

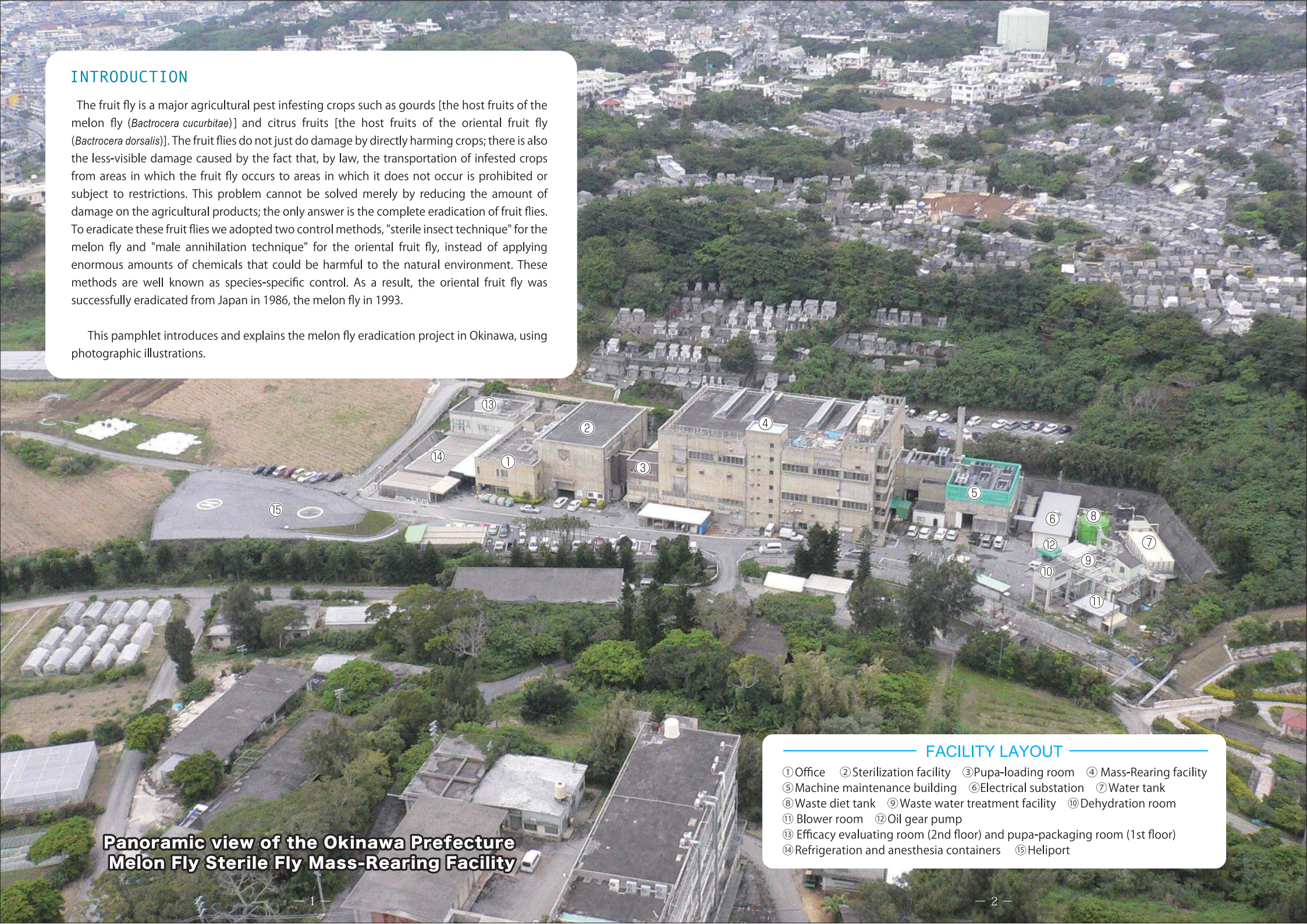
MELON FLY ERADICATION PROJECT IN OKINAWA, JAPAN



INTRODUCTION

The fruit fly is a major agricultural pest infesting crops such as gourds [the host fruits of the melon fly (*Bactrocera cucurbitae*)] and citrus fruits [the host fruits of the oriental fruit fly (*Bactrocera dorsalis*)]. The fruit flies do not just do damage by directly harming crops; there is also the less-visible damage caused by the fact that, by law, the transportation of infested crops from areas in which the fruit fly occurs to areas in which it does not occur is prohibited or subject to restrictions. This problem cannot be solved merely by reducing the amount of damage on the agricultural products; the only answer is the complete eradication of fruit flies. To eradicate these fruit flies we adopted two control methods, "sterile insect technique" for the melon fly and "male annihilation technique" for the oriental fruit fly, instead of applying enormous amounts of chemicals that could be harmful to the natural environment. These methods are well known as species-specific control. As a result, the oriental fruit fly was successfully eradicated from Japan in 1986, the melon fly in 1993.

This pamphlet introduces and explains the melon fly eradication project in Okinawa, using photographic illustrations.



FACILITY LAYOUT

- ① Office
- ② Sterilization facility
- ③ Pupa-loading room
- ④ Mass-Rearing facility
- ⑤ Machine maintenance building
- ⑥ Electrical substation
- ⑦ Water tank
- ⑧ Waste diet tank
- ⑨ Waste water treatment facility
- ⑩ Dehydration room
- ⑪ Blower room
- ⑫ Oil gear pump
- ⑬ Efficacy evaluating room (2nd floor) and pupa-packaging room (1st floor)
- ⑭ Refrigeration and anesthesia containers
- ⑮ Heliport

**Panoramic view of the Okinawa Prefecture
Melon Fly Sterile Fly Mass-Rearing Facility**

THE MELON FLY

As its name indicates, the melon fly is a major agricultural pest that affects live fruits and vegetables, primarily cucurbit crops (bitter cucumber, cucumber, watermelon, etc.). The distribution (see figure below) and biology of this pest are similar to those of the oriental fruit fly, and their host ranges partly overlap. The melon fly belongs to Diptera, Tephritidae, and Bactrocer, and the scientific name is *Bactrocera cucurbitae* Coquillett.

The adult fly is 8 - 9 mm in length and a warm brownish-to-reddish yellow in color. The egg is 1.1 - 1.4 mm long, milky white in color, and curved in banana-like shape. The larva is maggot-like in shape and milky white in color in youth, with mature larvae displaying a yellow color in the later third instar. The mature larva is approximately 12 mm in length. The larva spends its 4th instar in the puparium, which is the cast-off skin of the 3rd instar larva. It subsequently becomes a pupa in the puparium after moulting. The puparium is a yellow-brown in a barrel-shape, 4.8 - 6.0 mm in length.



Melon fly distribution

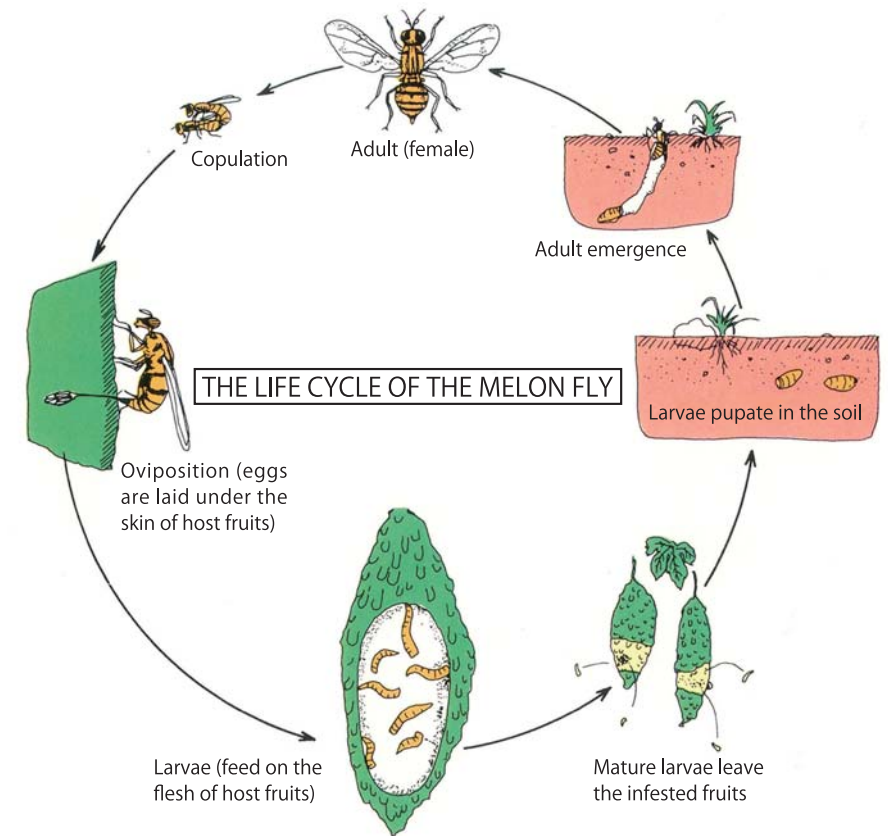


Adult melon fly



Melon fly pupa in puparium

In hot season, the adult melon fly limits its activities to the cooler morning and evening periods, during the day, it often rests on the undersurfaces of a large leaf. Adults ingest protein and other nutrients from plant sap, honeydew of scale insects and aphids, etc. Adult flies begin to copulate 9-12 days after emergence and lay eggs. They mate in the evening and continue copulation until dawn. A mated female fly lays 2-30 eggs at a time, and occasionally more than 1,000 eggs during her lifetime. The female lays eggs generally under the skin of young and/or soft fruit and sometimes in the bud. The longevity of the adult melon fly is 1 - 5 months. The egg hatches within about 27 hours after oviposition under 27-28°C. The larval period generally lasts 4 - 7 days, but there is substantial variation depending on nutrition and temperature. The mature larva leaves the host fruit, move by crawling and jumping, and burrow into the ground to pupate. The pupal period, including the prepupal period, is 7-13 days. The threshold temperature for growth of the egg and larva, and pupa is 10 and 9°C, respectively. Under optimal conditions, one generation time is approximately one month. In Okinawa, approximately 8 generations are produced in a year.



Before eradication of the fruit flies, the following agricultural products had been regulated or prohibited from transportation from Okinawa Prefecture to uninfested areas in Japan by Japanese Plant Protection Law.

Transportation allowed after inspection	Fresh fruit of watermelon, wax gourd, squash
Transportation allowed after disinfection treatment	Fresh fruit of tomato, papaya, green pepper, mango, musk-melon, bitter cucumber, cucumber, string beans
Transportation prohibited	Fresh fruit, bud and stem of luffa and other cucurbit crops Fresh fruit of eggplant, cowpea, etc.

MELON FLY ERADICATION PROJECT IN OKINAWA PREFECTURE

Since the melon fly was first discovered in the Yaeyama Islands in 1919, its distribution had expanded as shown in the figure below.

On Kume Island, an experimental melon fly eradication project started in 1972. They had been successfully eradicated in 1978. Following its successful eradication on Kume Island, the eradication project for all of Okinawa Prefecture was initiated in 1979.

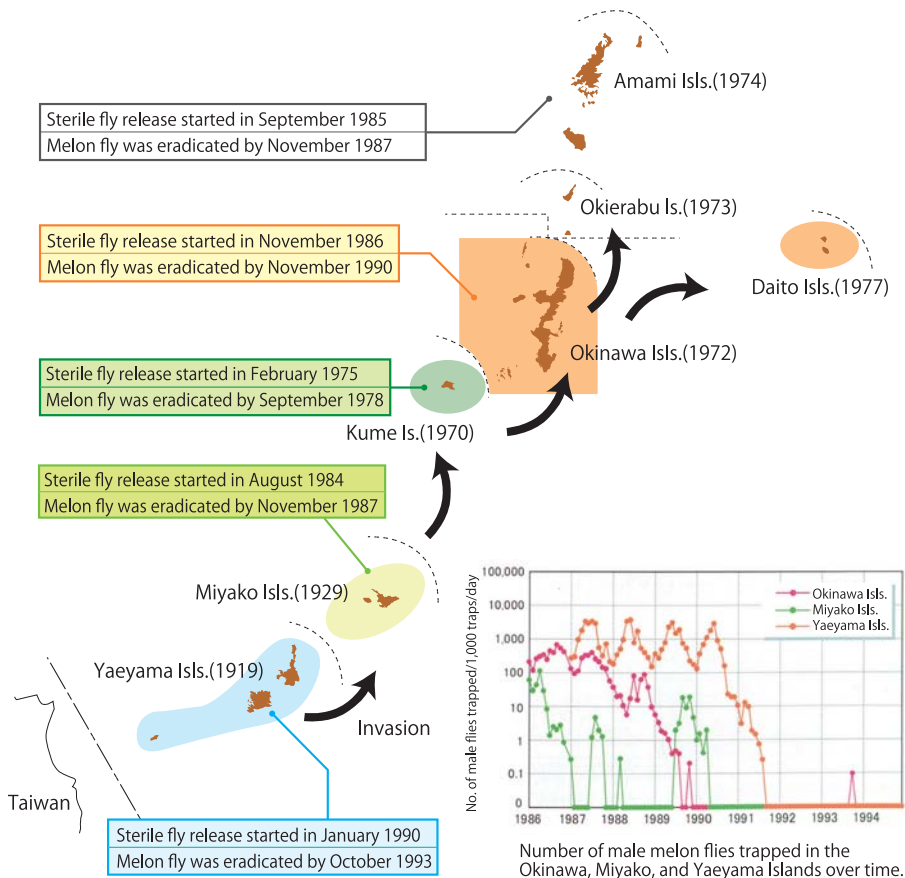
Construction of the melon fly mass-rearing facility, capable of rearing 30 million pupae per week, was started in 1980 and completed in 1982. The irradiation facility was completed in 1983. Sterile fly release using a new release technique (chilled adult release system) by helicopter began in the Miyako Islands in August 1984.

Construction to expand the mass-rearing facility to increase production to more than 100 million pupae per week began in 1984 and ended in 1986.

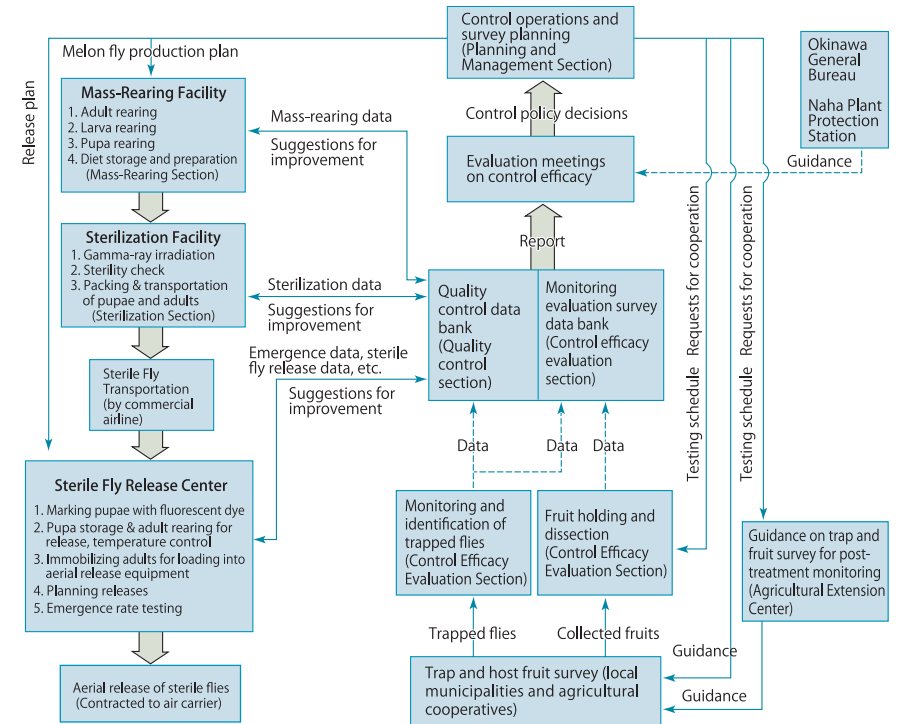
The sterile fly release started in November 1986 throughout the Okinawa Islands.

The fly was successfully eradicated by November 1987 in the Miyako Islands, by November 1990 in the Okinawa Islands, and by October 1993 in the Yaeyama Islands, respectively.

SPREAD AND ERADICATION OF THE MELON FLY IN JAPAN



FLOWCHART OF THE MELON FLY ERADICATION PROJECT IN OKINAWA



CHRONOLOGICAL TABLE OF MELON FLY ERADICATION PROJECT

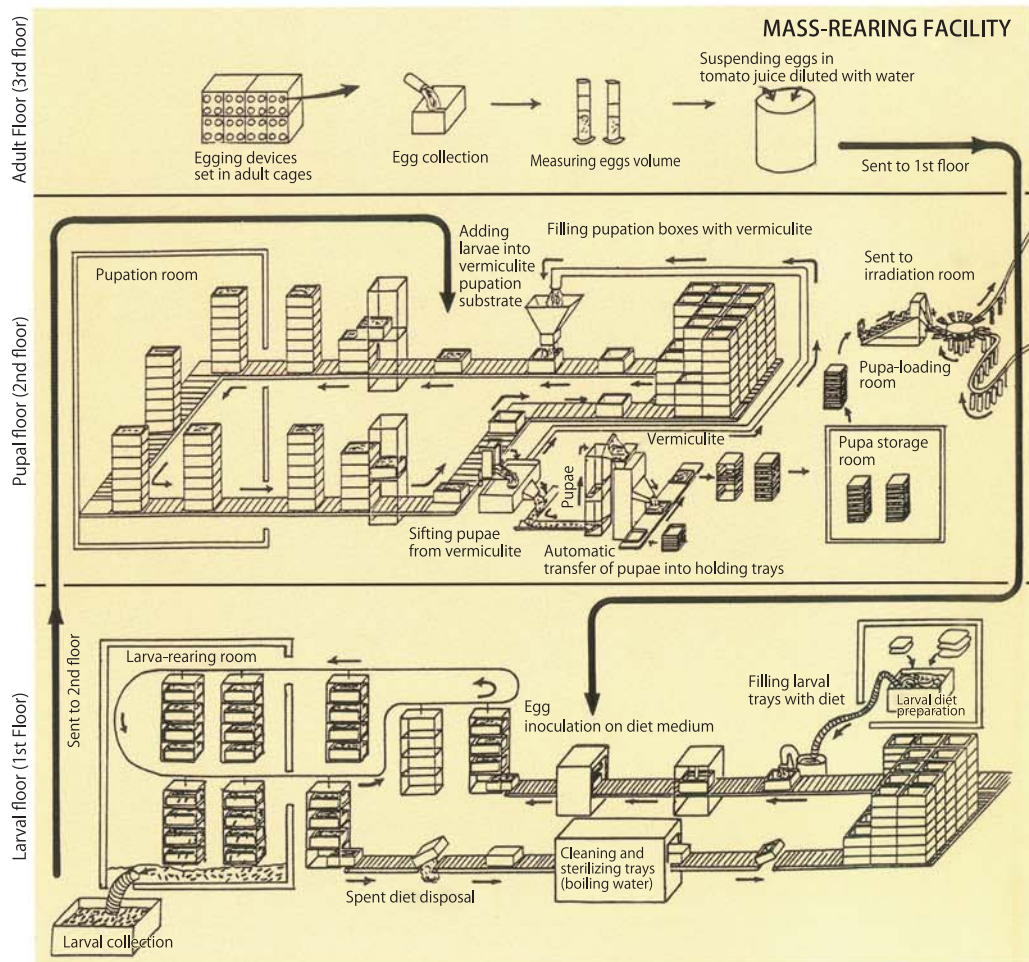
Fiscal Year (Apr.-Mar.)		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Facilities Installation Plan	(1) Mass-Rearing Facility	Conceptual design	Detailed design Building construction	Equipment installation				Internal equipment upgrade									
	(2) Sterilization Facility		Conceptual design	Detailed design	Building construction & equipment installation		Source installation (Cobalt 60, 39,900 Ci)	Radiation source upgrade (Total 103,700 Ci, June 1986)									
	(3) Sterile Fly Holding and Packaging Facility and Heliport					Miyako Isls.	South & Central Okinawa	North Okinawa				Yaeyama Isls.					
Sterile Fly Production (no. of pupae/ week)							30million	30-100 million				150-200 million					70million
Melon Fly Eradication Schedule	(1) Miyako Islands					Population suppression	Sterile fly releases	Eradication confirmation									
	(2) Okinawa Islands South & Central North						Population suppression	Sterile fly releases	Eradication confirmation								
	(3) Yaeyama Islands							Population suppression	Sterile fly releases	Eradication confirmation							

THE PRINCIPLE BEHIND THE STERILE INSECT TECHNIQUE (SIT)

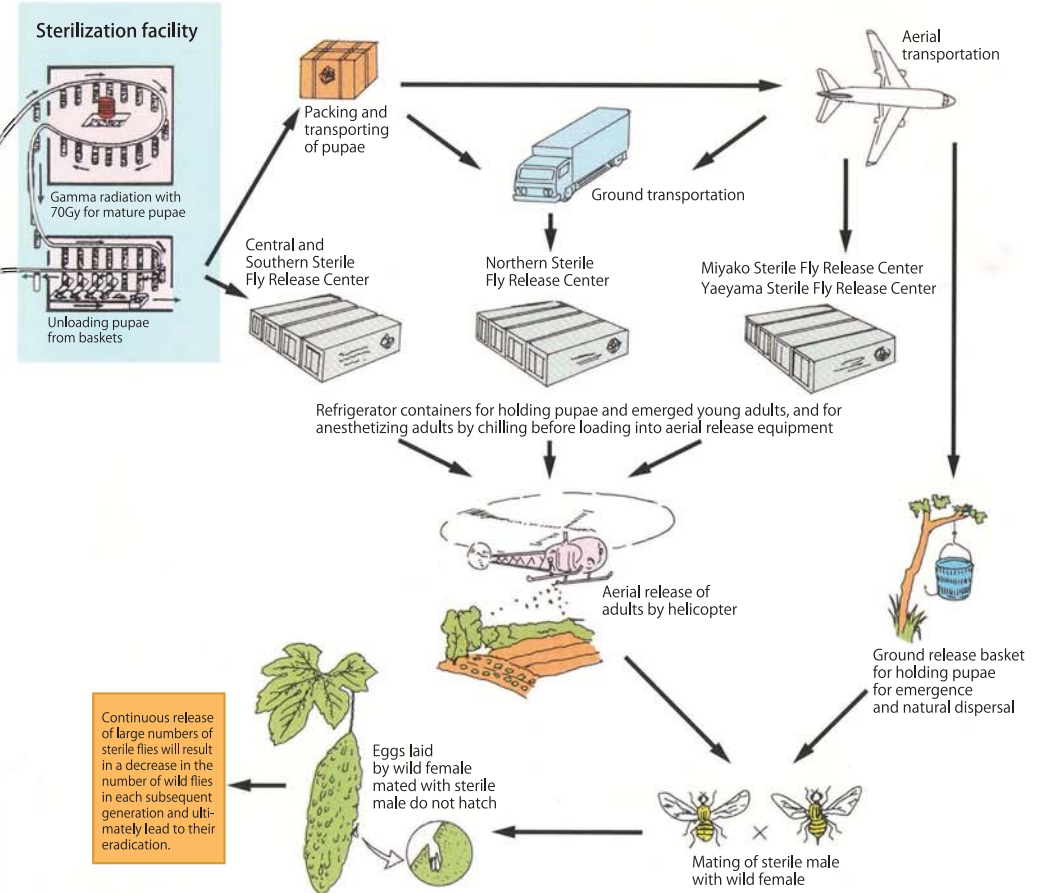
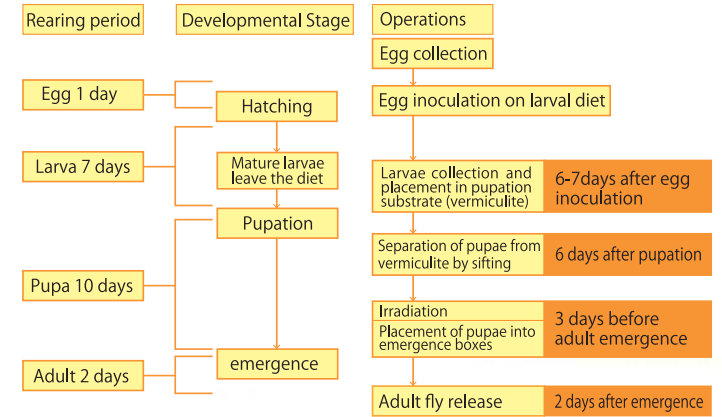
The "Sterile Insect Technique (SIT)" has been used to control the melon fly in Okinawa Prefecture. Its principle is as follows. When we a) artificially produce an enormous number of target species to be controlled, b)sterilize with gamma-radiation (or another treatments) without any harmful effect on their normal activity (i.e. they can mate normally), c) continuously release many more sterile insects than wild insects in the target area, mating chances of wild females and wild males should decrease with time. Wild flies that copulate with sterile flies cannot produce offspring. Thus, the natural population will decrease until eradication.

In application of SIT for the melon flies, the artificial mass-production, sterilization, release method, and efficacy evaluation method of released sterile flies in the field are very important. At the same time, quality control for all these production processes is also very important to maintain high quality sterile flies to be released.

*Scales and figures illustrated after p.9 are at the maximum production period.



MELON FLY MASS-REARING, STERILIZATION, AND RELEASE PROCEDURES



MASS-REARING



(1) Preparation of squash juice



(2) Insertion of eggging devices containing squash juice into the adult cages.



(3) Oviposition (the plastic eggging devices have many small holes 0.5 mm in diameter). Females insert their ovipositors through the holes to lay eggs.)

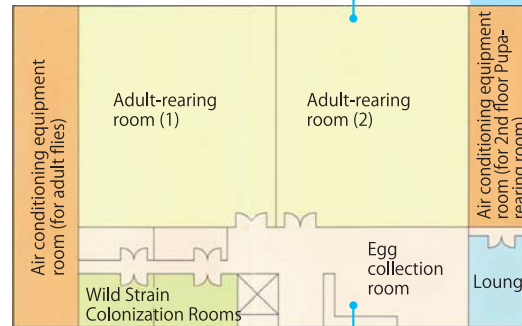


ADULT REARING

To collect eggs for mass-rearing, adults are reared in 480 cages in two adult rearing rooms. The adult rearing room is kept at a temperature of 27°C with a relative humidity of 60%. Each cage contains about 50,000 adult flies. The flies are fed an artificial diet consisting of sugar, autolyzed yeast, and water. They are reared for six weeks following emergence, and replaced with newly emerged mass-reared adults in the sixth week.

Female flies lay eggs during the day inside the eggging devices inserted into the adult cages. Each morning the eggging devices are removed from the cages and the eggs are collected by flushing with water.

Composition of Adult-Rearing Diet
sugar: autolyzed yeast = 4:1



Melon Fly Mass-Rearing Facility (3rd Floor)



(4) Eggs laid inside the eggging device (length of the egg is approximately 1.3 mm.)



(8) Eggs are suspended in tomato juice diluted with water to facilitate their even distribution on the diet.



(7) Measuring egg volume (1 ml = approximately 12,000 eggs)



(6) Eggs are collected by flushing the eggging devices with water.

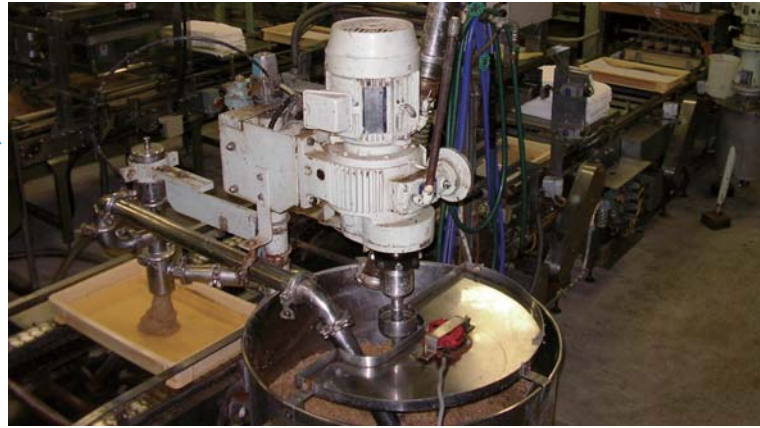


(5) Removing the eggging devices from the cages.

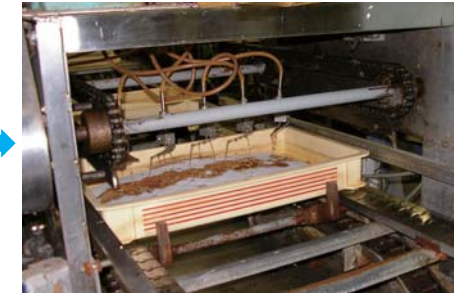
Sent to 1st floor



(1) Artificial larval diet mixing



(2) Diet supply and egg inoculating line (60 liters of diet per tray)



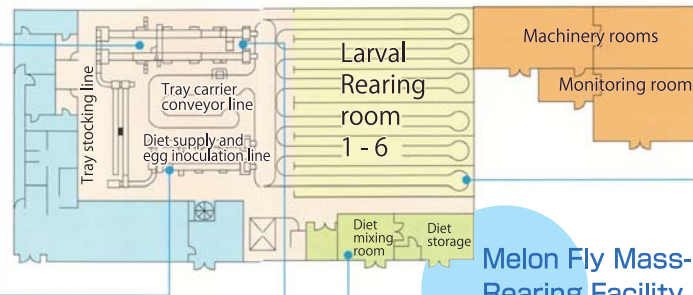
(3) Egg inoculation (appx. 90,000 eggs per tray)

LARVAL REARING

There are six larval rearing rooms, each capable of holding 960 rearing trays. Relative humidity in the rooms is maintained at 80%, while temperature is adjusted between 20-28°C, depending on larval development. Each larval tray is automatically filled with 6 liters of artificial diet and inoculated with around 90,000 eggs. The trays are held for 7 days after the inoculation and mature larvae are collected on the 5th, 6th, and 7th days.



(4) Inside the larval rearing room (floor covered with water)



Melon Fly Mass-Rearing Facility (1st Floor)

Composition of the artificial larval diet			
Amount required to produce 1 liter diet feeding 10,000 pupae			
Wheat bran	153 g	Sugar	66g
Defatted soy flour	33g	Brewer's yeast	33g
Coarse tissue paper	26g	Sodium benzoate	1g
HCl (3.5%)	23ml	Water	816 ml



(7) Spent diet disposal, tray washing.



(6) Larval collection (larvae in the water are collected by draining into a screened container and sent to the 2nd floor for pupation).



(5) Mature larvae leaving the trays (the larvae fall into the water and enter state of suspended animation)



(1) Larvae transferred from the 1st floor are collected in containers.



(2) Pupation trays are filled with vermiculite.



(3) Larvae are placed in the pupation trays.



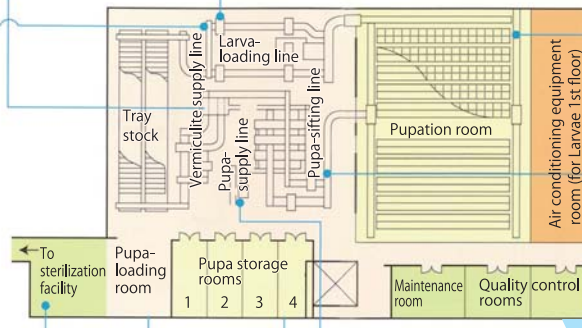
(4) Pupation room (the larvae burrow into the vermiculite to pupate)

PUPAL REARING

The pupation room is capable of holding 5,400 pupation trays. Room temperature is maintained at 25°C, and relative humidity at 60%. A pupation tray holds 10 liters of vermiculite and around 40,000 larvae.

On the fifth or sixth day after pupation, the pupae are sifted out of the vermiculite with an automatic sifting device. The pupae are thinly spread on trays held on racks and stored in the pupa storage rooms.

The development of the pupae is controlled by adjusting the room temperature from 20 to 27°C at 80% relative humidity.



Melon Fly Mass-Rearing Facility (2nd Floor)



(5) Sifting pupae from vermiculite with automatic sifters.



(8) Putting pupae into irradiation baskets.



(7) Pupa Storage racks (appx. 120,000 pupae per tray)



(6) Sifted pupae are automatically weighed and placed on pupal trays.

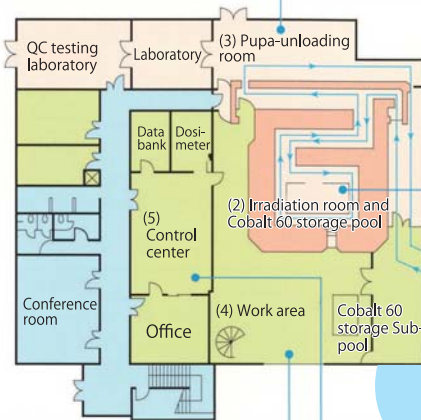
STERILIZATION

The pupae produced in the Mass-Rearing Facility are sterilized by 70 Gy of gamma radiation from a cobalt 60 source at 3 days before emergence. This facility is connected by a conveyor system to the mass-rearing facility and the pupae are conveyed to the radiation unit automatically.

The Irradiation Room is surrounded by a 2-meter-thick concrete radiation shield to prevent any leakage of radiation to the outside.



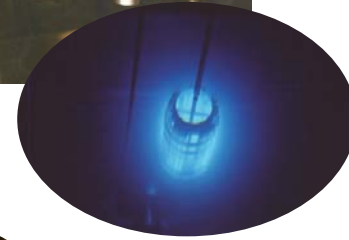
(3) Pupa-unloading equipment (irradiated pupae are unloaded and conveyed to the Sterile fly release center).



Melon Fly Sterilization Facility



(2) Inside the irradiation room



Cobalt 60 in water storage pool (showing Cherenkov effect).



(1) Pupa-loading room



(1) Pupa-loading equipment (loading pupal irradiation baskets).



(4) Exterior of the irradiation room: manipulator and lead glass (in the middle), water treatment control panel and sub-pool for temporary storage of Cobalt 60 source during maintenance (on the right).



(5) Irradiation system control center (pupa-loading, transfer, irradiation, and unloading are monitored by computers to ensure safety and accuracy).

(Blue lines show routing of pupal irradiation baskets)

STERILE MELON FLY RELEASE CENTER

PACKING AND TRANSPORTATION

TRANSPORTATION OF PUPAE



(1) Unloading pupae from irradiation baskets.



(2) Packing pupae for transportation.



(3) Transporting pupae to the Miyako, Yaeyama, Kume Islands, and the northern Okinawa.



Transporting containers with flies immobilized by chilling to the Daito Islands.

MELON FLY RELEASE

CHILLED ADULT (STERILE FLY) RELEASE SYSTEM



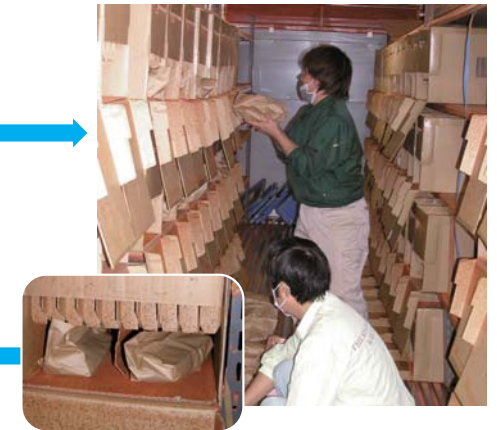
(1) Marking pupae with fluorescent dye



(2) Assembling adult emergence box.



(3) Putting pupae into small paper bags (20,000/bag)



(4) Placing bags containing pupae into emergence box (2 bags/box)



(5) Collecting flies immobilized by chilling (3°C) after emergence.



(6) Putting immobilized flies into adult release equipment.



(7) Loading release equipment onto a helicopter



(8) Around 4 million adults are released during each flight.

GROUND RELEASE OF ADULTS

Adults are released on the ground on the Miyako and Daito Islands.



(1) Adults immobilized by chilling



(2) Ground release of adults.



(3) Released adults

GROUND RELEASE OF PUPAE

Pupae are released on the ground on the Kume and Yonaguni Islands.



(1) Transporting pupae to Yonaguni Is.



(2) Marking pupae with fluorescent dye.



(3) Putting pupae into small paper bags.



(5) Emerged adults



(4) Pupae are placed in hanging baskets.

AERIAL RELEASE OF ADULTS IN PAPER BAGS

On the Kerama and Tarama Islands, adults in paper bags were released.



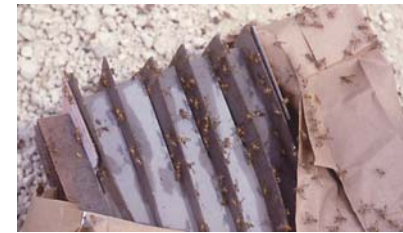
(1) Putting marked pupae into paper bags containing latticed partitions coated with sugar.



(2) The paper bags are sealed and maintained at 25°C for emergence.



(3) Loading the paper bags into helicopter.



(5) The dropped paper bag on ground.



(4) The bags were dropped from the helicopter.

STERILE FLY RELEASE CENTER



Central and Southern Sterile Fly Release Center



Northern Sterile Fly Release Center

Northern Heliport for sterile fly release



Miyako Sterile Fly Release Center



Yaeyama Sterile Fly Release Center

SYSTEM EVALUATION

TRAP SURVEY

Many monitoring traps with cue-lure (male attractant) and insecticide are placed throughout the target areas to evaluate the system efficacy. Once every two weeks, project personnel from the various municipalities and agricultural cooperatives service the traps and collect the flies.



(1) Trap servicing by project personnel.



(2) Trapped insects are immediately sent to Okinawa Prefectural Plant Protection Center for identification and counting.



Testes

(3) Trapped flies are examined in the following manner to determine whether they are sterile or wild.



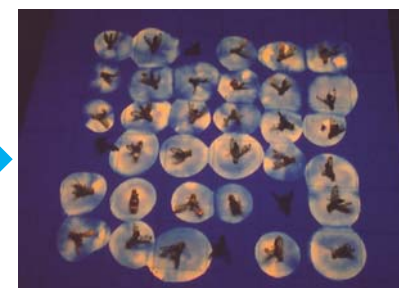
(a) Collected flies are placed on filter paper. A drop of Acetone + Alcohol (4:1) is applied on each fly to dissolve the fluorescent dye.



(b) The specimens on the filter paper are examined under ultra-violet light. The dye fluoresces when irradiated by ultra-violet rays.



(c) The specimens that fluoresce are considered to be released, sterile flies.



Glowing flies are sterile



(d) Testes of flies that do not fluoresce are removed by dissection, stained with dye, and examined under a microscope to determine whether each fly was sterile or not.

(4) All collected project data are filed and processed on computers.



FRUIT SURVEY

To evaluate the efficacy of the sterile insect release method, host fruits are surveyed in parallel with the monitoring trap survey.



(1) Cultivated and wild cucurbit fruits are collected



(2) Collected fruits are held in boxes.



(3) Collected fruits are checked for the presence of larvae by dissection.

Host Plants



Striped cucumber
(*Diplocyclos palmatus*)



Papaya (*Carica papaya*)



Tomato (*Lycopersicon esculentum*)



Infested bitter cucumber
(*Momordica charantia*)

Larvae infesting a fruit



QUALITY CONTROL

It is important for the effective SIT to keep the quality of the mass-reared melon flies always similar to that of wild melon flies. In order to this, the current conditions of the fly is constantly monitored.

Insect Stage	Qualities Investigated	
Adult for Egg Production	No. of generations, no. of eggs collected per age, total no. of eggs collected, survival rate	
Egg	Hatching rate	
Larva	Temperature of rearing medium, percentage of larvae remaining in the medium at time of diet disposal	
Pupa	Individual pupal weight, total pupal weight, total number of pupae produced, diameter of the pupa, pupation rate	
Adult	Before Irradiation After Irradiation Monitoring Sterilization Miyako Islands, Yaeyama Islands Upon Arrival At Time of Release Central and Southern Parts of Okinawa Islands After Marking At Time of Release	Emergence rate, flight capability rate Emergence rate, flight capability rate, emergence pattern Sterilization rate, survival rate Emergence rate, flight capability rate Emergence rate, survival rate, flight capability rate, number released Emergence pattern, emergence rate, flight capability rate Emergence rate, survival rate, flight capability rate, number released

All data are centrally managed by computer.



Checking survival rate



Pupal weight measurement



Checking adult emergence rate



Checking flight capability rate

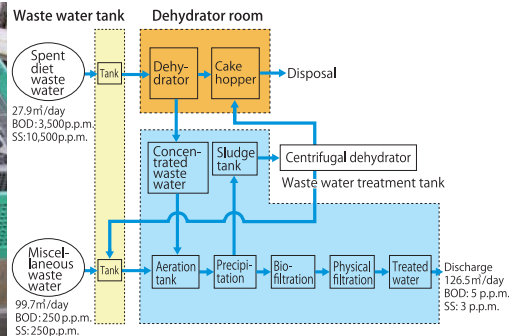
OTHER FACILITIES



- ① **Machine maintenance building**
Air conditioner: Cooling capacity 237,000 kcal/h x 6
Boiler: Rated evaporating output 2.4 t/h x 3
Control center: operating and monitoring electricity and air conditioner
Generator: Voltage 6,600 V
 Rated capacity 625 KVA
- ② **Electrical substation**
 Receiving Voltage 6,600 V
 Receiving Capacity 1,875 KVA
- ③ **Water tank**
 120,000 liter capacity
- ④ **Waste water treatment tank**



Air conditioning facility



Boiler



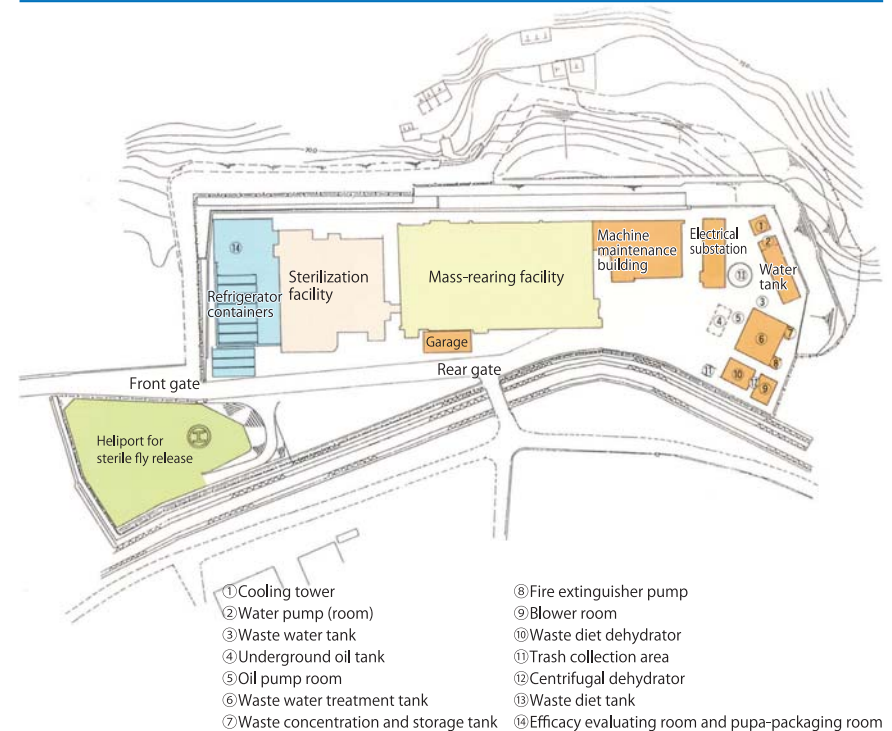
Aeration (tank)

FACILITY SPECIFICATIONS

Facility	Area (m ²)	Remarks
Mass-rearing facility	3,979.82	Adult rearing room (3rd floor), Pupa rearing room (2nd floor), Larva rearing room (1st floor).
Sterilization facility	1,498.66	Office, irradiation room, pupa-loading room.
Machine maintenance building	319.30	Control center, boiler room, generator room.
Efficacy evaluating room and pupa-packaging room	380.60	Efficacy evaluating room (2nd floor), Pupa-packaging room (1st floor)
Subtotal	6,178.38	
Others	201.88	Electrical substation, oil pump, fire extinguisher pump, waste diet dehydrator
Total	6,380.26	Total construction cost: ¥ 3,580,000,000 (National budget: ¥ 2,610,000,000, Prefectural budget ¥ 970,000,000)

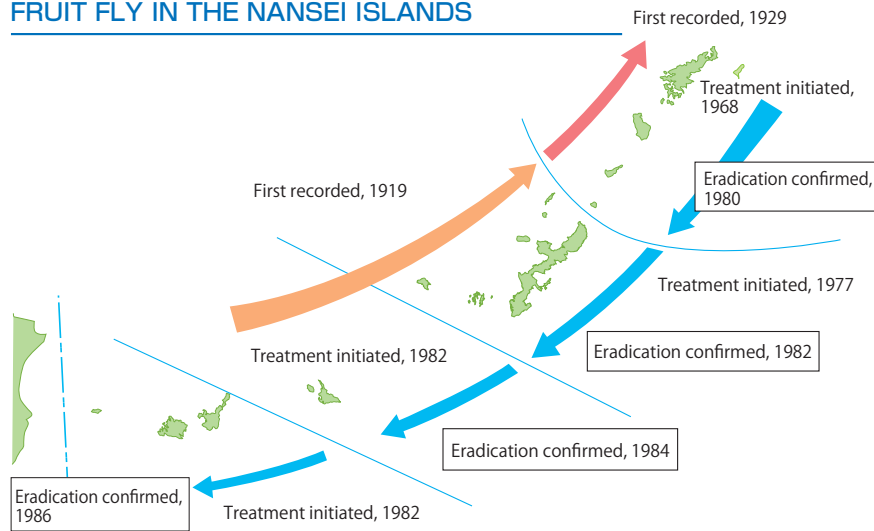
[Site area: 18,131 m² (developed area 9,832 m²), construction cost: 110 million yen (Prefectural budget: 110 million yen)]
 [Heliport for sterile fly release (Central and Southern Okinawa) 1,077.70 m², construction cost: 30 million yen (Prefectural budget: 30 million yen)]

FACILITY LAYOUT OF THE OKINAWA PREFECTURAL PLANT PROTECTION CENTER



SUMMARY OF THE ORIENTAL FRUIT FLY ERADICATION PROJECT

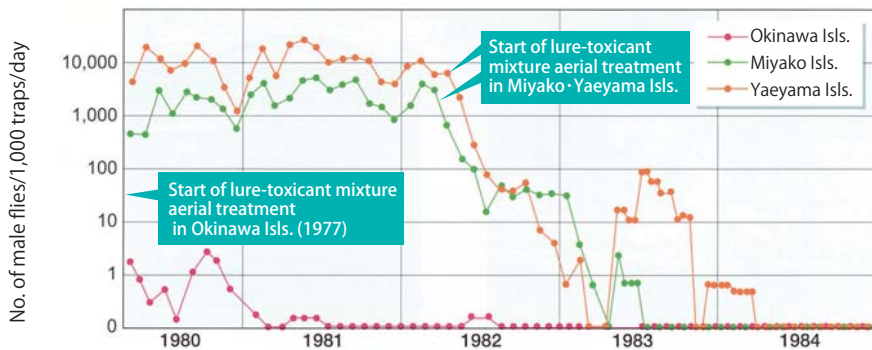
SPREAD AND ERADICATION OF THE ORIENTAL FRUIT FLY IN THE NANSEI ISLANDS



Item	Okinawa Isls	Miyako Isls	Yaeyama Isls	Total	
Target area (A)	144,000ha	23,000ha	58,000ha	225,000ha	
Cumulative treated area (B)	5,412,000ha	605,000ha	2,210,000ha	8,227,000ha	
(B)/(A)	38	27	38	37	
Total No. of Fiber Blocks Distributed(C)	9,446,000	1,372,000	5,248,000	16,066,000	
(C)/(A)	66/ha	60/ha	91/ha	72/ha	
Program Cost	JPY1,541,000,000	JPY214,000,000	JPY820,000,000	JPY2,575,000,000	
Period (years)	Start	10/1977	4/1982	4/1982	1977
	End	8/1982	11/1984	2/1986	1986
No. of Personnel Involved	91,000	8,000	11,000	110,000	



Oriental Fruit Flies



Transition in the numbers of male oriental fruit flies trapped in the Okinawa, Miyako and Yaeyama Islands.

ORIENTAL FRUIT FLY ERADICATION METHOD (MALE ANNIHILATION)

The male oriental fruit fly is strongly attracted to methyl-eugenol, a constituent of citronella oil, which is used as a flavoring agent. Using this characteristic, it is possible to remove the males from the wild population by distributing ample amounts of fiber board blocks (4.5 x 4.5 x 0.9 cm, impregnated with 10 g of 75-80% methyl eugenol and insecticide) in the target area. Continuous removal of the males by this method reduces the chances for mating by the females and leads to the ultimate eradication of this pest.

GROUND APPLICATION

In residential areas, fiber board blocks are suspended manually from tree branches at the rate of 4/ha.



The fiber board blocks with lure-toxicant mixture are suspended in the shade and high enough to be out of reach of children.



Male oriental fruit flies are attracted and killed by the lure-toxicant mixture.

AERIAL APPLICATION

Helicopters drop an average of 2 fiber board blocks per hectare over mountains terrain and agricultural areas.



Main hosts of the oriental fruit fly: Citrus fruits, peach, prune, date plum, loquat, tomato, green pepper, eggplant, papaya, mango, guava, banana, etc.

Larvae infesting a mandarin orange

CHRONOLOGY OF THE ERADICATION OF THE MELON FLY IN OKINAWA PREFECTURE

Date	Relevant events
1919	Dr. Tokuichi Shiraki, a technician at Agricultural Experiment Station of the Taiwan Governor-General's Office, reported that the melon fly had been discovered on Ishigaki Island, Taketomi Island, and Kohama Island in the Yaeyama Islands (World of Insects, journal of Nawa Insect Museum).
1920	Establishment of "the Melon Fly Eradication and Prevention Method" for Yaeyama County (Prefectural Ordinance no. 28 of June 8, 1920) to prohibit transportation of cucurbit crops outside of the county.
1929	The melon fly was confirmed present on the Miyako Islands (Miyako and Irabu Islands). Pursuant to the Melon Fly Eradication and Prevention Method (Prefectural Ordinance no. 28 of 1929), the transportation of gourds outside of Yaeyama and Miyako counties were either prohibited or restricted.
1945	End of World War II.
1950	Pursuant to the provisions of the Plant Protection Act (no. 151 of 1950), the transportation of the melon fly host plants from the Ryukyu Islands to the mainland was prohibited.
1951	An agricultural product inspection center was established in the Okinawa Prefectural Government. Voluntary-quarantine of agricultural products for import and export began (Okinawa-ken Norinsuisan Gyouseishi, vol. 13). Inauguration of the Ryukyu Ministry of Agriculture and Forestry.
1952	The Ryukyu Islands Plant Protection Act (Decree of the US Civil Administration in the Ryukyu Islands (USCAR), no. 62 of 1952) was promulgated; quarantine operations by the Ryukyu Plant Protection Center began (effective date: February 20). The Yokohama Plant Protection Station, headed by Sato Kaku, carried out an investigation, which found the melon flies to be present in the Miyako and Yaeyama Islands, but no such findings were made in Okinawa main Island and Amami Island (May-August).
1953	The ban on the export of tomatoes from Okinawa to Japan was lifted.
1958	The Plant Protection Act (Ryukyu Government Legislation no. 89 of 1958) was promulgated, and took effect in January 1959. Under § 14(1) of the Act, pursuant the Regulation on the Emergency Removal of Harmful Plants and Animals (regulation no. 18, February 1959), the transportation of the melon fly hosts from the Miyako and Yaeyama Islands was prohibited. NOTE: § 2(1) no. 3 of the regulation permitted the transportation, subject to inspection, of watermelon, squash, white gourd, etc.
1970	The Ryukyu Islands Plant Protection Center began investigations of the melon flies on the Okinawa Islands (May - August); the melon flies were found on Kume Island as a result of the investigations (June). Establishment of the Practical Guidelines on the Removal of the Melon Flies (Notification of the Government of the Ryukyu Islands, Office of Agriculture and Forestry) (July). Pursuant to the Plant Protection Act (Ryukyu Government Legislation no. 89 of 1958), restrictions were imposed on the transportation of the melon fly host plants from Kume Island to the Okinawa Islands (September).

Date	Relevant events
1971	Pursuant to the amendments to the endorsement regulation of the Plant Protection Act (Law no. 151 of 1950), the ban on the export of raw gourds, string beans, cowpeas, pidgeon peas from the Okinawa Islands (except for Kume Island) to the mainland Japan was lifted (April).
1972	Okinawa reverted to Japan. (May 15). With the promulgation of the Okinawa Reversion Legislative Amendments Act, the Plant Protection Act was partially amended (redrafting of the provisions on the restriction and prohibition of the transportation of plants, etc.), as was the enforcement regulations (prohibition and restriction of the transportation of the host plants of the oriental fruit flies, the melon flies and other major pests found in the Okinawa Islands, Amami Islands, Ogasawara Islands, etc-). The special pest control project was established pursuant to the Law Concerning Special Measures for the Promotion and Development of Okinawa began experiments with a view to eradicating the melon fly on Kume Island (establishment of the Okinawa Prefecture Special Pest Control Headquarters, Mass-Rearing Center established at the Yaeyama branch of the Agricultural Experiment Station, Sterilization Facility established at Okinawa Agricultural Experiment Station, control by suppression of the melon fly population started on Kume Island). The melon fly was detected on Motobu-town on Okinawa main island (September).
1973	The transportation of the melon fly host plants from the Okinawa Islands outside of the prefecture was banned or restricted (March).
1974	The ban on the transportation of raw cantaloupes and string beans was lifted subject to fumigation (January 1).
1975	Sterile fly release began on Kume Island (February).
1976	No. of sterile fly release on Kume Island increased from 2 million to 5 million per week (May). No. of melon fly-infested fruits found on Kume Island decreased to zero (October).
1977	The melon fly was found on the North and South Daito Islands (April). The Okinawa Melon Fly Control Ordinance (Prefectural Ordinance no. 25) was promulgated; the transportation of host plants to Kume Island was restricted (June). By order of the Ministry of Agriculture and Forestry, a team of researchers from the Kume Island Melon Fly Eradication Experiment Project Research Team visited Okinawa, and confirmed the eradication (September).
1978	Public hearings were held on the amendment of the Plant Protection Regulation related to the eradication of the melon Fly in Kume Island (August9). The ban and restrictions on the transportation of the melon fly host plants from Kume Island was lifted (September 1). The transportation of the melon fly host plants from the Daito Islands was banned or restricted (September 1).
1980	Okinawa Prefectural Fruit Fly Eradication Project Office was established (April 1). Construction began on the new melon fly mass-rearing facility (September).
1981	"The Melon Fly Control Ordinance in Okinawa" was amended to "The Melon Fly and The Oriental Fruit Fly Control Ordinance in Okinawa". (October).

Date	Relevant events
1982	The ban on the transportation of raw cucumber was lifted subject to fumigation (June 1).
	The ban on the transportation of raw green peppers was lifted subject to steaming (December 6).
1983	Construction was completed on phase 1 of the new facility of the melon fly mass-rearing (March).
	The melon fly rearing was discontinued in Yaeyama; rearing began at the new facility of the melon fly mass-rearing (May).
	Construction began on the new facility of the melon fly sterilization (June).
	The melon fly population suppression control began in the Miyako Islands (using fiber board blocks to eradicate the oriental fruit flies as well) (December).
1984	Construction completed on the new facility of the melon fly sterilization (March).
	Construction began on Miyako Sterile Fly Release Center (April).
	The melon fly population suppression control continued in the Miyako Islands (aerial treatment using cotton ropes impregnated with lure-toxicant continued from May to September).
	Cobalt 60 radiation source (60,000 Curies) was placed into the pool (July).
	The melon fly pupae production increased to 45 million/week (July).
	Construction completed on Miyako Sterile Fly Release Center (July).
	Irradiation began at the new facility of the melon fly sterilization (August 14).
	Okinawa Prefecture Sterile Melon Fly Mass-Rearing Facility completion ceremony (August 22).
	Sterile melon fly release began in Miyako Islands (August 28).
	Construction phase 2 began on new facility of the melon fly mass-rearing (October).
1985	Okinawa Fruit Fly Research Group wins the 6th Okinawa Research Incentive Award of the Okinawa Association Foundation with the study "Research on the Eradication of the Fruit Fly in Okinawa Prefecture Using Cobalt-60 Radiation" (January).
	The melon fly pupae production reached 50 million/week (October).
	[The melon fly was eradicated on Kikai-jima, Kagoshima Prefecture (October).]
1986	The ban on transportation of mangos was lifted subject to steaming (February 6).
	Okidaito Island was removed from the list of areas in which the melon fly occurs (February 6).
	Population suppression began in the Central and Southern Parts of Okinawa Islands (May-June).
	Adult flies for egg collection switched over to the new strain. The melon fly pupae production reached 100 million/week (September).
	Sterile fly release began in the Central and Southern Parts of Okinawa Islands (November).
	Number of fruit infested by the melon flies in the Miyako Islands reduced to zero (November).
	Pursuant to § 3 of the Prefectural Ordinance, the Miyako Islands are listed as a region from which the melon fly has been exterminated; restrictions were imposed on the transportation of host plants from the Okinawa Islands and the Yaeyama Islands to the Miyako Islands (November 21).
	Population suppression control began in the northern part of Okinawa main island (November).
	Construction completed on heliport for sterile fly release in Central and Southern Okinawa (December).

Date	Relevant events
1987	Construction completed on Northern Sterile Fly Release Center (January).
	Number of wild melon flies trapped in the Miyako Islands dropped to zero (February).
	Construction completed on Northern Heliport for sterile fly release (March).
	Sterile fly release began on Motobu peninsula and south of Nago. The melon fly production reached 150 million/week (March).
	Due to inadequate results, additional ground release was carried out in Itoman (in the southern region of Okinawa main island) (2-10 million/week, May).
	An application for confirmation of the eradication of the melon fly in the Miyako Islands was submitted to the Head of Naha Plant Protection Station (July 1).
	The Naha Plant Protection Office began verification for the eradication of the melon fly (July).
	By order of the Ministry of Agriculture, Forestry and Fisheries, a team was sent to the Miyako Islands to verify the eradication of the melon fly (September).
	The ban on the transportation of bitter cucumber and papayas was lifted subject to steaming (October 1).
	The eradication verification by the Naha Plant Protection Office was completed (October).
	Public hearings were held on the amendment of the Plant Protection Regulation related to the eradication of the melon fly in the Miyako Islands (November 12).
	The ban and restrictions on the transportation of the melon fly host plants from the Miyako Islands was lifted (November 30).
	[The melon fly was eradicated on Amami Oshima, Kagoshima Prefecture (November).]
	The melon fly pupae production reached 200 million/week (December).
Commemoration ceremony for the eradication of the melon fly in the Miyako Islands (December 19).	
1988	Sterile fly release began on Okinawa main island (except for the mountainous area and nearby isolated islands) as well as in North and South Daito Islands (January).
	Sterile fly release began in the mountainous area of northern part of Okinawa main island (April).
	Sterile fly release began on the isolated islands north of Okinawa main island (July).
	Due to inadequate results in Henza Island (central Okinawa main island), additional ground release was carried out (2.5 million/week, October).
	In order to facilitate eradication, release on Iejima increased from 3 million to 4 million /week (October).
	An additional 4 million flies/week were released in Ginowan City and Motobu Town, where sterile fly release results had been inadequate (December).
1989	Transportation of sterile flies to North and South Daito Islands was switched over to charter flights (December).
	The ban on the transportation of raw cantaloupes was lifted subject to steaming (March 1).
	Number of fruit infested by the melon flies on Okinawa main island reduced to zero (June).
	Number of wild melon flies trapped on Okinawa main island reduced to zero (July).
	Construction completed on Yaeyama Sterile Fly Release Center and heliport (September).
	Population suppression control began on Ishigaki and Taketomi Islands (October).
	[The melon fly was eradicated on Tokunoshima, Okierabu and Yoron Islands in Kagoshima Prefecture (October).]
Number of fruit infested by the melon flies and trapped wild melon flies reduced to zero on North and South Daito Islands (December).	

Date	Relevant events
1990	Sterile fly release began on Ishigaki and Taketomi Islands (January 24).
	Pursuant to § 3 of the Prefectural Ordinance, the Okinawa Islands (except for Kume Island) were listed as areas from which the melon fly had been eradicated; transportation of melon fly host fruit from the Yaeyama Islands to the Okinawa Islands was restricted (April 10).
	Population suppression began in the Taketomi and Yonaguni Islands (May).
	An application for confirmation of the eradication of the melon fly in the Okinawa Islands was submitted to the Head of Naha Plant Protection Station (June 1).
	The Naha Plant Protection Office began verification for the eradication of the melon fly (July).
	By order of the Ministry of Agriculture, Forestry and Fisheries, a team was sent to the Okinawa Islands to verify the eradication of the melon fly (July).
	The methods of sterile fly release in the Miyako Islands was switched from aerial to ground (August).
	The eradication verification by the Naha Plant Protection Office was completed (September).
	Number of fruit infested by the melon fly was reduced to zero in Ishigaki City (September).
	Public hearings were held on the amendment of the Plant Protection Regulation related to the eradication of the melon fly in the Okinawa Islands (October 16).
	The ban and restrictions on the transportation of the melon fly host plants from the Okinawa Islands were lifted (November 1).
	Sterile fly release began in the Taketomi and Yonaguni Islands (November).
	Commemoration ceremony for the eradication of the melon fly in the Okinawa Islands (November 7).
	Number of wild melon flies trapped in Ishigaki City reduced to zero (November).
1991	Number of fruit infested by the melon fly reduced to zero in Taketomi Island (April).
	Number of wild melon flies trapped in Taketomi Island reduced to zero (May).
	Number of fruit infested by the melon fly reduced to zero in Yonaguni Island (June).
1992	Ground release ended on Kume Island (April).
	Number of wild melon flies trapped reduced to zero in Yonaguni Island (July).
1993	Release ended in the Tarama and Irabu Islands (April).
	Transportation of pupa to the Miyako Islands switched over to adult fly transportation (April).
	An application for confirmation of the eradication of the melon fly in the Yaeyama Islands was submitted to the Head of Naha Plant Protection Station (April 15).
	The Naha Plant Protection Office began verification the eradication of the melon fly (May).
	By order of the Ministry of Agriculture, Forestry and Fisheries, a team was sent to the Yaeyama Islands to verify the eradication of the melon fly (July).
	The eradication verification by the Naha Plant Protection Office was completed (August).
	Public hearings were held on the amendment of the Plant Protection Regulation related to the eradication of the melon fly in the Yaeyama Islands (October 8).
	The ban and restrictions on the transportation of the melon fly host plants from the Yaeyama Islands was lifted (October 30).
	Commemoration ceremony for the eradication of the melon fly in the Yaeyama Islands (November 10).
	Monument commemorating the eradication of the melon fly in Okinawa Prefecture was built (November).

CHRONOLOGY OF THE ERADICATION OF THE ORIENTAL FRUIT FLY IN OKINAWA PREFECTURE

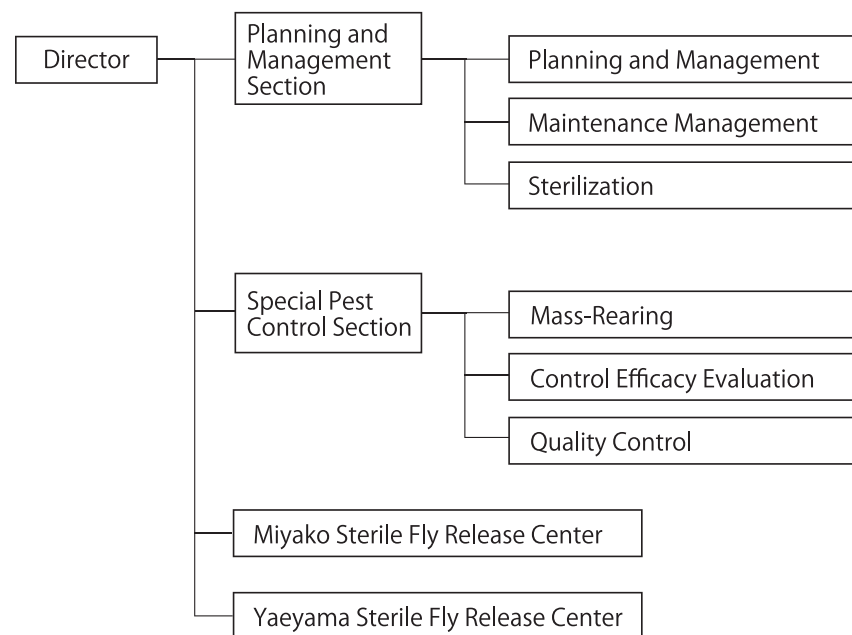
Date	Relevant events
1918	Early falling of native variety of mandarin (kabuchi) in the Oyama, Ginowan was reported by the orange dealer (according to report "1971" of Tomokiyo Iha).
1919	Presence of the oriental fruit fly larvae was reported by Plant Inspector Kariya (according to report "1971" of Tomokiyo Iha).
	Dr. Tokuchi Shiraki, a technician at Agricultural Experiment Station of the Taiwan Governor-General's Office, reported that the oriental fruit fly could also occur in the Ryukyu Islands (World of Insects; journal of Nawa Insect Museum).
1922	The Methods for the Disinfestations and Prevention of Citrus Pests (Okinawa Prefectural Ordinance no. 2 of 1922), enacted pursuant to the § 2(2) of Act on Disinfestations and Prevention of Pest (Act No. 17 of 1896) prohibited the export of citrus fruits, etc. from Okinawa main island (except for the remote to islands).
1945	End of World War II.
1950	Pursuant to the provisions of the Plant Protection Act (no. 151 of 1950), the export of host plants of the oriental fruit fly from the Ryukyu Islands to Japan was prohibited.
1953	The ban on the export of tomatoes from Okinawa main island to Japan was lifted.
1968	[Kagoshima Prefecture: The oriental fruit fly eradication experiments began on the Amami Islands.]
1969	[Tokyo: Fundamental research began on male oriental fruit fly annihilation in the Ogasawara Islands.]
1970	Pursuant to the Guidelines on the Control of the Oriental Fruit Fly (Notification of the Government of the Ryukyu Islands, Office of Agriculture and Forestry), research on damage control measures began in one region (October).
1972	Okinawa Reverted to Japan (May 15).
	With the promulgation of the Okinawa Reversion Legislative Amendments Act, the Plant Protection Act was partially amended (redrafting of the provisions on the restriction and prohibition of the transportation of plants, etc.), as was the enforcement regulations (prohibition and restriction of the transportation of the host plants of the oriental fruit flies, the melon flies and other major pests found in the Okinawa Islands, Amami Islands, Ogasawara Islands, etc.).
	The special pest control project established pursuant to the Law Concerning Special Measures for the Promotion and Development of Okinawa began damage control and eradication measures for the oriental fruit fly in the Okinawa Islands.
	The ban on the transportation of citrus unshu, ponkan, tankan, prune, guava, passion fruit, and papaya was lifted subject to steaming (May 15).
1975	Research began on the occurrence of the oriental fruit fly in the Okinawa Islands (including US bases).
	[Tokyo: Control of the oriental fruit fly began in the Ogasawara Islands (November).]
1976	Special pest control offices were established in three regions (north, central and south) of the Okinawa Islands in order to eradicate the oriental fruit fly in the Okinawa Islands.

Date	Relevant events
1977	The Oriental Fruit Fly Eradication Program began operation in the Okinawa Islands (aerial treatment using cotton ropes impregnated with lure-toxicant, cotton wicks for ground treatment) (October).
1978	Special pest control offices were established in the Miyako and Yaeyama Islands (April). Due to difficulties and poor achievement during the eradication of the oriental fruit fly in the Okinawa Islands, emphasis placed on Kume Island with a view to the complete eradication of the oriental fruit fly (October).
1979	The method for insecticide application were switched from cotton ropes and wicks to wooden fiber blocks in the Okinawa Islands. (April). [Kagoshima Prefecture: The oriental fruit fly was eradicated on the Tokunoshima, Amami Oshima, Kikai-jima Islands (May).] Number of trapped flies and infested fruits reduced to zero on Kume Island (November).
1980	[Kagoshima Prefecture: The oriental fruit fly was eradicated on the Okierabu and Yoron Islands. (May).] Number of trapped flies and infested fruit reduced to zero in south and central Okinawa main island (June).
1981	Two oriental fruit flies were trapped on Kume Island (June); number returned to zero after additional treatment (July). Number of trapped flies and infested fruits reduced to zero on Okinawa main island, and surrounding remote islands (including North and South Daito Islands). (July). "Melon Fly Control Ordinance in the Okinawa" was amended to "The Melon Fly and the oriental Fruit Fly Control Ordinance in Okinawa". (October).
1982	Pursuant to § 3 of the Prefectural Ordinance, the Okinawa Islands were listed as an area from which the oriental fruit fly has been removed; transportation of host fruit from the Miyako and Yaeyama Islands to the Okinawa Islands was restricted (January7). An application for confirmation of the eradication of the oriental fruit fly in the Okinawa Islands was submitted to the Head of Naha Plant Protection Station (April 6). The Naha Plant Protection Office began verification for the eradication of the oriental fruit fly (April). Oriental fruit fly eradication project by aerial application began in the Miyako and Yaeyama Islands (April). By order of the Ministry of Agriculture, Forestry and Fisheries, a team was sent to the Okinawa Islands to verify the eradication of the oriental fruit fly (June). The eradication verification by the Naha Plant Protection Office was completed (July). Public hearings were held on the amendment of the Plant Protection Regulation related to the eradication of the oriental fruit fly in the Okinawa Islands (August 10). The ban and restrictions on the transportation of the oriental fruit fly host plants from the Okinawa Islands was lifted (August 26). Commemoration ceremony for the eradication of the oriental fruit fly in the Okinawa Islands (September 21). Emergency eradication measures were implemented after the oriental fruit flies found in traps on Kume Island (October).

Date	Relevant events
1983	Number of fruit infested by the oriental fruit fly in the Miyako Islands reduced to zero (May). Special plant quarantine measures related to the oriental fruit fly on Kume Island was lifted (July). Number of the oriental fruit flies trapped in the Miyako Islands reduced to zero (September). The oriental fruit flies were trapped in Chatan-cho, emergency eradication measures implemented (October). Number of fruit infested by the oriental fruit fly reduced to zero in the Yaeyama Islands (December).
1984	Pursuant to § 3 of the Prefectural Ordinance, the Miyako Islands were listed as an area from which the oriental fruit fly has been eradicated; the transportation of host plants from the Yaeyama Islands to the Miyako Islands was restricted (April 8). Emergency eradication of oriental fruit flies in Chatan-cho was completed (April). An application for confirmation of the eradication of the oriental fruit fly in the Miyako Islands was submitted to the Head of Naha Plant Protection Station (May 1). The Naha Plant Protection Office began verification for the eradication of the oriental fruit fly (May). By order of the Ministry of Agriculture, Forestry and Fisheries, a team was sent to the Miyako Islands to verify the eradication of the oriental fruit fly (July). The eradication verification by the Naha Plant Protection Office was completed (August). Since the oriental fruit flies were trapped in the Izena and Iheya Islands, emergency eradication measures were implemented (August). Number of oriental fruit flies trapped in the Yaeyama Islands reduced to zero (October). Public hearings were held on the amendment of the Plant Protection Regulation related to the eradication of the oriental fruit fly in the Miyako Islands (October 15). The ban and restrictions on the transportation of the oriental fruit fly host plants from the Miyako Islands was lifted (November 1). Commemoration ceremony for the eradication of the oriental fruit fly in the Miyako Islands (November 26). Emergency eradication of the oriental fruit flies in the Izena and Iheya Islands were completed (November).
1985	[Tokyo: The oriental fruit fly were eradicated in the Ogasawara Islands (February).] An application for confirmation of the eradication of the oriental fruit fly in the Yaeyama Islands was submitted to the Head of Naha Plant Protection Station (June 20). The Naha Plant Protection Office began verification the eradication of the oriental fruit fly (June). By order of the Ministry of Agriculture, Forestry and Fisheries, a team was sent to the Yaeyama Islands to verify the eradication of the oriental fruit fly (October). The eradication verification by the Naha Plant Protection Office was completed (November).

Date	Relevant events
1986	Public hearings were held on the amendment of the Plant Protection Regulation related to the eradication of the oriental fruit fly in the Yaeyama Islands (January 21).
	The ban and restrictions on the transportation of the oriental fruit fly host plants from the Yaeyama Islands was lifted (February 6).
	Okidaito Island was removed from the list of areas in which the oriental fruit fly had occurred (February 6).
	Commemoration ceremony for the eradication of the oriental fruit fly in the Yaeyama Island (February 20).

Okinawa Prefecture Fruit Fly Control Project Organizational Structure



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