	Acokanthera (Toxicophloea). A. longiflora. ?	

*observed in Central America and Panama

APPENDIX IV (continued)

Source	Scientific Name and/or Common Name	Group
A,B,G,H,L	Acordia. Acordia (?)	3
D	Adelia. Adelia. A. segregata. ?	4
C,F,L	*Ananas comosus (A. sativus). Pineapple.	____
C,H,L	Annona cherimola. Cherimoya.	____
D,G,L	Annona glabra (A. laurifolia palustris). Pondapple. Alligator apple.	
A,B,C,D,E,G, H,L	*Annona muricata. Soursop. (Guanábana)	2
C,H,I,K,L	*Annona reticulata. Bullocks-heart. Custard-apple. Anona.	3
C,D,G,H,L	*Annona squamosa (A. biflora cinerea; A. forskahli). Sugar apple. Custard-apple. Sweetsop.	____
H,L	Arbutus unedo. Strawberry madrone.	____
A,B,C,D,E,G, H,L	Arenga pinnata (Saccharifera). Gomuti sugar palm.	3
H,L	Argania sideroxylon (Hardwood evergreen tree).	____
C,H,L	Argemone mexicana. Mexican prickle poppy. Cardosanta. Cardo.	____
D	Arozia arbutifolia (A. erythrocarpa; Pyrus arbutifolia). Red chokeberry.	4
D,G,L	Artabotrys uncinatus (A. odoratissimus). Fragrant tailgrape. Clinging ylang-ylang.	____
A,B,C,E,F,G, H,I,L	*Artocarpus altilis (A. communis. A. incisus). Breadfruit.	3
D,G	Asimina triloba. Pawpaw (papaw). A. obovata. Bigflower pawpaw. A. parviflora. Smallflower pawpaw. A. pygmaea. Sprawling pawpaw. A. reticulata. Seminoletea pawpaw. Common pawpaw.	____
C,D,G,H,L	*Asparagua sprengeri. Sprenger asparagua. Sprengeri fern.	____
C,H	Atropa belladonna. Belladonna.	____
A,B,C,D,E,F, G,H,I	*Averrhoa carambola. Carambola. Star-fruit.	2
H	Berberis holstii. Barberry.	____
C,E,H,L,N	Blighia sapida (Cupania sapida). Akee.	1
H,L	Brucea antidysenterica. ?	____
H	Bumelia lycioides. Buckthorn bumelia.	____
D,G	Bumelia tenax. Tough bumelia. Buckthorn.	____
D,G,L	Butia. Butia palm. B. capitata (Cocos capitata). Coco palm. Brazilian butia palm.	____
C,G,H,L,I,	Calocarpum sapota. (C. mammosum. Lucuma mammosa). Sapote.	____
A,B,C,E,G,H, I,L,N	Calophyllum inophyllum. Indiapoon beauty-leaf. Kamani. Alexander laurel.	1

APPENDIX IV (continued)

Source	Scientific Name and/or Common Name	Group
E	Cananga odorata. Ylang-ylang.	____
H	Capparis citrifolia. Caper	____
A,B,C,D,E,F, G,H,L	*Capsicum frutescens (C. annuum. C. baccatum): Red pepper. var. Grossum: Sweet bell red pepper. Var. Longum (C. longum): Chili, Cayenne, or Long red pepper. Var. Cerasiforme: Cherry red pepper.	2
A,B,C,D,E,F, G,H,I,K	*Carica papaya. Papaya. Papaw.	2
A,B,C,H,L	Carica quercifolia. Dwarf papaya. Oakleaf papaya.	2
A,B,C,E,F, H,L	Carissa arduina (C. acuminata. C. bispinosa). Amatungula Carissa. Hedge thorn.	2
D,G,L	Carissa carandas. Karanda Carissa.	____
C,D,G,H,I,L	Carissa grandiflora. Natal plum. Carissa.	3
A,B,C,D,E, F,N,	Calocarpum sapota.	____
A,B,C,D,E,F, H,K,L	*Casimiroa edulis. White sapote. Casimiroa. Mexican apple.	1
A,B,C,E,G, H,L	*Cestrum. Cestrum (Jessamine). C. nocturnum. Night-jessamine. Chinese inkberry. Night-blooming Cestrum.	3
D,G,L	Chaenomeles. Flowering quince. C. sinensis (Cydonia sinensis; Pseudocydonia sinensis). Chinese flowering quince.	4
C,H,L	Chrysobalanus ellipticus. ?	____
C,D,G,H,L	*Chrysobalanus icaco. Icaco coco plum. Gopher apple. Gopher plum.	____
H,L	Chrysophyllum africanum (C. argyrophyllum). African star apple.	____
A,B,C,E,F,G, H,I,L	*Chrysophyllum cainito. Caimito. Star apple.	1
A,B,C,D,E,G, H,L	*Chrysophyllum oliviforme. Satin leaf star apple. Caimitillo. Damson plum.	1
A,B,C,E,G, H,L	Chrysophyllum polynecium. Chrysophyllum.	1
H,L	Chrysophyllum viridifolium. ?	____
D,G,L	Citharexyllum fruticosum (C. cinereum). Florida fiddlewood.	____
D,H	*Citrullus vulgaris. Watermelon.	____
A,B,C,D,E,F, G,H,I,K,L	*Citrus aurantifolia (C. limetta). Lime.	1
A,B,C,D,E,F, G,H,K,L	*Citrus aurantium (C. amara. C. bigaradia. C. vulgaris). Sour orange, Seville orange, Bittersweet orange. Myrtifolia. Myrtle-leaf orange.	1

APPENDIX IV (continued)

Source	Scientific Name and/or Common Name	Group
A,B,C,E,F,G, H,K,L	*Citrus grandis (C. decumana. C. maxima). Pummelo. Pompelmous shaddock. Pernambuco.	1
A,B,C,D,E,F, G,H,I,K,L	Citrus limon (C. limonia). Lemon.	1
C,G,H,L	Citrus medica. Citron	
C,D,E,G,H, K.L	*Citrus mitis. Calamondin. Panama orange.	1
A,B,C,D,E,F, G,H,I,K,L	*Citrus nobilis. King orange. Satsuma orange. Myrtle orange.	1
A,B,C,D,E,G, H,I,K,L	*Citrus paradisi (C. maxima uvacarpa). Grapefruit. Pomelo.	1
A,B,C,D,E,F, G,H,I,K,L	*Citrus reticulata (C. deliciosa. C. nobilis deliciosa). Mandarin orange. Tangerine.	1
A,B,C,D,E,F, G,H,I,K,L	*Citrus sinensis. Sweet orange. Valencia. Parson Brown orange. Malta orange. Lambs summer orange, Lue Gim Gong.	1
D	Citrus taitensis. Tahiti orange. Otaheite orange.	4
A,B,C,E,G, H,L	Clausena lansium (C. punctata. C. wampi). Chinese wampee. Wampi.	3
C,H,L	Clintonia umbellulata (C. umbellata. Ekebergia capensis). Spreckled beadlily. Dog plum.	
D	Coccolobis floridans (C. laurifolia). Pigeon sea grape. Dove plum.	4
D,G,L	*Coccolobis uvifera. Sea grape.	
K	Cocos campestris. Syagrus coconut.	3
	Coffea canephora. Robusta coffee.	1
A,B,C,D,E,F, G,H,I,L	Coffea arabica. Arabian coffee. Common coffee.	1
A,B,C,E,H,L	Coffea liberica. Liberian coffee.	1
H	Cotoneaster adpressa praecox (C. praecox). Early creeping cotoneaster.	
C,G,H,L	Cratageus azarolus. Azarole hawthorn. Haw.	
D	Cratageus floridans. Jacksonville Hawthorn.	4
D	Cratageus gallana. Haw.	4
D,G,L	Crinum asiaticum var. sinicum. St. John's lily.	
D	Cucumis anguria (C. arinaceus. C. grossulariaeformia). West Indian gherkin. Wild cucumber.	4
G	Cucumis dipsaceus. Hedgehog or teaselgourd. Wild cucumber.	
D,G,H,L	*Cucumis melo. Melon. Muskmelon var. Cantalupensis: cantaloupe var. Indorus: winter or Cassaba melon.	
D,G,H,L	*Cucumis sativus. Cucumber.	

APPENDIX IV (continued)

Source	Scientific Name and/or Common Name	Group
C,D,G,H,L	Cucurbita maxima. Winter squash. Hubbard squash.	
H	Cucurbita moschata. Cushaw pumpkin. Canada and winter crookneck pumpkin.	
C,H,L	*Cucurbita pepo. Pumpkin. Vegetable marrow.	
A,B,C,D,G,H, I,K,L	Cydonia oblonga (C. vulgaris. Pyrus cydonia). Quince. Mannela.	1
N	Cyphomandra betaceae. Tree tomato.	
A,B,C,H,K	Diospyros decandra. Persimmon.	1
C,D,E,G,H, I,L	Diospyros kaki (D. chinensis. D. roxburghi schitse). Kaki. Persimmon. Oriental persimmon.	1
H,L	Diospyros mespiliformis. Medlar persimmon.	
D,G,H,L	Diospyros virginiana. Common persimmon. Wild persimmon.	
C,H,K,L	Dovyalis caffra (Aberia caffra). Keiapple. Umkokolo.	1
D,G,I	Dovyalis hebecarpa (Aberia gardneri). Kitembilla. Ceylon gooseberry.	
D	Echinocereus polycanthus (Cereus polycanthus). Cactus.	4
A,B,C,D,E,F, G,H,I,K,L, M	*Eriobotrya japonica (Photinia japonica). Loquat. Malta plum.	1
D	Eugenia axillaris. Whitestopper Eugenia.	4
A,B,C,E,G,H	Eugenia brasiliensis (Stenocalyx brasiliensis). Brazil Eugenia. Brazilian plum. Spanish cherry.	
C,D,G	Eugenia edulis. Willowleaved Eugenia.	
A,B,C,D,E,F, G,H,I,K	*Eugenia jambos. (Syzygium jambos; Caryophyllus jambos). Rose apple. Jambos. Malabar plum.	1
K	Eugenia javanica. ?	3
A,B,C,E,F,G, H,I,L	*Eugenia malaccensis (Syzygium malaccensis; Caryophyllus malaccensis; Jambosa malaccensis). Ohia Malay apple. Pomerack. Mountain apple.	2
A,B,C,D,E, F,G	*Eugenia uniflora (E. micheli. Stenocalyx brasiliensis. S. micheli). Surinam cherry. Pitanga. Brazil cherry. Cayenne cherry. Florida cherry. French cherry.	1
L	Euphorbia lathyris. Caper euphorbia. Gopher apple.	
H	Euphoria longan (E. longana. Dimocarpus longan. Nephelium longana). Longan. Dragons eye.	

APPENDIX IV (continued)

Source	Scientific Name and/or Common Name	Group
D,G,H,I,K, L,M	Feijoa sellowiana. Feijoa. Guavasteen. Pineapple guava.	
A,B,C,D,E,F, G,H,I,K,L	*Ficus carica. Common fig. Lemon fig.	1
G,H	Ficus indica. Glabrous tree. India fig.	
D,G	*Flacourtia indica (F. ramontchi). Ramontchi. Governors plum.	
C,G,L	Fortunella crassifolia. Meiwa kumquat.	
D	Fortunella hindsii. Hongkong kumquat.	4
A,B,C,D,E,F, G,H,L	Fortunella japonica (Citrus japonica). Round and Marumi kumquat.	1
L	Fortunella margarita. Eustis limequat. Megami kumquat.	
D	Fragaria chiloensis. Strawberry. Chiloe strawberry.	4
A,B,C,E,F,G, H,L	*Garcinia mangostana. Mangosteen.	2
A,B,H	Garcinia zanthochymus. Garcinia. Gourka.	2
D	Geobalanus oblongifolius. Gopher apple.	4
D,G,L	Glycosmis pentaphylla. Glycosmis. Malay Glycosmis.	
A,B,C,E,G,H, I,L	*Gossypium. Cotton.	2
L	*Gardenia sp. Gardenia.	
C,H,L	Harpephyllum caffrum. Kafir plum.	
D,G,L	*Hevea brasiliensis. Para rubber tree. Caoutchoue. Brazil rubber.	
D	*Hibiscus sabdariffa. Roselle. Jamaica sorrel.	4
L	Homalocladium platycladum. Ribbon bush.	
D	Hylocereus undatus. (Cereus undatus. C. tricostatus). Night-blooming cereus.	4
D	Ilex glabra. Inkberry.	4
D,G	Ilex vomitoria (I. caroliniana). Carolina holly. Yaupon.	
H,I,K	*Juglans sp. Walnut.	2
M	Juglans hindsii.	
H	Landolphia sp. Gumvine.	
A,B,C,E,G, H,L	Latania loddigesii (L. glaucophylla. L. placuachulla). Blue palm.	3
A,B,C,E,G, H,L	*Litchi chinensis (Nephelium litchi). Litchi. Lychee.	3

APPENDIX IV (continued)

Source	Scientific Name and/or Common Name	Group
D,E,M	Lucuma nervosa. (L. rivicoa angustifolia). Canistel Incuma. Egg fruit.	
H	Lycium carnosum. ?	
L	Lycium campaneslatum. Box thorn.	
D,G,	Lycium carolinianum. Carolina wolfberry. Box thorn.	
K,L	Lycium european. European wolfberry.	3
C,L	Lycium horridum. African buckthorn.	
A,B,C,D,F,G, H,I,J,L	*Lycopersicon esculentum. Tomato.	2
C,H,L	Maclura pomifera (M. aurantiaca. Toxylon pomiferum). Osage orange.	
C,D,G,H,K,L	*Malpighia glabra. Barbados cherry.	3
N	Malpighia punicifolia.	
A,B,C,D,E,G, H,I,K,L	*Malus pumila (M. sylvestris. Pyrus malus). Common apple.	1
C,H,L	*Mammea americana. Mamey. Mammee apple.	
A,B,C,D,E,F, G,H,I,K,L	*Mangifera indica. Mango.	1
L	Marrubium vulgare. Common hoarhound.	
C,H,L	*Melicocca bijuga (Melicoccus bijugatus). Mamoncillo. Mamón. Spanish lime. Genip.	
D,G	Melothria pendula. Creeping cucumber.	
C,H,L	Mespilus germanica. Medlar.	
C,L	Mimusops sp. Milkwood.	
H	Mimusops caffra. Kafir bulletwood.	
A,B,C,E,G, H,L	Mimusops elengi. Elengi tree. Pogada. West Indian medlar. Elengi bulletwood.	1
H,L	Mimusops kirkii. ?	
H,M	Momordica balsamina. Balsam apple.	
C,D,G,H,L	*Monstera deliciosa. (Philodendron pertusum). Ceriman.	
C,H,L	*Morus. Mulberry.	
A,B,C,E,G, H,I,L	*Murraya exotica. (Chalcus exotica). Orange-Jessamine. Mock orange.	1
A,B,C,F,G,H	*Musa acuminata (M. cavendishi. M. Nana. M. chinensis). Dwarf banana. Chinese banana.	3
A,B,C,D,E,D, G,H,I,L	*Musa sp. (hybrid). (M. paradisiaca var. sapientum). Common banana. Plantain.	3
A,B,C,E,H,L	Noronhia emarginata. Madagascar olive. Noronhia. Chinese plum.	3
D	Nyssa ogeche. Ogeche lime. Ogechi plum. Ogeechee tupelo.	4
D,L	Nyssa sylvatica (N. multiflora). Sour gum.	
D,G	Nyssa sylvatica biflora. Black gum. Swamp black tupelo.	

APPENDIX IV (continued)

Source	Scientific Name and/or Common Name	Group
A,B,C,E,G, H,L	Ochrosia elliptica. Ochrosia.	2
H,G,L	Olea europea. Common olive.	____
A,B,C,D,E, G,H	*Opuntia. Prickly pear. Cholla: O. compressa (O. opuntia). Dillen P: O. dilleni (O. horrida). Engelmann P: O. engelmanni. Mission P: O. megacantha (O. castillae). Tuna P: O. tuna (O. humilis; O. multiflora; O. polyantha). Common P: O. vulgaria (O. humifusa; O. mesacantha; O. monacantha; O. monacantha variegata; O. nana; O. rafinesquei).	____
C,D,H,L	Opuntia ficus-indica. Indian fig. Spineless cactus.	____
D	Osmanthus floridanus. Wild olive. Hammock Osmanthus.	4
A,B,C,E,G,H, I,L.M	*Passiflora. Passion flower. P. caerulea: Blue-crown passion flower. P. foetida. Tagua passion flower.	3
H	Passiflora edulis. Purple granadilla. Lilikoi. Passion fruit.	____
C,D,G,L	Passiflora incarnata. Wild passion flower. Maypop.	____
G,I	Passiflora laurifolia. Yellow granadilla. Water lemon. Jamaica honeysuckle.	____
G,I	*Passiflora ligularis. Sweet granadilla.	____
G,I,L	Passiflora mollissima (Tacsonia mollissima). Lilikoi. Soft-leaf passion flower.	____
C,H,L	*Passiflora quadrangularis (P. macrocarpa). Giant granadilla.	____
H,L	Peponium mackenii. Wild cucurbit.	____
C,D,H,L	Pereskia aculeata (P. pereskia). Barbados-gooseberry.	____
A,B,C,D,E,F, G,H,K,L	*Persea americana (P. gratissima. P. persea). Avocado. Alligator pear.	2
C,H	Phaseolus lunatus. Sieva bean. Cibet bean.	____
C,H,L	Phaseolus limensis. (P. lunatus var. macrocarpus). Lima bean	____
C,H,L	*Phaseolus vulgaris. Kidney bean. Haricot. String bean.	____
A,B,C,E,G,H, K.L	Phoenix dactylifera. Date palm.	3
L	*Phyllanthus acidus. Otaheite gooseberry leafflower; Ceylon gooseberry.	____
N	Physalis peruviana. Cape gooseberry. Poha.	____

APPENDIX IV (continued)

Source	Scientific Name and/or Common Name	Group
H	Pimenta officinalis. Allspice. Pimenta.	____
D,G,L	Pleiogynium solandri (Spondias solandri). Burdekin plum.	____
C,H,L	Podocarpus elongata. Yellowood. Fern Podocarpus.	____
D,G,L	Poncirus trifoliata. Trifoliate orange.	____
A,B,G,H,K,L	Prunus americana. Native American plum.	1
C,H,L	Prunus amygdalus (Amygdalus communis. P. communis Arcang.). Almond.	____
A,B,C,G,H,I, K,L	Prunus armeniaca (Armeniaca vulgaris). Apricot.	1
C,H,L	Prunus cerasus (Cerasus caproniana). Sour cherry.	____
A,B,C,D,E,G, H,I,K,L	Prunus domestica (P. communis Huds.). Garden plum. P. domestica var. institia. Damson. Bullace.	1
L	Prunus japonica. Plum. Chinese bushcherry.	____
A,B,C,D,E,G, H,I,K,L	*Prunus persica (Amygdalus persica. Persica vulgaris). Peach.	1
A,B,C,G,H,L	Prunus persica var. nectarina (Prunus persica nucipersica; Amygdalus persica nectarina). Nectarine.	1
C,H	*Prunus salicina (P. triflora). Japanese plum.	____
D,G	Prunus umbellata. Wild plum. Flatwoods plum.	____
A,B,C,D,E,F, G,H,I,K,L	*Psidium cattleianum. (P. littorale). Strawberry guava. Cattley guava. Waiawi.	1
A,B,C,D,E,F G,H,I,K,L	*Psidium guajava. Guava.	1
H	Psidium guineense (P. araca). Brazilian guava.	____
I,K	Psidium littorale lucidum. (P. cattle lucidum). Yellow Cattley guava.	____
A,B,C,D,E,G, H,L	Punica granatum. Pomegranate.	3
L	Putranjiva roxburghii. Wild olive. India amulet plant.	____
D,G,L	Pyrocantha coccinea var. lalandi. (Crataegus lalandi). Laland firethorn.	____
A,B,C,D,E,G, H,I,K,L	*Pyrus communis. Common pear. Leconte pear.	1
H	Ribes sp. Currant. Gooseberry.	____
C,H	Robinia sp. Locust	____
C,H	Rosa sp. Roseberries.	____
H,L	Royana pallena. ?	____
C,L	Royens pubescens. Monkey apple.	____
K,L	*Rubus. Blackberry. Youngberry.	3

APPENDIX IV (continued)

Source	Scientific Name and/or Common Name	Group
L	Salix sp. Willow leaf.	
C,E,G,H,I,L	Santalum album. Sandalwood. White sandalwood.	
A,B,C,H,L	Santalum freycinetianum var. littorale. Beach sandalwood.	3
M	Santalum paniculatum. ?	
D	Scaefola plumieri. Goodenia beechberry.	
C,H,L	Schinus molle. California pepper tree blossoms.	
D,G,L,,	*Sechium edule (Chayota edulis). Chayote. Christophine.	
D,L	Selenicereus pteranthus (Cereus Nycticallus. C. pteranthus). Cactus.	
D,G,L	Serenoa repens (S. serrulata. Brahea serrulata. Chamaerops serrulata. Corypha repens. Sabal serrulata). Saw palmetto.	
C,H,L	Severinis buxifolia (Atalantea buxifolia. Triphasia monophylla). Chinese box orange.	
C,H,L	Sideroxylon inarme. Ironwood.	
D,L	Sideroxylon mastichodendron. Mastic. Jungle plum. Ironwood.	
D,G,L	Smilax bevrichii (S. sandwicensis). Smilax.	
C,D,G,H,L	Solanum aculeatissimum. Solanum. Sodoms apple. Nightshade.	
C,H,L	Solanum capsicastrum. Solanum cherry. False Jerusalem cherry.	
D,G,L	Solanum carolinense. Caroline horse-nettle.	
K,L	Solanum coagulans. ?	3
A,B,C,D,E,F, G,H,L	*Solanum melongena. Garden eggplant.	3
C,D,G,H,L	Solanum nigrum guineense. Solanberry black nightshade. Garden huckleberry.	
I	Solanum pseudocapsicum. Jerusalem cherry.	
D	Solanum seaforthianum. Brazilian nightshade.	4
D	Solanum sisymbrifolium. Nightshade.	4
C,H,L	Solanum sodomeum. Apple of Sodom.	
D	Solanum verbascifolium. Potato tree. Mullein nightshade.	4
H	Sorbus sp. Mountain ash.	
C,L	*Spondias sp. West Indian plum.	
A,B,C,E,G, H,L	Spondias cytherea (S. dulcis). Ambarella. Otaheite apple. Vi-apple. Wi. Jew plum.	3
C,G,H,L	*Spondias mombin. (S. lutea, S. axillaris). Yellow mombin. Spanish plum. Hog plum. Jobo. Cajamerin.	
C,H,L	Strychnos atherstonei. Cape teak.	
C,H,L	Strychnos pungens. Poison nut. Wild orange.	
C,G,H	Syzygium cumini (S. jambolanum. Eugenia cumini. E. jambolana). Jambolan. Java plum.	

APPENDIX IV (continued)

Source	Scientific Name and/or Common Name	Group
H,L	Teclea trichocarpa. ?	____
A,B,C,E,G,H, I,L	*Terminalia catappa (Myrobalan in part). Tropical almond. False kamani. Winged kamani.	1
A,B,C,H,L	Terminalia chebula. Black myrobalan. Chebula terminalia.	1
H,M	Terminalia pallida. Terminalia sp.	____
C,H,L	*Theobroma cacao. Cacao. Cocoa.	____
A,B,C,D,E,G, H,I,K,L	*Thevetia nereifolia (Cerbere thevetia). Yellow oleander. Be-still. Lucky nut thevetia.	____
H	Vaccinium cereum. ?	____
H	Vangueria edulis. Vangueria.	____
C,H,L	Vangueria infausta. Wild medlar. Vangueria.	____
C,L	Vangueria madagascariensis. Voavanga. Madagascar plum.	____
C,H,L	Vicia faba. Broad bean. Horse bean (V. faba equina).	____
A,B,C,E,F,H, K,L	Vitis labrusca. Fox grape. Isabella grape.	3
D,G,H	Vitis sp. hybrid. Beacon grape.	____
C,G,H,L	Vitis vinifera. Wine grape. European grapes.	____
E	Wikstroemia phillyreaefolia. Wikstroemia.	____
D	Ximenia americana. Tallow-wood.	4
G,H	Zizyphus jujuba (Z. vulgaris. Z. sativa). Jujube. Chinese date.	____

APPENDIX IV - Addendum

Additional Hosts which were Intercepted at U.S. Ports of Entry by USDA Inspectors and found to be infested with medfly. 1/

Year	Host	Origin	Intercepted at
1961	*Pandanus odoratissimus* (Pandanus)	Hawaii	Hawaii
1964	*Synsepalum delcificum*	Ghana	New York
"	*Sorbus domestica* (Mt. Ash)	Italy	New York
"	*Cordyline* sp. (Ti)	Hawaii	Hawaii
"	*Opuntia humifusa*	Italy	New York
1965	*Opuntia occidentalis*	Italy	New York
"	*Prunus cerasifera* (myrobalan plum)	Hawaii	Hawaii
1966	*Murraya paniculata* (orange jasmine)	Hawaii	Hawaii

1/ Listed in USDA "List of Intercepted Plant Pests" (1961-1966).

APPENDIX V.

SCIENTIFIC, COMMON AND SPANISH NAMES OF MEDFLY HOST FRUITS FOUND IN CENTRAL AMERICA AND PANAMA

Genus, species and common name (respectively)	Guatemala	El Salvador	Honduras	Nicaragua	Panama	Costa Rica	Belize
Annona cherimola cherimoya	anona chirimoya	anona anona blanca	anona	anona	chirimoya	anona chirimoya	tukib cherimoya pox
Annona muricata soursop	guanaba guanábana	guanaba guanábana	guanábana	guanaba guanábana	guanaba guanábana	guanábana	soursop
Annona squamosa sweetsop	chirimoya anona saramuya	anona	anona	anona	anona	anona	sweetsop sugar apple
Averrhoa carambola star fruit	carambola	carambola	carambola	carambola	carambola	carambola	star fruit carambola
Calocarpum mammosum red sapote	mamey zapote	zapote	zapote	zapote	mamey mamey de tierra	zapote	mamey mamey sapote
Casimiroa edulis white sapote	matasano	matasano	matasano	matasano	matasano	matasano	white sapote
Chrysophyllum cainito star apple	caimito	caimito	caimito	caimito	caimito	caimito	

APPENDIX V (continued)

Genus, species and common name (respectively)	Guatemala	El Salvador	Honduras	Nicaragua	Panama	Costa Rica	Belize
Citrus aurantium sour orange	naranja ácida	naranja ácida	naranja agria	naranja agria	naranja ácida naranja agria	naranjo agrio naranja ácida	sour orange
Citrus paradisi grapefruit	toronja	toronja	toronja	toronja	toronja	toronja	grapefruit pomelo
Citrus reticulata mandarin orange	mandarina	mandarina	mandarina	mandarina	mandarina	mandarina	mandarin tangerine
Citrus sinensis orange	naranja naranja dulce	naranja	naranja	naranja dulce	naranja	naranja naranja dulce	orange
Coffea arabica coffee	café	café	café	café	café	café	coffee
Eriobotrya japonica loquat	níspero japonés	níspero japonés	níspero japonés	níspero japonés	níspero japonés	níspero del japón	loquat
Eugenia jambos rose apple	manzana rosa	manzana rosa manzana de pedorra	manzana rosa	manzana rosa	pomarosa	pomarosa manzana rosa	rose apple
Eugenia uniflora surinam cherry	pitanga	pitanga guinda	pitanga	pitanga	pitanga	pitanga	surinam cherry

APPENDIX V (continued)

Genus, species and common name (respectively)	Guatemala	El Salvador	Honduras	Nicaragua	Panama	Costa Rica	Belize
Ficus carica fig	higo	higo	higo	higo	higo	higo higuera	higo
Malpighia glabra Barbados cherry and Acerola	acerola nance nance colorado	acerola camaroncita	cereza	-	cereza	acerola jupiter	wild craboo Barbados cherry
Manilkara achras sapodilla	chico chicozapote	níspero chicozapote	níspero	níspero	níspero	níspero chicozapote	naseberry sapodilla
Malus sylvestris apple	manzana	manzana	manzana	manzana	manzana	manzana	apple
Mangifera indica mango	mango	mango	mango	mango	mango	mango	mango
Opuntia vulgaris and *O. ficus-indica* cactus	tuna	tuna	tuna	tuna	tuna	tuna nopal	cactus fruit
Prunus persica peach	doraz durazno	melocotón durazno	durazno	durazno melocotón	durazno	melocotón durazno	peach

APPENDIX V (continued)

Genus, species and common name (respectively)	Guatemala	El Salvador	Honduras	Nicaragua	Panama	Costa Rica	Belize
Prunus salicina plum	ciruela	ciruela	ciruela del japón	ciruela	ciruela	ciruela	plum
Psidium cattleianum strawberry guava	guayaba de fresa	guayaba de fresa	guayaba de fresa	guayaba de fresa	guayaba japonesa guayaba de fresa	guayaba japonesa cas dulce	strawberry guava
Psidium guajava guava	guayaba	guayaba	guayaba	guayaba de gusano guayaba	guayaba	guayaba	guava guayaba
Spondias mombin (lutea) hog plum	jobo jocote jobo	jobo	jobo	jocote	jobo	jobo	hobo hog plum
Spondias purpurea Spanish plum	jocote	jobo jocote	jocote ciruela	jocote común ciruela	jocote ciruela	jocote ciruela	hog plum ciruela
Terminalia catappa tropical almond	almendro	almendro	almendro	almendra	almendra	almendra	almond almendro

APPENDIX VI

COUNTRIES WHERE MEDFLY IS KNOWN TO OCCUR

Albania
Algeria (1858)
Angola
Argentina (1905)
Australia
Austria
Azores (1829)
Balearic Island
Belgium
Bermuda (1865)
Bolivia
Botswana
Brazil (1901)
Burundi
Cameroon
Canary Islands
Cape Verde Island (1829)
Chile
Costa Rica (1955)
Crete
Cyprus
Dahomey
Egypt (1901)
El Salvador (1975)
Ethiopia
France (1900)
Germany
Ghana
Greece (1916)
Guatemala (1975)
Guinea
Hawaii* (1910)
Honduras (1975)
Hungary (1928)
Italy (1863)
Israel
Ivory Coast
Jamaica
Jordan
Kenya
Lebanon
Liberia
Libya
Madeira (1829)
Madagascar
Malagasy Republic
Malawi
Mali
Malta (1845)
Mauritius (1817)
Morocco
Mozambique
New Zealand (1901)
Netherlands
Nicaragua (1960)
Niger
Nigeria
Panama (1963)
Paraguay
Peru
Portugal
Réunion
Rhodesia
Rwanda
Santa Helena
San Miguel (Azores)
Sardinia (1950)
Saudi Arabia
Senegal
Seychelles
Sicily (1878)
Sierra Leone
South Africa (1889)
Spain (1842)
Sudan
Swaziland
Syria
Switzerland
Tanzania
Tasmania (1899)
Togo
Tunisia (1885)
Turkey (1904)
Uganda
Upper Volta
Uruguay
Venezuela
Yugoslavia
Zaire
Zambia

NOTE: Date shows when first reported in country.

* Hawaii - non-contiguous U.S. state.

APPENDIX VII

DISTRIBUTION AND HOSTS OF ECONOMICALLY IMPORTANT *Anastrepha* spp.

The following distribution and host list was mainly taken from Alan Stone (1942). The most recent distribution is given by Foote (1967).

A. distincta Greene

Found from Texas south to Peru and Brazil.

Mainly found in *Inga*; but also been reared from *Chrysophyllum cainito*, *Eugenia nesiotica*. In the lab from apple, chile pepper and lime.

A. fraterculus (Wied.)

Found from Texas south to Argentina and Chile, Trinidad and Tobago.

Mainly found in guava, peach and surinam cherry; but also has been reared from *Manilkara achras*, *Annona cherimola*, *Eugenia jambos*, *E. malaccensis*, *Citrus grandis*, *C. sinensis*, *Coffea arabica*, *Cydonia brasiliensis*, *Dovyalis hebecarpa*, *Eriobotrya japonica*, *Eugenia brasiliensis*, *E. uniflora*, *Turpinia paniculata*, *Vitis vinifera* and *Ximenia americana*. This species has also been reared from other hosts exposed in the laboratory (see Baker, *et al.*, 1944).

A. ludens (Loew)

Found south from Texas to Costa Rica.

Mainly found in citrus and mango; but has been reared from *Casimiroa edulis*, *C. tetrameria*, *Annona cherimola*, *A. reticulata*, *Mammea americana*, *Cydonia oblonga*, *Punica granatum*, *Prunus persica*, *Sargenta greggii* and *Inga jinicuil*.

A. mombinpraeoptans Sein

Found from Southern Florida and Texas, throughout Antilles to Trinidad, Mexico to Panama, Ecuador, Venezuela and Brazil.

The favored food plants of the larvae are mombins, jobos, or hog plums of the genus Spondias followed by the mango, the rose apple or pomarosa (Eugenia jambos) and the guava. It also has been reared from Anacardium occidentale, Annona hayesii, Dovyalis hebecarpa, Eugenia malaccensis, E. nesiotica, Averrhoa carambola, Prunus amygdalus, Citrus grandis, C. aurantium and Calocarpum mammosum. It has also been reared to other hosts exposed in the laboratory (see Baker et al., 1944).

A. serpentina (Wied.)

Found from Texas south throughout Mexico and Central America to Peru, Trinidad, British Guiana south to Brazil, Venezuela, Argentina and Ecuador.

The preferred food plants are members of the family Sapotaceae particularly Chrysophyllum cainito and Manilkara achras. It also has been reared from C. panamense, Calocarpum mammosum, Mimusops coriacea, Mammea americana, Zschokkea panamensis, Citrus sinensis, Dovyalis hebecarpa, and Cydonia oblonga. Grapefruit and peach served as good hosts in the laboratory. Other experimental hosts are discussed by Alan Stone (1940) and Baker et al., 1944.

A. striata Schiner

Found from Texas south through Mexico to Panama, northern South America south to Peru and Brazil (Amazonas).

Guava is the preferred host plant of this species, but it has been reared from Calyptranthes tonduzii, mango, Spondias sp. and one infestation of Manihot esculenta. In the laboratory it has been reared in Eugenia uniflora and Manilkara achras.

A. suspensa (Loew)

Found in southern Florida, Cuba, Puerto Rico, Jamaica, Hispaniola.

More than 50 host fruits of A. suspensa have been recorded. Preferred hosts were: the tropical almond, guava, rose apple, peach, Surinam cherry. It also attacks mango, loquat, grapefruit and several other kinds of citrus.

APPENDIX VIII

Table A. HYMENOPTEROUS PARASITES OF *Ceratitis capitata* Wied.

BRACONIDAE

Bracon celer Szépligeti	(Field) Africa
Biosteres angaleti Fullaway 1/	(lab) Hawaii
Biosteres caudatus Szépligeti	(field,lab) Africa, Hawaii
Biosteres desideratus Bridwell	(lab) Hawaii
Biosteres fuscipennis Szépligeti	(lab) Hawaii
Biosteres fullawayi (Silvestri)	(field) Africa
Biosteres giffardii (Silvestri)	(field,lab) Africa, Hawaii
Biosteres hageni (Fullaway)	(lab) Hawaii
Biosteres longicaudatus Ashmead	(field) Hawaii, Costa Rica, Mexico
Biosteres oophilus (Fullaway)	(field) Hawaii
Biosteres persulcatus Silvestri	(lab) Hawaii
Biosteres tryoni (Cameron)	(field) Hawaii,
Biosteres vandenboschi Fullaway	(lab,field) Hawaii, Australia
Opius africanus Szépligeti	(field) Africa
Opius bellus Gahan	(field) Venezuela
Opius concolor Szépligeti	(field Africa, Europe
Opius fletcheri Silvestri var.?	(lab) Hawaii
Opius humilis Silvestri	(field) Africa
Opius incisi Silvestri	(lab) Hawaii
Opius makii Sonan	(lab) Hawaii
Opius manii Fullaway	(lab) Hawaii
Opius phaeostigma Wilkinson	(lab) Hawaii
Parachasma cereum (Gahan)	(lab) Hawaii
Phaenocarpa anastrephae Muesebeck	(field) Venezuela

DIAPRIIDAE

Psilus (=*Galesus*) *silvestri* (Kieffer)	(lab) Italy, Hawaii
Psilus 2 spp.	(field) Africa
Trichopria capensis Kieffer	(field) So. Africa

CYNIPIDAE (Eucolinae)

Trybliographa daci Weld	(lab) Hawaii

1/ Fischer (1971) recognizes the genus *Biosteres* which now includes a group of species formerly placed in the genus *Opius*.

APPENDIX VIII, Table A (continued)

EULOPHIDAE

Aceratoneuromyia indica (Silvestri) (=Syntomosphyrum indicum Silvestri)	(lab,field)	Hawaii, Italy, Australia, So. Africa, Mexico, Costa Rica
Tetrastichus dacicida	(lab)	Hawaii
Tetrastichus giffardianus Silvestri	(field)	Africa, Brazil, Hawaii
Tetrastichus giffardii Silvestri	(field)	Africa

PTEROMALIDAE

Dirhinus giffardii Silvestri	(field)	Africa, Hawaii
Pachycrepoideus vindemiae Rondoni (=P. dubius Ashmead)	(field)	Africa, Central America
Spalangia afra Silvestri	(field)	Africa

APPENDIX VIII

Table B. HYMENOPTEROUS PARASITES OF SOME COMMON *Anastrepha* spp.

BRACONIDAE

Species	Location	Host
Biosteres longicaudatus varieties	El Salvador Costa Rica Mexico	*A. ludens*
	Florida	*A. suspensa*
Biosteres tryoni (Cameron)	Laboratory - Puerto Rico	*A. mombinpraeoptans*
Diachasma areolatum (Szépligeti)	Brazil	*A. fraterculus*
Opius anastrephae Viereck	Brazil West Indies	*A. fraterculus* *A. mombinpraeoptans* *A. suspensa*
Opius argentinus (Brethes)	Argentina	*A. fraterculus*
Opius bellus Gahan	Panama Venezuela	*A. fraterculus* *A. mombinpraeoptans*
Opius gomesi Costa Lima	Brazil	A. *serpentina*
Opius humilis Silvestri	Laboratory - Puerto Rico	*A. suspensa*
Opius mombinpraeoptantis Fischer	Panama	A. *mombinpraeoptans*
Opius pseudobellus Ratkovich	Argentina	*A. fraterculus*
Opius vierecki Gahan	Mexico	*A. striata*
Parachasma anastrephilum Marsh	Florida	*A. suspensa*
Parachasma auripenne (Muesebeck)	Panama	*A. serpentina*

APPENDIX VIII, Table B. (continued)

BRACONIDAE

Species	Location	Host
Parachasma brasiliense (Szépligeti)	Argentina Brazil	A. fraterculus
Parachasma cereum (Gahan)	Brazil Florida Mexico Panama Trinidad	A. ludens A. mombinpraeoptans ? A. suspensa
Parachasma crawfordi (Viereck)	Costa Rica Mexico	A. ludens A. striata
Parachasma fluminense (Costa Lima)	Brazil Venezuela	A. fraterculus A. striata
Parachasma trinidadense (Gahan)	Trinidad Peru	A. serpentina A. striata
Parachasma zeteki (Muesebeck)	Panama	A. fraterculus
Phaenocarpa anastrephae Muesebeck	Venezuela	A. mombinpraeoptans

DIAPRIIDAE

Ashmeadopria sp.	Panama Puerto Rico	A. mombinpraeoptans A. suspensa
Phaenopria sp.	Puerto Rico	A. suspensa
Psilus (=Galesus) sp.	Mexico	A. ludens
Trichopria sp.	Puerto Rico Florida	A. mombinpraeoptans A. suspensa

CYNIPIDAE (Eucoilinae)

Cothonaspis sp.	Florida	A. suspensa
Eucoila spp.	Mexico Panama Puerto Rico	A. ludens A. mombinpraeoptans A. suspensa

APPENDIX VIII, Table B. (continued)

CYNIPIDAE (Eucoilinae)

Species	Location	Host
Eucoila (*Hexamerocera*) sp.	Brazil Puerto Rico	*A. mombinpraeoptans* *A. suspensa*
Ganaspis carvalhoi Dettmer	Brazil Venezuela	*A. fraterculus* *A. mombinpraeoptans* *A. striata*
Ganaspis sp.	Puerto Rico	*A. suspensa*
Pseudeucoila brasiliana (Weld)	Brazil Panama	*Anastrepha* sp.
Psichacra pellaneranoi (Brethes)	Argentina Peru	*A. fraterculus*
Zaeucoila sp.	Nicaragua	*Anastrepha* sp. in *Eugenia jambos*

EULOPHIDAE

Aceratoneuromyia indica (Silvestri)	Costa Rica Florida Mexico	*A. ludens* *A. suspensa*

PTEROMALIDAE

Dirhinus giffardii Silvestri	Laboratory - Puerto Rico	*A. mombinpraeoptans* *A. suspensa*
Pachycrepoideus vindemiae Rondoni	Brazil Florida Puerto Rico Panama	*A. mombinpraeoptans* *A. suspensa*
Spalangia cameroni Perkins	Florida	*A. suspensa*
Spalangia endius Walker	Florida	*A. suspensa*

APPENDIX IX

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FRUIT AND VEGETABLES APPROVED FOR ENTRY INTO THE UNITED STATES FROM CENTRAL AMERICA AND PANAMA UNDER SPECIFIED TREATMENTS AND CONDITIONS

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Ports of entry

SAG = South Atlantic & Gulf
NA = North Atlantic
NP = North Pacific
PR = Puerto Rico
VI = Virgin Islands

Fumigation

MB = Methyl bromide
EDB = Ethylene dibromide
NAP = Normal atmospheric pressure

FOOTNOTES

3/ Beans

a. Lima beans (*Phaseolus lunatus*) and string beans (*P. vulgaris*)

(1) Dried (Shelled) - subject to Sec. 319.56-2(b). Permit not required.

(2) Fresh (pod or shelled). Enterable from approved sources listed in Section II, M319.56-2-A.

Shipments from British Honduras, Costa Rica, El Salvador, Guatemala, Honduras, Ecuador, Venezuela, and the West Indies are enterable at NA ports for destinations north of 38°N.L. (Washington, D.C. and north) and east of the 115°W.L. (generally east of Great Falls and Salt Lake). Fumigation not required for *Maruca*, *Epinotia*, or *Laspeyresia* when from these areas unless destined to SAG areas. Shipments transiting NA port for SAG destinations require T-104 as a condition of entry.

Shipments from Mexico found infested with *Maruca*, *Epinotia*, or *Laspeyresia* require T-104; or in lieu thereof, may move by bonded carrier to Washington, D.C., and destinations north thereof and east of Great Falls Salt Lake.

b. Broad (faba) beans (*Vicia* spp.)

(1) Dried (shelled) - subject to Sec. 319.56-2(b). Permit and treatment with T-203 required except for the following, when not infested:

- Quantities of 1 lb. or less
- Samples and noncommercial lots
- Shipments from Canada, Mexico, West Indies, Central and South America
- Shipments of non-Canadian origin accompanied by a Canadian fumigation certificate

(2) Fresh (pod or shelled) - same as for lima and string beans.

c. Lentils (Lens spp.) - same as for broad beans except Lentils are prohibited from South America. Use T-104 instead of T-203. Permit required.

d. Other beans (including Glycine max (soy), Vigna sinensis (cowpea group), and Phaseolus aureus (mung)).

(1) Dried - enterable subject to Sec. 319.56-2(b). No permit required.

(2) Fresh - (pod or shelled) - same as for lima or string beans.

14/ Peas

a. Pigeon pea (Cajan cajanus) - Pod or shelled

(1) Dried - Subject to Sec. 319.56-2(b). No permit required.

(2) Fresh - same as for lima and string beans (See item 3). Permit required.

b. Garden pea (Pisum sativum)

(1) Dried - entry subject to Sec. 319.56-2(b). No permit required.

(2) Fresh - enterable from authorized sources listed in Section II, M319.56-2-A. Permit required.

c. Sweet pea (Lathyrus spp.)

See M319.37-4a and -4c.

15/ Lemon - The lemon approved in Section II is the smooth skinned lemon of commerce.

APPENDIX IX

CENTRAL AMERICA AND PANAMA

FRUIT AND VEGETABLES

APPROVED FOR ENTRY INTO THE UNITED STATES

UNDER SPECIFIED TREATMENTS AND CONDITIONS*

Belize
(formerly British Honduras)

All:	Acorn (26)	Corn, green	Pea 14/
	Acrocomia	Cucurbit	Pepper
	Allium	Dasheen	Pineapple (except Hawaii)
	Arrowroot	Durian	Radish (no tops)
	Asparagus	Eggplant	Roselle
	Astrocarym	Ginger root	Rubus
	Ayale	Husk or mil tomato	Rutabaga
	Banana	Lemon 15/	Salsify
	Beet	Lettuce	Spinach
	Brassica oleracea	Lime (sour)	Strawberry
	Breadfruit	Mangosteen	Swiss chard
	Carrot	Marang	Thyme
	Cassava	Okra	Tomato
	Celery	Pacaya	Turnip
	Ceriman	Palm heart	Watercress
	Chestnut (26)	Papaya (except Hawaii)	Yam (22)
	Chinese cabbage	Parsley	
	Cichorium		
NA:	Artichoke (Gl. & Jer.)	Carambola	Mango (4)
	Bean, pod or shelled 3/	Culantro	Orange (3) or (5)
	Cacao bean pod	Ethrog	Pigeon pea 14/
	Cactus fruit	Grapefruit (3) or (5)	Sorrel
			Tangerine (3) or (5)
SAG & NP:	Artichoke (Jer.)	Cacao bean pod	Culantro

(Rev. November 1975)

* From Plant Quarantine Manual, USDA, APHIS, PPC, Hyattsville, MD. Subject to change. Write for current information.

COSTA RICA

All:	Acorn (26)	Corn, green	Radish (no tops)
	Allium	Culantro	Rubus
	Arrowroot	Dasheen	Rutabaga
	Asparagus	Durian	Salsify
	Ayale	Ginger root	Spinach
	Banana	Lettuce	Strawberry
	Beet	Lime (sour)	Swiss chard
	Brassica oleracea	Okra	Thyme
	Carrot	Palm heart	Turnip
	Cassava	Parsnip	Watercress
	Celery	Pineapple (except Hawaii)	Yam (2))
	Chestnut (26)		
NA:	Artichoke (Gl. & Jer.)	Cucurbit*	Orange (3) or (5)
	Bean, Lima 3/	Grapefruit (3) or (5)	Papaya (7)
	Cacao bean pod	Husk or mil tomato	Pigeon pea 14/
	Chickpea	Lemon 15/	Tangerine (3) or (5)
	Ethrog (3) or (24)	Mango (4)	Tomato*
SAG:	Artichoke (Jer.)	Chayote	
NP:	Artichoke (Jer.)	Cucurbits	Tomato
VI:	Chickpea		
PR:	Chickpea		

(Rev. March 1976)

* Movement through SAG ports, under Customs Bond, for PPQ clearance at NA ports authorized IF in closed van containers or on pallets completely enclosed by cardboard or plastic cover.

EL SALVADOR

All:	Acorn (26)	Chestnut (26)	Roselle
	Acrocomia	Corn, green	Rubus
	Allium	Dasheen	Rutabaga
	Arrowroot	Durian	Salsify
	Asparagus	Ginger root	Spinach
	Astrocaryum	Lettuce	Strawberry
	Ayale	Lime (sour)	Swiss chard
	Banana	Marang	Thyme
	Beet	Okra	Turnip
	Brassica oleracea	Palm heart	Watercress
	Carrot	Pea 14/	Yam (22)
	Cassava	Pineapple (except Hawaii)	
	Celery		
NA:	Artichoke (Gl. & Jer.)	Grapefruit (3) or (5)	Orange (3) or (5)
	Cacao bean pod	Husk or mil tomato	Papaya (7)
	Cucurbit*	Lemon 15/	Pigeon pea 14/
	Ethrog (3) or (24)	Mango (4)	Sorrel
			Tangerine (3) or (5)
			Tomato*
SAG:	Artichoke (Jer.)	Chayote	
NP:	Artichoke (Jer.)	Cucurbits	Tomato

(Rev. March 1976)

* Movement through SAG ports, under Customs Bond, for PPQ clearance at NA ports authorized IF in closed van containers or on pallets completely enclosed by cardboard or plastic cover.

GUATEMALA

All:	Acorn (26)	Corn, green	Roselle
	Acrocomia	Dasheen	Rubus
	Allium	Durian	Rutabaga
	Arrowroot	Ginger root	Salsify
	Asparagus	Lettuce	Spinach
	Astrocaryum	Lime (sour)	Strawberry
	Ayale	Marang	Swiss chard
	Banana	Okra	Thyme
	Beet	Palm heart	Turnip
	Brassica oleracea	Parsley	Watercress
	Carrot	Pea 14/	Waterlily root
	Cassava	Pineapple (except Hawaii)	Yam (22)
	Celery		
	Chestnut (26)	Radish (no tops)	
NA:	Artichoke (Gl. & Jer.)	Grapefruit (3) or (5)	Papaya (7)
	Cacao bean pod	Husk or mil tomato	Pigeon pea 14/
	Cucurbit*	Lemon 15/	Plum (3) or (5)
	Ethrog (3) or (24)	Mango (4)	Sorrel
		Orange (3) or (5)	Tangerine (3) or (5)
			Tomato*
SAG:	Artichoke (Jer.)	Chayote	
NP:	Artichoke (Jer.)	Cucurbits	Tomato

(Rev. March 1976)

* Movement through SAG ports, under Customs Bond, for PPQ clearance at NA ports authorized IF in closed van containers or on pallets completely enclosed by cardboard or plastic cover.

HONDURAS

All:	Acorn (26)	Celery	Roselle
	Acrocomia	Chestnut (26)	Rubus
	Allium	Corn, green	Rutabaga
	Arrowroot	Dasheen	Salsify
	Artocarpus	Durian	Spinach
	Asparagus	Ginger root	Strawberry
	Astrocaryum	Lettuce	Swiss chard
	Ayale	Lime (sour)	Thyme
	Banana	Marang	Turnip
	Beet	Okra	Watercress
	Brassica oleracea	Palm heart	Yam (22)
	Carrot	Pea 14/	
	Cassava	Pineapple (except Hawaii)	
NA:	Artichoke (Gl. & Jer.)	Grapefruit (3) or (5)	Papaya (7)
	Cacao bean pod	Husk or mil tomato	Pigeon pea 14/
	Chickpea	Lemon 15/	Sorrel
	Cucurbit*	Mango (4)	Tangerine (3) or (5)
	Ethrog (3) or (24)	Orange (3) or (5)	Tomato*
SAG:	Artichoke (Jer.)	Chayote	
NP:	Artichoke (Jer.)	Cucurbits	Tomato

VI & PR: Chickpea

(Rev. March 1976)

Movement through SAG ports, under Customs Bond, for PPQ clearance at NA ports authorized IF in closed van containers or on pallets completely enclosed by cardboard or plastic cover.

NICARAGUA

All:	Acorn (26) Allium Arrowroot Asparagus Ayale Banana Basil Beet Brassica oleracea Carrot Cassava Celery Chestnut (26)	Corn, green Dasheen Durian Ginger root Lettuce Lime (sour) Okra Palm heart Parsnip Parsley (tops and roots) Pineapple (except Hawaii)	Rubus Rutabaga Salsify Spinach Strawberry Swiss chard Thyme Turnip Watercress Yam (22)
NA:	Artichoke (Gl. & Jer.) Cucurbit* Ethrog (3) or (24) Grapefruit (3) or (5)	Huck or mil tomato Lemon 15/ Mango (4) Naranjilla Orange (3) or (5)	Papaya (7) Pigeon pea 14/ Tangerine (3) or (5) Tomato*
SAG:	Artichoke (Jer.)	Chayote	
NP:	Artichoke (Jer.)	Cucurbits	Tomato

(Rev. March 1976)

* Movement through SAG ports, under Customs Bond, for PPQ clearance at NA ports authorized IF in closed van containers or on pallets completely enclosed by cardboard or plastic cover.

PANAMA

All:	Acorn (26)	Chestnut (26)	Roselle
	Acrocomia	Corn, green	Rubus
	Allium	Dasheen	Rutabaga
	Arrowroot	Durian	Salsify
	Asparagus	Ginger root	Spinach
	Astrocaryum	Lettuce	Strawberry
	Ayale	Lime (sour)	Swiss chard
	Banana	Okra	Thyme
	Beet	Palm heart	Turnip
	Brassica oleracea	Pea 14/	Watercress
	Carrot	Pineapple (except Hawaii)	Yam (22)
	Cassava		
	Celery		
NA:	Artichoke (Gl. & Jer.)	Grapefruit (3) or (5)	Papaya (7)
	Cacao bean pod	Husk or mil tomato	Pigeon pea 14/
	Cucurbit*	Lemon 15/	Sorrel
	Ethrog (3) or (24)	Mango (4)	Tangerine (3) or (5)
		Orange (3) or (5)	Tomato*
SAG:	Artichoke (Jer.)	Chayote	
NP:	Artichoke (Jer.)	Cucurbits	Tomato

(Rev. March 1976)

* Movement through SAG ports, under Customs Bond, for PPQ clearance at NA ports authorized IF in closed van containers or on pallets completely enclosed by cardboard or plastic cover.

** Direct to NA or NP port concerned, or subject to containerization for transshipment through Miami to northern port.

T-101 - Deciduous Fruits

(a) Chamber

MB at NAP -

1 1/2 lbs. for 2 hours at 80°-89°F.
2 lbs. for 2 hours at 70°-79°F.
2 1/2 lbs. for 2 hours at 60°-69°F.
3 lbs. for 2 hours at 50°-59°F.
4 lbs. for 2 hours at 40°-49°F.

(b) Tarpaulin, van, & refrigerator railway car fumigation:

MB at NAP -

1 1/2 lbs./1,000 cu. ft. for 2 1/2 hours at 80°-89°F.
(18 oz. minimum gas concentration at 1/2 hour)
(14 oz. minimum gas concentration at 2 1/2 hours)
2 lbs./1,000 cu. ft. for 2 1/2 hours at 70°-79°F.
(25 oz. minimum gas concentration at 1/2 hour)
(18 oz. minimum gas concentration at 2 1/2 hours)
2 1/2 lbs./1,000 cu. ft. for 2 1/2 hours at 60°-69°F.
(31 oz. minimum gas concentration at 1/2 hour)
(24 oz. minimum gas concentration at 2 1/2 hours)
3 lbs./1,000 cu. ft. for 2 1/2 hours at 50°-59°F.
(36 oz. minimum gas concentration at 1/2 hour)
(28 oz. minimum gas concentration at 2 1/2 hours)
4 lbs./1,000 cu. ft. for 2 1/2 hours at 40°-49°F.
(45 oz. minimum gas concentration at 1/2 hour)
(34 oz. minimum gas concentration at 2 1/2 hours)

Note: Treatment outlined in (a) or (b) above required as a condition of entry in addition to such requirements of T-107 as specified for country of origin and fruit named therein:

(1) For apricot, grape, nectarine, peach, and plum from Chile.
(2) For apple, cherry, pear from Chile, if any of the following are found on inspection:

Proeulia spp. (Tortricidae) larvae
Leptoglossus chilensis (Coreidae) adults
Megalometis chilensis (Curculionidae) adults
Naupactus xanthographus (Curculionidae) adults
Listroderes subcinctus (Curculionidae) adults
Conoderus rufangulus (Elateridae) adults
Brevipalpus chilensis (Tenuipalpidae) mites

T-101 (continued)

ADD new note

(3) For apples from Australia (including Tasmania). Preferred treatment when qualified is T-108(b) or T-109.

(4) For apples from New Zealand or pears from New Zealand and Australia (including Tasmania) for pests of the family Tortricidae when found on inspection. Alternative treatment for Epiphyas spp. ... T-108(b) or T-109.

California which are discharged at ports in other States must be accompanied by fumigation certification;

- The temperature of cold treated fruit discharged at California ports awaiting State-required fumigation must not rise above 50°F. unless tarped pending treatment. Such treatment must be accomplished promptly upon discharge under supervision of State or Program Inspectors.

- T-101 is waived for shipment transiting California provided fruit temperatures not exceeding 50°F. are maintained while in California.

Exceptions: Epiphyas spp. .....T-108(b) or T-109.

(c) Alternate treatment for certain fruit

Fumigation with MB plus refrigeration - T-108.

Refrigeration plus fumigation with MB - T-109.

(d) Stone fruits

(1) For Rhagoletis cingulata

EDB at NAP - 16 oz. for 2 hours at 70°F. or above.

(2) Plums from Mexico

For Anastrepha spp. - T-102(2)(a).

Load limit 50% of chamber volume.

(3) Plums from Guatemala

For Anastrepha spp. and Ceratitis capitata - T-102(2)(b).

Load limit 50% of chamber volume.

T-101 (continued)

(4) Alternate treatment from certain countries

Fumigation with MB plus refrigeration - T-108

Cold treatment for fruit flies - T-107

(5) Cherries for *Laspeyresia pomonella*

MB at NAP - 2 lbs. for 2 hours at 70°F. or above

(6) Other insects - T-101(a) or (b)

(e) Grape

(1) For vine moth, *Lobesia botrana*

MB Chamber or tarpaulin - T-101(b)

For shipments of field-grown grapes from Algeria, Austria, Bulgaria, Cyprus, Egypt, France, Germany, Greece, Hungary, Israel, Italy, Libya, Luxembourg, Morocco, Portugal, Spain, Switzerland, Syria, and the USSR, this treatment is a precautionary requirement for the vine moth, *Lobesia botrana*. (T-107(a) will also be required from those countries in which the Mediterranean fruit fly is known to occur.)

(2) For fruit flies

Cold treatment - T-107.

Fumigation with MB plus refrigeration - T-108.

(3) Other insects - T-101(a) or (b)

T-102 - Tropical and Subtropical Fruits

(1) Avocado

(a) From areas where either Mediterranean fruit fly, melon fruit fly, or oriental fruit fly occur:

MB at NAP followed by refrigeration -

2 lbs. for 2 1/2 hours at 70°F. or above
7 days storage at 45°F. or below

. Avocados to be fumigated in wooden field boxes.

. Aerate 30 minutes minimum following fumigation.

. Seven days refrigeration may include up to 24 hours precooling time.

. Time lapse between fumigation and start of cooling not to exceed 24 hours.

. Above treatment only slightly injurious to fruit in mature, green stage of development.

. Treatment not approved for avocado pests, other than fruit flies listed above:

(b) Alternate treatment - T-105(c)

(2) Citrus Fruits

(a) Grapefruit, orange, and tangerine from *Anastrepha* spp. countries of the West Indies (as defined in M319.56-2-A, Section I, Note #16), Mexico, and Belize (British Honduras), except the Mediterranean fruit fly country of Bermuda.

Fruit load in Chamber	Dosage of EDB in oz./1,000 cu.ft./2hours		
	50°F.-59°F.	60°F.-69°F.	70°F.or above
25% or less	12 oz.	10 oz.	8 oz.
26% to 49%	14 oz.	12 oz.	10 oz.
50% to 80%	16 oz.	14 oz.	12 oz.

Post-treatment aeration: Forced circulation in the fumigation chamber for 1/2 hour following treatment and then placed in a well ventilated area.

Alternate cold treatment - T-107

Alternate vapor heat treatment from Mexico - T-106(a)

Treatment from Medfly countries - T-102(2)(b)

T-102 (continued)

(b) Orange, grapefruit, tangerine, and ethrog from Mediterranean fruit fly countries with the exception of those countries south of Panama.

Fruit load in Chamber	Dosage of EDB in oz./1,000 cu. ft./2 hours 60°F.-69°F.	70°F. or above
25% or less	10 oz.	8 oz.
26% to 49%	12 oz.	10 oz.
50% to 80%	14 oz.	12 oz.

Post-treatment aeration: Forced circulation in the fumigation chamber for 1/2 hour following treatment and then placed in a well ventilated area.

Alternate cold treatment from certain countries - T-107

Alternate treatment for ethrog - T-102(d)

(c) From Puerto Rico and Virgin Islands - T-102(2)(a)

(d) Ethrog infested with *Prays citri* from Medfly countries

MB at NAP - 2 lbs. for 3 1/2 hours at 70°F. or above

(e) Citrus fruit with leaf contamination for Citrus Blackfly, *Aleurocanthus woglumi*
Chamber or Tarpaulin: MB at NAP

28 oz./1,000 ft.^{3} for 2 hours at 65-70°F.
(23 oz. concentration at 1/2 hour)
(17 oz. concentration at 2 hours)
24 oz./1,000 ft.^{3} for 2 hours at 70-80°F.
(19 oz. concentration at 1/2 hour)
(15 oz. concentration at 2 hours)
20 oz./1,000 ft.^{3} for 2 hours at 80-85°F.
(16 oz. concentration at 1/2 hour)
(12 oz. concentration at 2 hours)
16 oz./1,000 ft.^{3} for 2 hours at 85° or above
(13 oz. concentration at 1/2 hour)
(9 oz. concentration at 2 hours)

Conduct tarpaulin fumigations in shaded areas, if possible, to prevent the development of high space temperatures within the tarpaulin enclosure.

Note: Ounces per 1,000 ft.^{3} = grams per cubic meter.

T-102 (continued)

(3) Mango

(a) For all *Anastrepha* spp. from West Indies, Mexico, and Belize (British Honduras), except those countries infested with Mediterranean fruit fly - Bermuda.

West Indies. As used in this section, the term "West Indies" means the foreign islands lying between North and South America, the Caribbean Sea, and the Atlantic Ocean including the Bahamas, the Great Antilles, and the Lesser Antilles, but excluding the chain of islands adjacent and parallel to the north coast of South America, the largest of which are Aruba, Curaçao, Bonaire, Tortuga, Margarita, Trinidad, and Tobago.

Fruit load in Chamber	Dosage of EDB in oz./1,000 cu. ft./2 hours 50°F.-59°F.	60°F.-69°F.	70°F. or above
25% or less	12 oz.	10 oz.	8 oz.
26% to 49%	14 oz.	12 oz.	10 oz.
50% to 80%	16 oz.	14 oz.	12 oz.

Post-treatment aeration: Forced circulation in the fumigation chamber for 1/2 hour following treatment and then in well ventilated area.

(b) Alternate Vapor Heat Treatment from Mexico - T-106(a)

(c) For *Anastrepha* spp. and Mediterranean fruit fly from Bermuda and Central America (Panama and countries north thereof except Mexico and Belize (British Honduras)) - T-102(2)(b)

(d) For *Anastrepha* spp. (including *A. fraterculus*) and *Ceratitis capitata* from Brazil.

EDB at NAP - 16 oz. for 2 hours at 70°F. or above

Load limit 50% of chamber

(4) Pineapple

(a) MB at NAP - 2 lbs. for 6 hours at 70°F. or above

T-102 (continued)

(b) EDB at NAP - 8 oz. for 2 hours at 70°F. or above

(c) Vapor Heat - T-106

(5) Papaya

For *Ceratitis capitata*, *Dacus dorsalis*, *D. cucurbitae*

(a) Hot water dip at 115°F. or above for 20 minutes followed by fumigation with EDB at NAP - 8 oz. for 2 hours at 70°F. or above.

Maximum time between hot water dipping and fumigation - 6 hours. Allow sufficient time to enable skin surface of papayas to dry; packing boxes, if used, must be drip dry.

(d) EDB at NAP - 16 oz. for 2 hours at 70°F. or above.

Either (a) or (b) is required as a treatment for papaya from Bermuda, Ceylon, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, and Venezuela; also required for interstate movement from Hawaii.

(c) Alternate Vapor Heat treatment for Movement from Hawaii - T-106(b)

T-103 - Nuts

(1) Chestnut and Acorn: For *Laspeyresia splendana* and *Curculio* spp.

(a) MB at NAP-Chamber, van container, or tarpaulin

4 lbs. for 3 hours at 90°-96°F.
(58 oz. concentration at 1/2 hour)
(34 oz. concentration at 3 hours)
4 lbs. for 4 hours at 80°-89°F.
(58 oz. concentration at 1/2 hour)
(32 oz. concentration at 4 hours)
5 lbs. for 4 hours at 70°-79°F.
(72 oz. concentration at 1/2 hour)
(42 oz. concentration at 4 hours)
5 lbs. for 5 hours at 60°-69°F.
(72 oz. concentration at 1/2 hour)
(40 oz. concentration at 5 hours)
6 lbs. for 5 hours at 50°-59°F.
(85 oz. concentration at 1/2 hour)
(50 oz. concentration at 5 hours)
6 lbs. for 6 hours at 40°-49°F.
(85 oz. concentration at 1/2 hour)
(48 oz. concentration at 6 hours)

(b) MB in 26" vac. -

3 lbs. for 2 hours at 80°-96°F.
4 lbs. for 2 hours at 70°-79°F.
4 lbs. for 3 hours at 60°-69°F.
4 lbs. for 4 hours at 50°-59°F.
4 lbs. for 5 hours at 40°-49°F.

Either (a) or (b) is required from all countries except Canada and Mexico. Chestnuts from any country enterable from Canada if accompanied by a Canadian certificate attesting to fumigation with MB as specified above.

(2) *Macadamia* for *Cryptophlebia illepida*:

MB at NAP -

2 lbs. for 2 hours at 70°F. or above
2 1/2 lbs. for 2 hours at 60°-69°F.
3 lbs. for 2 hours at 50°-59°F.
3 1/2 lbs. for 2 hours at 40°-49°F.

T-104 - Sweet potatoes (Ipomoea) and Yams (Dioscorea)

Sweet potatoes and yams should be cured, free from surface moisture, and held at the fumigation temperature for 24 hours following treatment.

MB at NAP -

Chamber - 2 1/2 lbs. for 4 hours at 90°-96°F.
3 lbs. for 4 hours at 80°-89°F.
3 1/2 lbs. for 4 hours at 70°-79°F.
4 lbs. for 4 hours at 60°-69°F.

Tarpaulin - 2 1/2 lbs. for 4 1/2 hours at 90°-96°F.
(32 oz. concentration at 1/2 hour)
(20 oz. concentration at 4 1/2 hours)
3 lbs. for 4 1/2 hours at 80°-89°F.
(38 oz. concentration at 1/2 hour.
(24 oz. concentration at 4 1/2 hours)
3 1/2 lbs. for 4 1/2 hours at 70°-79°F.
(44 oz. concentration at 1/2 hour)
(28 oz. concentration at 4 1/2 hours)
4 lbs. for 4 1/2 hours at 60°-69°F.
(50 oz. concentration at 1/2 hour)
(32 oz. concentration at 4 1/2 hours)

Temperatures below 70°F. may cause injury. Fumigation below 70°F. is to be made only on specific request from the importer.

For interstate movement of sweet potato from Hawaii and importations of yam from all foreign countries, this treatment is a precautionary requirement except from Japan, from Dominican Republic into Puerto Rico, or from all of West Indies into U.S. Virgin Islands.

T-105 - Hawaiian Fruits & Vegetables for Fruit Flies

For interstate movement from Hawaii the treatments described below are precautionary requirements for the commodities indicated.

(a) Bitter melon, cavendish banana, Hawaiian bluefield banana, apple banana, green cooking banana, cucumber, fresh litchi fruit, pineapple other than smooth cayenne, string bean, zucchini squash:

EDB at NAP - 8 oz. for 2 hours at 70°F. or above

. Hold banana for 24 hours at 65°F. or above before release or chilling to cooler temperatures.

(b) Papaya - T-102(5)

. Alternate treatments for papaya, pineapple other than smooth cayenne, and zucchini squash - T-106(b)

(c) Avocado:

(1) MB at NAP - 2 lbs. for 4 hours at 70°F. or above

This treatment is marginal as to host tolerance and shipper should be warned of possible injury.

Treatment approved upon issuance of 318.13-4e certification

(2) Alternate treatment

Fumigation plus refrigeration - T-102(1)(a)

(d) Bell pepper, Eggplant - T-106(b)

(e) Tomato:

MB at NAP - 2 lbs. for 3 1/2 hours at 70°F. or above

This treatment is marginal as to host tolerance and shipper should be warned of possible injury.

Alternate vapor heat treatment - T-106(b)

T-106 - Vapor Heat

(a) For *Anastrepha ludens*:

- Grapefruit, orange, tangerine, mango:

  Temperature of fruit gradually raised by saturated water vapor at 110°F. until approximate center of fruit reaches that temperature in 8 hours, then held at 110°F. for 6 hours.

- Alternate procedure for orange and tangerine:

  Temperature of fruit raised by saturated water vapor at 110°F. until approximate center of the fruit reaches that temperature in 6 hours, then held at 110°F. for 4 hours. The raising of the temperature of the fruit to 110°F. must be rapid in the first 2 hours; gradually in the next 4 hours.

- For shipments of grapefruit, orange, tangerine, and mango from Mexico, treatment is a precautionary requirement.

- Alternate treatments:

  Grapefruit, orange, tangerine - EDB-T-102
  Mango - EDB-T-102

(b) For *Ceratitis capitata*, *Dacus dorsalis*, *Dacus cucurbitae*:

- Bell pepper, eggplant, papaya, pineapple other than smooth cayenne, tomato, zucchini squash:

  Temperature of articles raised by saturated water vapor at 112°F. until approximate center reaches that temperature, within a period of time designated by the inspector, held for 8 3/4 hours, then immediately cooled.

  Commodities other than papaya should be exposed to 112°F. to determine each commodity's tolerance to the treatment before commercial treatments are attempted.

- Pretreatment conditioning is an optional prelude to the required treatment, such conditioning being a responsibility of the shipper and in accordance with procedures he believes necessary. For example, it is the practice to condition eggplant at 110°F. at 40% relative humidity for 6 to 8 hours.

T-106 (continued)

For shipments of the listed fruits and vegetables from Hawaii, treatment is a precautionary requirement. For alternate treatment of Hawaiian pineapple and zucchini squash with EDB, see T-105; for alternate treatment of Hawaiian papaya with EDB, see T-102(5); for alternate treatment of tomato, see T-105(e).

T-107 - Cold Treatment

(a) For *Ceratitis capitata* -

10 days at 32°F. or below
11 days at 33°F. or below
12 days at 34°F. or below
14 days at 35°F. or below
16 days at 36°F. or below

Alternate treatment: fumigation plus refrigeration - T-108

(b) For *Anastrepha ludens* -

18 days at 33°F. or below
20 days at 34°F. or below
22 days at 35°F. or below

(c) For other species of *Anastrepha* -

11 days at 32°F. or below
13 days at 33°F. or below
15 days at 34°F. or below
17 days at 35°F. or below

(d) For *Dacus tryoni* -

13 days at 32°F. or below
14 days at 33°F. or below

(e) For *Cryptophlebia leucotreta* -

22 days at 31°F. or below

If the temperature exceeds 31.5°F., the treatment shall be extended 1/3 of a day for each day or part of a day the temperature is above 31.5°F. If the temperature exceeds 34°F. at any time, the treatment is nullified.

Notes: Pulp of the fruit must be at or below the indicated temperature at time of beginning treatment (for all T-107 treatments).

Fruits for which cold treatment is authorized as a condition of entry and approved countries of origin:

T-107 (continued)

Albania	ethrog
Algeria	ethrog, grape*, grapefruit, pear, plum, orange, tangerine
#Argentina	apple, apricot, cherry, grape, nectarine, peach, pear, plum, pomegranate, quince
#Australia	apple, pear
Austria	grape*
Bolivia	grapefruit, orange
Brazil	grape
Belize (British Honduras) .	grapefruit, orange, tangerine
Bulgaria	grape*
#Chile	apple, apricot**, cherry, grape**, nectarine**, peach**, pear, plum**
Colombia	ethrog, grapefruit, orange, plum, tangerine, grape
Costa Rica	ethrog, grapefruit, orange, tangerine
Corsica	ethrog
Cyprus	ethrog, grape*
Ecuador	grapefruit, orange, tangerine
Egypt	grape*, orange, pear
El Salvador	grapefruit, orange, tangerine
France	apple, ethrog, grape*, pear
Germany (West) . . .	grape*
Greece	ethrog, grape*, orange
Guatemala	grapefruit, orange, plum, tangerine
Guyana	orange
Haiti	pomegranate
Honduras	grapefruit, orange, tangerine
Hungary	apple, grape*
Israel	ethrog, grape*, grapefruit, orange, plum, pomegranate, tangerine
Italy	apple, ethrog, grape*, grapefruit, peach, orange, pear, persimmon, tangerine
Libya	ethrog, grape*
Luxembourg	grape*
Mexico	apple, grapefruit, orange, plum, tangerine
Morocco	ethrog, grape*, grapefruit, orange, peach, pear, plum, tangerine
Nicaragua	ethrog, grapefruit, orange, tangerine

T-107 (continued)

Panama	ethrog, grapefruit, orange, tangerine
Portugal	ethrog, grape*
Peru	grape
#Rep. of So. Africa . .	apple, apricot, grape, nectarine, orange, passion fruit, peach, pear, plum
Spain	ethrog, grape*, grapefruit, orange, tangerine, pear
Surinam	grapefruit, orange, tangerine
Switzerland	grape*
Syria	ethrog, grape
Tunisia	ethrog, grape*, grapefruit, orange, peach, pear, plum, tangerine
Turkey	ethrog
Uruguay	apple, grape, nectarine, peach, pear
USSR	grape*
Venezuela	grapefruit, orange
Yugoslavia	ethrog

See special provisions in Section M319.56-2-A regarding fruits from these countries.

* T-101(e) also required.

** T-101(a or b) also required.

Treatment upon arrival may be accomplished at northern ports as named in the permits; treatment in transit may be authorized for specifically equipped and approved vessels and from approved countries for entry at ports named in the permits. Intransit cold treatment authorization must be preceded by a visit to the country of origin by an Agricultural Quarantine official to explain loading, inspection, and certification procedures to designated certifying officials of country of origin. Refrigerated compartments on carrying vessels and cold storage warehouses must have prior approval by Agricultural Quarantine. Authorization of cold treatments from countries with direct sailing time less than the number of days prescribed for intransit refrigeration treatment must be contingent on importer understanding that prescribed intransit refrigeration period must be met before arrival of vessel at the approved U.S. port.

T-108 - Fumigation Plus Refrigeration of Fruits

(a) For *Ceratitis capitata* and *Dacus dorsalis*:

Chamber or tarpaulin: 2 lb. MB/1,000 ft.^{3} at 70°F. or above (Chamber load not to exceed 80% of volume).

Fumigation Exposure	Regrigeration
(1) 2 hours	4 days at 33°-37°F. or 11 days at 38°-47°F.
(2) 2 1/2 hours	4 days at 34°-40°F. or 6 days at 41°-47°F. or 10 days at 48°-56°F.
(3) 3 hours	3 days at 43°-47°F. or 6 days at 48°-56°F.

Minimum concentrations for above fumigations.

(25 oz. concentration at 1/2 hour)
(18 oz. concentration at 2 or 2 1/2 hours)
(17 oz. concentration at 3 hours)

Exception: For grapes from Algeria, Austria, Bulgaria, Cyprus, Egypt, France, Germany, Greece, Hungary, Israel, Italy, Libya, Luxembourg, Morocco, Portugal, Spain, Switzerland, Syria, and USSR only (2) or (3) may be used. For avocado use T-102(1)(a).

Some varieties of fruit may be injured by the 3-hour exposure. Importers should be encouraged to test treat before making commercial shipments.

Aerate all fruit at least 2 hours following fumigation.

Time lapse between fumigation and start of cooling not to exceed 24 hours.

Approved country of origin and fruits for which T-108 is authorized as a condition of entry:

Albania	ethrog
Algeria	ethrog, grape, pear, plum
Austria	grape
Bulgaria.	grape
Chile	apple, apricot, cherry, grape, nectarine, peach, pear, plum

Corsica	ethrog
Cyprus	ethrog, grape
Egypt	grape, pear
France	apple, ethrog, grape, pear
Germany (West). . .	grape
Greece	ethrog, grape
Hungary	apple, grape
Israel	ethrog, grape, plum
Italy	apple, ethrog, grape, peach, pear
Libya	ethrog, grape
Luxembourg	grape
Morocco	ethrog, grape, peach, pear, plum
Portugal	ethrog, grape
Spain	ethrog, grape, pear
Switzerland	grape
Syria	ethrog, grape
Tunisia	ethrog, grape, peach, pear
Turkey	ethrog
USSR	grape
Yugoslavia	ethrog

(b) For light brown apple moth complex - *Epiphyas* spp.

Chamber or tarpaulin: MB at NAP - Exposure 2 hours

2 lbs. at 41°-49°F.
(30 oz. minimum concentration at 1/2 hour)
(25 oz. minimum concentration at 2 hours)

1 1/2 lbs. at 50°-59°F.
(23 oz. minimum concentration at 1/2 hour)
(20 oz. minimum concentration at 2 hours)

Load not to exceed 80%

Refrigeration for 21 days at 33°F. or below

Time lapse between fumigation and start of cooling not to exceed 24 hours.

T-109 - Refrigeration Plus Fumigation of Fruits

For *Epiphyas* spp. in apples and pears

Refrigeration for 21 days at 33°F. or below

MB at NAP - Chamber or tarpaulin:

3 lbs. for 2 hours at 40°-59°F.
(44 oz. minimum concentration at 1/2 hour)
(36 oz. minimum concentration at 2 hours)

2 1/2 lbs. for 2 hours at 60°-69°F.
(36 oz. minimum concentration at 1/2 hour)
(28 oz. minimum concentration at 2 hours)

2 lbs. for 2 hours at 70°-79°F.
(30 oz. minimum concentration at 1/2 hour)
(25 oz. minimum concentration at 2 hours)

Load not to exceed 80%.

T-110 - Quick Freeze

Initial freezing at subzero temperatures. Subsequent storage and transportation at 0°F. or below is preferred but in no instance may temperature exceed 20°F.

All fruits and vegetables enterable from all foreign countries after receiving the above treatment as specified in CFR 319.56-2c. Also, interstate movement of all fruits and vegetables from off-shore areas of the United States is authorized in the frozen state after being quick frozen.

Exceptions:

Avocado with seed not enterable from Mexico, Central America, and South America.

Citrus with peel not enterable from countries listed in CFR 319.28.

Mango with seed not enterable from Oceania, Hawaii, Southeastern Asia, Philippines, and the Republic of South Africa. Black currant enterable only to areas specified in permit.

APPENDIX X

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