NPAG DATA: *MELANAGROMYZA OBTUSA*
PIGEONPEA POD FLY

POTENTIAL THREAT TO PIGEONPEA IN PUERTO RICO

March 15, 2000

TAXONOMY:

Phylum: Arthropoda
Class: Insecta
Order: Diptera
Family: Agromyzidae

Full Name: *Melanagromyza obtusa* Malloch 1914
Synonym: *Agromyza obtusa* Malloch (Sigh & Ipe, 1973)
Melanagromyza brevigena Garg 1971 (Delfino & Hardy, 1977)
Melanagromyza weberi de Maijere 1922 (Shanower *et al*., 1999)
Common Name: Pigeonpea Pod Fly (Shanower *et al*., 1999)
Bean Pod Fly; Pod Fly (FAO/RLAC, 1989)

INTERCEPTION DATA:

Recent Interception in Pigeonpea Seed from Dominican Republic:

Location: San Juan, Puerto Rico (Port Number 112701)
Date: 25Feb00
Host: Pigeonpea (*Cajanus cajan*) seed moving in baggage for consumption
Collector: Sonja Fidalgo Cruz, USDA-APHIS, PPQ Officer
Identifier: To *Melanagromyza* species (probably *M. obtusa)*:
Allen Norrbom, USDA-ARS, Systematic Entomology Laboratory
Museum of Natural History Building, Washington, DC 20024
Note: Passed to Sonja Scheffer (USDA-ARS) for identification to species.
Iden. Date: On or before 01Mar00 (The PPQ 309 record was entered on 01Mar00)

Recent Interception in Pigeonpea Seed from Puerto Rico:

Location: San Juan, Puerto Rico (Port Number 112676)
Date: 15Feb00
Host: Pigeonpea (*Cajanus cajan*) seed moving in baggage for consumption
Collector: Petra de Arce, USDA-APHIS, PPQ Technician
Identifier: To *Melanagromyza* species (probably *M. obtusa)*:
Allen Norrbom, USDA-ARS, Systematic Entomology Laboratory
Museum of Natural History Building, Washington, DC 20024
Note: Passed to Sonja Scheffer (USDA-ARS) for identification to species.
Iden. Date: On or before 22Feb00 (The PPQ 309 record was entered on 22Feb00)

Interception in Seattle:

Location:	? Seattle, WA (Port Number 002365)
Date:	? 10Jan95
Host:	? Passenger baggage (Philippines origin)
Collector:	?
Identifier:	?
	?
Iden. Date:	? Seattle 002365 (PPQ 309 not available)

Interception Note:

Comments are necessary on the interception of *Melanagromyza obtusa* on soybean seed from the Philippines. Spencer (1990) does *not* list soybean, *Glycine max*, as a host for the pigeonpea pod fly. No other reference (found during research) lists soybeans as a host for the pigeonpea pod fly. (See Hosts.) This raises several questions: Was the identification of the pest accurate? Was the identification of the seed accurate? (The Pin309 would help to answer these questions.)

QUARANTINES:

A review of the List of Intercepted Plant Pests (Fiscal Years 1973 to 1987 and 1991) did *not* reveal an interception of *Melanagromyza obtusa*, probably because identification seemed to stop at the family level. However, the following interceptions are of note:

1973-77	Species in Agromyzidae	Seed of *Cicer arietinum*(Chickpea)
1982	Species in Agromyzidae	Seed of *Cajanus cajan* (Pigeonpea)
1983	Species in Agromyzidae	Seed of *Cajanus cajan*
1984	Species in Agromyzidae	Seed of *Cajanus cajan*
1985	Species in Agromyzidae	Seed of *Cajanus cajan*

Apparently, because of its widespread distribution in Asia (See Distribution), quarantines are *not* in place in Asia.

The FAO document *Plant Pests of Quarantine Importance to the Caribbean* (FAO/RLAC, 1989) mentions the pigeonpea pod fly; in addition, this document comments on the importance of the pigeonpea pod fly: "Can be very serious. Up to 100% pod damage and up to about 85% seed damage reported in India. Damaged seed unfit for human consumption."

Probably, prohibitions on the transport of infested seed will inhibit much of the long-distance dispersal of this pest. (The larvae and pupae could move easily in infested seed.)

LIFE HISTORY:

The life cycle may take 4 to 5 weeks (FAO/RLAC, 1989).

Spencer (1973) describes the stages in detail.

Eggs: Females produce up to 80 eggs and lay them individually into developing pigeonpea pods. Under field conditions, the egg stage lasts for 3 to 5 days (Shanower *et al*., 1999).

More than one egg is generally found in a single pod, the maximum being seven, the average four. With the temperature fluctuating between 23°C and 28°C, the average incubation period of eggs is 3.1 days (Spencer, 1973).

Larvae: After egg hatch, the young larvae attach themselves to the soft seeds inside the pods and for the first few hours do *not* bore into the seed but feed on the surface. Soon after they mine into the seed like leaf-miners, their galleries running just under the epidermis of the seed. As the larvae grow and become well-developed, they feed deeper in the seeds and even damage the embryos. As long as the larvae remain inside, the seed may appear undamaged and complete. Usually, one seed is quite sufficient for the complete development of the larvae. In rare cases, a larva may move from one seed to the next; however, the larva will never leave the pod in which it hatched. Thus, larvae spend their entire lives in the same pod (Spencer, 1973).

Before pupating, the full-grown larvae come out of the seeds and eat partial holes into the walls of the pods to enable the emerging flies to excape. The holes do not communicate with the exterior; each hole retains a thin, circular layer of epidermis. The emerging flies will force through the remaining epidermal layer (Spencer, 1973).

At Pusa, India, the average duration of larval feeding was 6.1 days in March/April and 18 to 20 days in December (Spencer, 1973).

The average larval period ranges from 5 to 6 days. The first instar takes about one and a half days, the second instar takes just over two days, and the last instar takes about two and a half days (Singh & Ipe, 1973).

Under field conditions, the three larval stages last for 6 to 11 days (Shanower *et al*., 1999).

Pupae: Pupation occurs within the pod itself and pupal periods range from 7 to 12 days, depending on the climatic conditions (Singh & Ipe, 1973).

Under field conditions, the pupal stage lasts for 9 to 23 days (Shanower *et al*., 1999).

Adults: The adult is a medium-sized green species with a large ocellar triangle (Spencer, 1973). On the abdomens of the females, the basal cone of the ovipositor is conspicuously elongated (Spencer, 1973).

Females copulate within 24 hours after emergence and oviposition quickly follows (Spencer, 1973).

When fed with honey, the adult stage lasts for approximately 12 days; without feeding, only half as long (Shanower *et al*., 1999).

Ecology: The narrow host range and feeding niche of the pigeonpea pod fly govern its population dynamics. In India, pigeonpea pods are available in the field from approximately October to April, and infestations increase rapidly over a relatively short period. Fewer eggs are laid in December and January when temperatures are low. Populations increase as temperatures rise. Long-duration pigeonpea crops which mature in March or April can be heavily damaged (Shanower *et al*., 1999). According to Spencer (1973), the main activity period of the pigeonpea pod fly is March-April and up to three generations can be completed in this period. The first flies of the autumn generation appear around mid-October (Spencer, 1973).

In contrast, Singh and Ipe (1973) state that the maximum infestation around Agra occurs in January; the level remains almost the same in February but declines by March.

The pigeonpea pod fly may survive the off-season on alternate hosts, such as *Rhyncosia minima*, which have been found to be infested with eggs, larvae, and/or pupae between April and November (Shanower *et al*., 1999).

Dispersal: Agromyzids have the "well-known ability to cross substantial water gaps" (Spencer, 1990; Spencer & Stegmaier, 1973).

Long-distance dispersal is likely with the movement of infested seed.

DISTRIBUTION:

Asia:	China (Formosa-Taiwan), Flores Island, India (Assam, Bihar, Delhi, Maharashtra, Uttar Pradesh), Indonesia (Java), Malaya, Sri Lanka (Ceylon) (Delfino & Hardy, 1977; Singh, 1971; Shanower *et al.*, 1998, Spencer, 1973) Bangladesh, Myanmar, Nepal, Pakistan, Philippines, Thailand, Vietnam (Shanower *et al.*, 1998; Shanower *et al.*, 1999) New Guinea; Japan (Singh, 1971; Singh & Ipe, 1973)
Australia:	Australia (Queensland) (Spencer, 1999)
N. America:	No record found
S. America:	No record found
Caribbean:	No record found

A 1999 review article on the insect pests of pigeonpea states that the distribution of the pigeonpea pod fly "appears to be restricted to Asia" (Shanower *et al.*, 1999).

There are reports of the pigeonpea pod fly in Africa with countries, such as Kenya and Uganda, being listed in the geographic distribution. However, these reports are uncertain. Because of the presence of the morphologically and ecologically similar *Melanagromyza chalcosoma* in Africa, these reports could be misidentifications (Shanower *et al.*, 1998).

HOSTS:

Cajanus albicans	(Not in *Hortus Third*)	Shanower *et al*., 1998
C. cajan	Pigeonpea (tur, dhal, red gram)	Spencer, 1973
C. cajanifolios	(Not in *Hortus Third*)	Shanower *et al*., 1998
C. platycarpus	(Not in *Hortus Third*)	Shanower *et al*., 1998
C. sericcus	(Not in *Hortus Third*)	Shanower *et al*., 1998
C. volabiis	(Not in *Hortus Third*)	Shanower *et al*., 1998
Cajanus sp.	Genus containing pigeonpea	Spencer, 1990
Cicer arietinum	Chickpea	FAO/RLAC, 1989
Dunbaria spp.	(Not in *Hortus Third*)	Shanower *et al*., 1998
Flemingia macrophylla	(Not in *Hortus Third*)	Shanower *et al*., 1998
F. stricta	(Not in *Hortus Third*)	Shanower *et al*., 1998
F. strobilifera	(Not in *Hortus Third*)	Shanower *et al*., 1998
Flemingia sp.	A legume	Spencer, 1973
Phaseolus sp.	Genus containing bean	Spencer, 1990
Rhyncosia aurea	(A legume; not in *Hortus T.*)	Shanower *et al.*, 1998
R. bracteata	(Not in *Hortus Third*)	Shanower *et al.*, 1998
R. cana	(Not in *Hortus Third*)	Shanower *et al.*, 1998
R. minima	(Not in *Hortus Third*)	Shanower *et al.*, 1999
R. rothii	(Not in *Hortus Third*)	Shanower *et al.*, 1998
R. rufescens	(Not in *Hortus Third*)	Shanower *et al.*, 1998
R. suaveolens	(Not in *Hortus Third*)	Shanower *et al.*, 1998
Tephrosia pupurea	(A legume; not in *Hortus T.*)	Shanower *et al.*, 1998
Vigna radiata (Phaseolus radiatus)	Mung bean (green gram)	Spencer, 1973
Vigna unguiculata	Cowpea	FAO/RLAC, 1989
Vigna sp.	Genus containing cowpea	Spencer, 1990

Spencer (1990) notes that the pigeonpea pod fly is not host-specific; however, the pigeonpea pod fly does feed primarily on *Cajanus* and secondarily on *Vigna* and *Phaseolus*. Spencer notes that agromyzids are often resticted to a single tribe in the legume family. This would be in case in the distribution which he gives: *Cajanus*, *Phaseolus*, and *Vigna* are all in the Tribe Phaseoleae. Spencer does *not* list *Cicer*, which is in the Tribe Cicereae, as a host.

According to Shanower and his coworker (1998), five genera in the legume family are hosts: *Cajanus*, *Dunbaria*, *Flemingia*, *Rhynchosia*, and *Tephrosia*. They consider *Cajanus cajan*, the pigeonpea, and *Fleminga macrophylla* to be the only commercially cultivated host plants. *Fleminga macrophylla*, used in the production of lac, is heavily attacked by the pigeonpea pod fly.

Shanower and his coworkers question the reports of five other agriculturally important species as hosts of the pigeonpea pod fly: okra (*Hibiscus esculentus*, Family Malvaceae); safflower (*Carthamus tinctorius*, Family Asteraceae); sesame (*Sesamum indicum*, Family Pedaliaceae); mung bean (*Vigna radiata*, Family Fabaceae); and cowpea (*Vigna unguiculata*, Family Fabaceae).

Rhyncosia minima, which is in the Tribe Phaseoleae, is listed as a host (Shanower *et al.*, 1999; Shanower *et al.*, 1998).

According to the FAO document *Plant Pests of Quarantine Importance to the Caribbean*, the main host is pigeonpea, while alternate hosts are chickpea, cowpea and others (FAO/RLAC, 1989).

DAMAGE WHERE ESTABLISHED:

The FAO document *Plant Pests of Quarantine Importance to the Caribbean* (FAO/RLAC, 1989) mentions the pigeonpea pod fly; in addition, this document comments on the importance of the pigeonpea pod fly: "Can be very serious. Up to 100% pod damage and up to about 85% seed damage reported in India. Damaged seed unfit for human consumption."

In *Agricultural Entomology*, the pigeonpea pod fly appears in a list of "the more notable pest species of Agromyzidae" (Hill, 1994).

In *Agricultural Insect Pests of Temperate Regions and Their Control*, the pigeonpea pod fly appears in a list of "important leaf miner (Agromyzidae) pests" (Hill, 1987).

In India, the pigeonpea pod fly is a more serious pest in northern and central areas than in other parts of the country. Damage levels in farmers' fields range from 10% to 50%. In Vietnam, the pigeonpea pod fly is a key pest, causing seed losses of more than 90%. In Taiwan, damage of 43% occurs (Shanower *et al.*, 1999).

According to Singh and Ipe (1973), the pigeonpea pod fly is widely distributed in India wherever its host plants are grown and causes extensive damage. Preliminary investigations revealed that the damage to the crop exceeded more than 40% of the total yield.

The young larvae immediately start feeding on the soft seed, initially just below the epidermis; as the larvae grow, they burrow deeper down, consuming the starchy food as well as the embryo. Since the larvae deposit excreta as they feed, the damaged seeds become unfit for human consumption (Spencer, 1973).

In the earliest record of this pest from India at Nagpur, damage to tur-pods was estimated at 12.5% of the whole crop. More recent observations at Pusa and Delhi show that serious damage can be as high as 63%. At Pusa, 80% of the pods and 40% to 60% of the grains were affected during March and April, 1936. At New Delhi, the percentage of damaged grains was 42% in April but only 12% in January (Ahmad, 1938; Spencer, 1973)

In Hyderabad and Nizamabad, attacks to tur-pods of above 80% did occur; however, the actual loss of weight of infested grains was *not* substanial. In nine samples taken in these two areas, the loss of weight ranged from less than 1% to 3.3%. However, as a result of the attacks of the larvae, the grains became unfit for human consumption (Spencer, 1973).

According to Srivastava (1980), the percentage of grain infested by the pigeonpea pod fly varies from 50.7% to 54.2% in India. Because the larvae burrow deeper and deeper consuming starchy food material and, on occasion, the embryo, the seed is unfit for human consumption and unsuitable for germination.

The pigeonpea pod fly, *Melanagromyza obtusa*, is one of the two most important pests of pigeonpea (Shanower *et al.*, 1998). Results in a table comparing reports of damage indicated that seed damage varied from 2% to more than 90% with large variation across locations, seasons, and genotypes (Shanower *et al.*, 1998; Table 3).

METHODS OF CONTROL:

Several methods may be used to control pigeonpea pod flies:

Chemical Control: Hill (1987) notes that several insecticides, such as diazinon and chloropyrifos, are effective against dipterans. Field tests showed a number of insecticides, such as fenvalate, monocrotophos, and quinalphos, to be effective against the pigeonpea pod fly (Srivastava *et al*., 1984; Shanower *et al.*, 1998). Several studies showed that two or three applications are more effective in reducing pod fly infestations than single applications of the same insecticide (Shanower *et al.*, 1998).

Because of (1) the high cost of insecticides used in repeated sprays, (2) the comparatively low value of the crops, and (3) the cryptic nature of the pest, control by insecticides may not be feasible.

Cultural Activities: Because of its restricted host range (Shanower *et al.*, 1999) crop rotation will probably influence populations of pigeonpea pod flies, particularly if alternate hosts are not available.

The maturation date of pigeonpeas in India greatly influenced the quality and quantity of damage caused by the pigeonpea pod fly. Pigeonpea cultivars maturing at the end of November had 4% seed damage; cultivars maturing in mid-February had 11% seed damage; and cultivars maturing in the last week of April had 35% seed damage (Shanower *et al.*, 1998).

Natural Enemies: More than 14 species of parasitic hymenoptera attack the larval stage. (No reports on any other stage.) The two most important taxa are *Euderus* spp. and *Ormyrus* spp. (Shanower *et al.*, 1999; Shanower *et al.*, 1998). Although parasitism levels may reach 50% by the end of a pigeonpea growing season, the parasites were *not* effective in minimizing damage and yield losses (Shanower *et al.*, 1998).

Euderus spp. are solitary or facultatively gregarious ectoparasitoids which are found in India, Sri Lanka, and the Philippines. Parasitism rates of more than 25% have been reported for this group (Shanower *et al.*, 1999). *Euderus agromyzae* (Eulophidae: Chalcidoidea) has a rate of parasitism of up to 18.7% in Madhya Pradesh (Spencer, 1973). *Euderus lividus* (Eulophidae: Chalcidoidea) attacks larvae in the latter half of February and thereafter the percentage of parasitism increases steadily (Singh & Ipe, 1973; Spencer, 1973).

Ormyrus orientalis and *Ormyrus fredricki* are solitary endoparasitoids that parasitize up to 13% of hosts in India. Parasitism rates of up to 30% have been reported for *O. orientalis* in Sri Lanka (Shanower *et al.*, 1999).

Resistance: Different cultivars have different levels of damage (Jakhmola & Bhadauria, 1998; Shanower *et al.*, 1998). The potential for developing cultivars with high levels of resistance appears to be good (Shanower *et al.*, 1998).

Host-plant resistance has significant advantages over other pest control strategies in situations where:

1. The insect is exposed for only a brief period of its life cycle.
2. The crop is of low economic value.
3. The pest is continuously present and is the single most limiting factor in sucessful cultivation of a crop in a wide area.
4. Other controls are *not* available.

For pigeonpea, these four conditions apply to pigeonpea pod fly throughout much of its range (Shanower *et al.*, 1998).

PERTINENT POINTS/PREDICTED CONSEQUENCES:

Importance of Pigeonpea: Pigeonpea, *Cajanus cajan*, is an important pulse or grain legume in semi-arid tropical and subtropical areas of the world. In Asia, which accounts for 90% of world production, pigeonpea is the third most important pulse crop. Although Asia accounts for the bulk of production, pigeonpea is also an important crop in Africa and Latin America. Countries with the largest production in the New World are the Dominican Republic, Venezuela, Ecuador, Puerto Rico, and Haiti (Shanower *et al.*, 1999).

In Latin America, pigeonpea is both a backyard garden crop and an export crop grown for canning green seeds (Shanower *et al.*, 1999).

The ARS is seeking a pigeonpea variety that will mature in 120 to 150 days. This variety will be introduced into the wheat rotation. The pigeonpea variety will be planted just after the wheat has been harvested (usually in June) and will be harvested before the replanting of wheat (usually in October) (Weaver, 1998). The New Crops Program of Virginia State University tested the pigeonpea as a potential new crop for the Mid-Atlantic States (Bhardwaj *et al.*, 1999). Except for Hawaii and Puerto Rico, the pigeonpea is *not* commercially grown in the United States (Prine & French, 1999).

Potential Distribution in the United States: The pigeonpea pod fly is widespread in Asia and present in Queensland, Australia. (See Distribution.) However, this distribution in Asia and Australia seems to indicate a distribution that favors the two warmest climatic zones and their intermediate zone:

(1) the Equatorial Zone	Zone I	Examples: Malaya, Sri Lanka
(2) the Tropical Summer-rainfall Zone	Zone II	Examples: India, Vietnam
(3) an intermediate zone	Zone I-II	Example: Taiwan

Apparently, the Subtropical Dry Zone (Zone III) is not favored, although the pigeonpea pod is listed as occurring in Pakistan. The Warm Temperate Zone (Zone V) is *not* favored. (See attached maps showing Asia and Australia.)

In the United States, the pigeonpea pod fly is likely to establish only in the Southwestern United States: Zone II-III, probably; Zone III, possibly. Because the pigeonpea pod fly does *not* seem to occur in climatic zones with a definite frost, most of the United States should *not* be affected by this pest. In the Caribbean (Zone I-II and Zone II), the pigeonpea pod fly should establish easily. In Central America (Zone I, Zone I-II, and Zone II) and in southern Mexico (Zone II), the pigeonpea pod fly should also establish easily. (See attached map showing North America and the Caribbean.)

Alternate Hosts in North America and the Caribbean: Possibly, a number of species in various genera within the legume family will be alternate hosts. *Tephrosia pupurea* is a legume host of the pigeonpea pod fly (Shanower *et al.*, 1998). In *Hortus Third*, Bailey and Bailey (1976) state that the Genus *Tephrosia* includes 300 to 400 species of herbs or shrubs of wide distribution, although mostly tropical and subtropical. Some *Tephrosia* species are inportant in the tropics for green manure; a few are planted as ornamentals. In the tropics, *Tephrosia candida* is often a green-manure crop or a low windbreak. Goat's rue, *Tephrosia virginiana*, grows from Maine south to Florida and New Mexico.

The following species are either native species that might be threatened or exotic species that might be alternate hosts.

Flemingia strobilifera	Wild hops	Exotic	HI
Phaseolus acutifolius	Tepary bean	Native	AZ, NM, TX
P. pedicellatus	Sonoran bean	Native	AZ, NM, TX
P. polymorphus	Variable bean	Native	TX
Rhynchosia edilis	Chihuahuan snout-bean	Native	AZ
R. parvifolia	Small-leaf snout bean	Native	FL
R. reniformis	Dollarleaf	Native	AL, FL, GA, LA, MS, NC
R. senna	Texas snout-bean	Native	AZ, NM, TX
R. swartzii	Swartz's snout-bean	Native	FL
Vigna adenantha	Wild pea	Native	FL, HI
V. marina	Notched cow-pea	Native	HI
V. speciosa	Snail flower	Exotic	FL, HI

Potential Control Mechanisms: Because of various factors, the effective control methods may be limited. For pigeonpea, chemical control may be too expensive. Control may be obtainable by cultural control (crop rotation, early planting, and/or destruction of alternate hosts). Control is *probably not* obtainable by biological control. Control is most likely to be obtainable by resistance.

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