Host Status of *Citrus* spp. for *Anastrepha obliqua* (Diptera: Tephritidae)

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EXECUTIVE SUMMARY

Anastrepha obliqua (Macquart) (West Indian fruit fly) has a low likelihood of infesting *Citrus* spp. based on the scientific literature, APHIS interception records, and identification of larvae in fruits from Mexico intercepted by APHIS at Texas and California border stations between 2001-2004. APHIS concludes that there is a low likelihood of *Citrus* spp. being a host and *A. obliqua* being in the pathway of commercial *Citrus* spp. "Sweet orange, *Citrus sinensis";* "grapefruit, *Citrus paradisi";* "sweet lime, *Citrus aurantifolia"*, and "sour orange, *Citrus aurantium"* should be removed as regulated hosts of *Anastrepha obliqua* in 7 CFR 301.98-2.

INTRODUCTION

This report originated as a request from Wayne Burnett (APHIS-PPQ National Fruit Fly Program Manager) in 2004.

METHODS

Evidence that *Citrus* spp. fruit is a natural field host was determined based on records in Norrbom (2004) and other papers cited below as found in Entomology Abstracts, Zoological Record, Agricola, and CABabstracts up to March 2004 or cited in Norrbom (2004), APHIS infestation records, identification of larvae in oranges coming across border stations from Mexico to Texas in 2004, and identification of larvae collected by APHIS-IS from 2001 and 2002 in Tijuana, Mexico.

A host is any fruit or vegetable in which fruit flies oviposit under field conditions, the eggs hatch into larvae, and the larvae acquire sufficient sustenance to form viable pupae from which adults emerge which are capable of reproduction (Cowley *et al*., 1992). We examined the host records for the species. Records consist of published and unpublished reports of field fruit collections and artificial laboratory and field fruit infestation studies. For each record, APHIS tried to determine what criteria were used to determine host status. APHIS considered host determination studies reliable if they followed the experimental criteria of Cowley *et al*. (1992) developed for multivoltine fruit flies. Those criteria are 1/ laboratory cage trials, 2/ field collection of fruit to detect natural infestations, 3/ trapping for presence in the area of the fruit, and 4/ field cage trials under semi-natural conditions. The criteria have been applied in several host studies of fruit flies of quarantine importance (*e. g.*, Aluja *et al.*, 2003, 2004; Gould & Hallman, 2001a, b; Gould *et al.*, 1999; Hennessey *et al.*, 1995a, b; Hennessey & Schnell, 2001). Under these criteria, laboratory cage trials that are positive indicate only potential host status and call for further assessment of infestability under field conditions (criteria 2-4) before

host status is confirmed.

Factors adding reliability to the host records APHIS examined were: the record listed credible identification of both fly and host (credible meaning either flies and plants were identified by specialists as stated in the paper or a recognized tephritid taxonomist and botanist were authors); multiple date, fruit, or locality records were listed in the case of field collections; multiple replications were listed in the case of experiments; fruit was a *Citrus* spp. (Wiersma and Leon, 1999); and description of fruit such as commercial or non-commercial, green, mature, or ripe, and from the tree, market, or ground.

APHIS based status on the most reliable records available. Norrbom (2004) analyzed 5,984 records of *Anastrepha* and *Toxotrypana* host records in over 330 plant species from 252 references published up to 2003. That publication analyzed the following about each record: original and valid names for fly and plant; plant part; whether relationship between fly and plant was field host, artificial host, possible host, questionable host, doubtful host, or erroneous record; native or exotic host; whether the reference was primary (original), citation, or uncertain; whether flies were field reared, lab reared, incidental, based on larvae, unclear or probably not or not based on reared flies. APHIS found 44 records for *A. obliqua* cross referenced with the host genus *Citrus*. All *Citrus* spp. are exotic to the range of *A. obliqua* (Wiersma and Leon, 1999).

RESULTS

Based on the 44 records from Norrbom (2004):

29 of the records are based on citations of other papers. The 29 were not counted here as reliable records. Instead, APHIS consulted the information from the original papers, which were also analyzed by Norrbom (2004).

6 of the records are listed as of uncertain origin, meaning it was not clear in the record if it was based on original research or a citation. Being questionable, these records were not counted here as reliable records.

Of the 9 records listed as from original research papers, 2 were from a paper by McAlister (1936) and were based on cage trials as follows: McAlister (1936) reared the pest from "grapefruit, *Citrus grandis*" [*Citrus* x *paradisi* Macfad. is grapefruit, *Citrus grandis* is pummelo] and "calamondin lime, *Citrus mitis*" [*Citrus madurensis* Lour. is calamondin] infested in cage trials in Florida where flies had a choice of several kinds of fruit in the cage to oviposit into. Flies also used "kumquat, *Citrus japonica*" [*Fortunella japonica* (Thunb.) Swingle is marumi or round kumquat] in McAlister's (1936) cage trials, but it was not recorded by Norrbom (2004) as a host of *Citrus* because it is *Fortunella*. The above 2 *Citrus* spp. records established the possibility that *Citrus* spp. is a host according to Cowley *et al.* (1992).

Of the 9 records listed as from original research papers, 7 called *Citrus* spp. a host based on rearing from natural field infestations. The 7 records came from 5 papers: [McAlister

et al. (1941); Bressan and Teles (1991); Aguiar-Menezes and Menezes (1997); Stone (1942); Eskafi and Cunningham (1987)]. The 5 papers are discussed as follows:

McAlister *et al.* (1941) determined that commercial "grapefruit" were "rarely" naturally infested in the field in Puerto Rico. In that study, five specimens of *A. obliqua* (0.3% of the total flies reared) were recovered from the collection of large numbers of grapefruit from several orchards during the period 1932-1938. Those fruits that were infested were from orchards adjacent to mangos, which are known as hosts (47 original research papers listing as natural field host; Norrbom, 2004). The authors concluded that the species was not a C*itrus*-breeding fruit fly under normal conditions and not a pest of *Citrus*. Adult flies were authoritatively identified by C. T. Greene, then a fruit fly taxonomist of USDA.

It is interesting to note that the taxonomic revision of *Anastrepha* by Stone (1942) disagrees with what Greene identified as the pest. Stone (1942) lists "*Citrus grandis* and *C. aurantium*" as "food plants" and states "…the species only rarely occurs in *Citrus*, a few infestations having been found in grapefruit in Puerto Rico.", an apparent reference to the findings of McAlister *et al.* (1941). Stone (1942) does not present original research documenting *Citrus* as a host, therefore, the host status given there is not reliable.

Eskafi and Cunningham (1987) reared the pest from naturally field infested grapefruit, sweet orange, and sweet lime in Guatemala. Plants were authoritatively identified, but adults were keyed by the authors, and were not authoritative. Several of the records listed were first time host records never again verified. These included listing *A. obliqua* from coffee (no other original records in Norrbom, 2004) and sweet lime (no other original records in Norrbom, 2004). References for previous reports of host use were erroneous in several instances (*e. g.*, papers on Hawaiian fauna used to reference *Anastrepha* spp.), so data in the paper are considered questionable.

The species was reared from naturally infested experiment station *Citrus* (species unidentified) in the field in Guatemala (Eskafi, 1988). The infestation was made up of a mixture of at least three *Anastrepha* species, one of which was called *A. obliqua.* The flies were not authoritatively identified. This paper was not cited by Norrbom (2004).

Three flies were reared from field collected, naturally infested oranges (non-commercial, unknown if tree or ground collected) in Brazil. There was authoritative fly identification, but the experimental conditions and accuracy of fruit identification are unknown. The paper is only available as an abstract (Uramoto *et al.*, 2001). This paper was not cited by Norrbom (2004).

The species was reared from naturally infested non-commercial *Citrus* spp. from the field in Brazil (Bressan and Teles, 1991). Flies (keyed) and hosts were not authoritatively identified.

The species was reared from naturally infested sour orange in the field (Aguiar-Menezes and Menezes, 1997) in Brazil. Samples included a mixture of mature, non-commercial

fruit from trees and ground. Flies and hosts were not authoritatively identified, adults were keyed, and it was designed primarily as a parasitoid study.

APHIS considers the above three *Citrus* spp. host records from Brazil as unreliable in light of the DNA analysis study by Smith-Caldas *et al.* (2001) who determined that Brazilian populations of *A. obliqua* can represent hybrids with *A. fraterculus* (Wiedemann), which is known as a *Citrus* spp. pest in Brazil (16 original research papers listing as natural field host; Norrbom, 2004). The identifications could have been hybrids that keyed to or looked like *A. obliqua*. At this time, APHIS does not consider that there is enough evidence to regulate various geographic populations or hybrids of *A. obliqua* differently with regard to *Citrus* spp. and that further taxonomic study of the species is needed.

Of 297 infested oranges intercepted by APHIS at several border crossings from passengers traveling from Mexico to Texas during 2001-2003, two larvae were identified by USDA authorities questionably as *A. obliqua* (McCoy, 2004; McCoy, Personal communication, 2004). The identifications are not considered reliable evidence of host status.

Of 1,038 larvae of possibly this sp. (or *A. fraterculus*, which can not be distinguished in larval form), collected by IS from 3/01-3/02 in Tijuana, MX, from 193 confiscated passenger fruit or smuggled fruit from trucks, none of the fruit were citrus (Hoffman, 2004).

Table 1 lists the interceptions of *Anastrepha* from the West Indies in all hosts. Of the two major tephritid pests occurring in the West Indies, the Caribbean fruit fly, *A suspensa* (Loew), occurs only in the Greater Antilles and *A. obliqua* occurs both in the Greater and Lesser Antilles. The APHIS interception records from 1985 to present (the only ones that are currently available, listed below) indicate that out of 475 interceptions of *Anastrepha* (identified to the generic level) from all hosts from the Lesser Antilles none of the hosts were *Citrus*. In addition, of the 16,783 interceptions of *Anastrepha* from all hosts from the Greater Antilles, only eight were from *Citrus* spp. In a closer review of these eight interceptions, most were invalid. For example, three were reported as on fruit (not in fruit), two were listed as adults, one was listed as on leaves, and one was listed as from Haiti *Citrus* from stores from an American airline. The other interception could have been *A. suspensa* which is known to use *Citrus* spp. as a host (39 original research papers listing as natural field host; Norrbom, 2004). Additionally, *A. obliqua* larvae can not be reliably differentiated from *A. suspensa* larvae using keys (Steck, 2001). Currently, APHIS allows *Citrus* spp., including sweet orange and grapefruit, to be imported into the United States without treatment from the various West Indian locations where *A. obliqua* occurs. This has been allowed for many decades without a reported outbreak although *A. obliqua* was formerly established in southern Florida (Steck, 2001). Because mango is available and the subtropical climate of southern Florida is favorable for establishment, Florida is at risk for this pest. Smuggled mangos in passenger baggage from the New World tropics are probably a major pathway into Florida for this pest.

Table 1. *Anastrepha* interceptions, 1985-February, 2004 (PPQ, 2004)				
Citrus only, Greater Antilles (1=baggage, 6=ships stores)				
Origin	Host	Where found	Total	
Haiti	*Citrus* sp. fruit	1	1	
Haiti	*Citrus* sp. fruit	6	1	
Haiti	*Citrus* sp. leaf	1	1	
Jamaica	*Citrus maxima* fruit	1	1	
Jamaica	*Citrus sinensis* fruit	1	2	
Jamaica	*Citrus sinensis* fruit	6	1	
Puerto Rico	*Citrus* sp.	1	1	
Total			8	
All Hosts, Greater Antilles				
Bahamas?			2	
Bahamas			24	
Cayman Islands			8	
Cuba?			1	
Cuba			943	
Dominican Republic			1	
Dominican Republic			2,838	
Haiti?			6	
Haiti			2,103	
Jamaica			1	
Jamaica?			6	
Jamaica			4,564	
Puerto Rico?			1	
Puerto Rico			6,285	
Total			16,783	
All Hosts, Lesser Antilles				
Anguilla			4	
Antigua & Barbuda?			15	
Antigua & Barbuda?			59	
Barbados			7	
Dominica			80	
Grenada?			1	
Grenada			9	

Guadeloupe			8	
Martinique			11	
St. Christopher			60	
St. Croix			13	
St. Kitts & Nevis			23	
St. Lucia			63	
St. Martin			12	
St. Thomas			53	
St. Vincent			1	
Tortola			24	
Virgin Islands			31	
Windward Islands			1	
Total			475	
All Countries, C*itrus* only			6,588	
All Countries, all hosts			59,663	

After the 2001 detection of eight adults of this pest in traps in southern Texas, APHIS regulated *Citrus*. This was done during an emergency outbreak and should be considered prudent, but after a more in-depth evaluation in this report APHIS concludes that the evidence supports only a low likelihood that *Citrus* is a host. APHIS should, therefore, not regulate commercial grapefruit, sweet orange, sour orange, or sweet lime for *A. obliqua*. Sour limes and lemons have never been regulated by APHIS for *Anastrepha*. The species is a quarantine pest and its preferred hosts, including mango, should be regulated for it.

RECOMMENDATIONS

APHIS concludes that there is a low likelihood of *Citrus* spp. being a host and *A. obliqua* being in the pathway of commercial *Citrus* spp. "Sweet orange, *Citrus sinensis";* "grapefruit, *Citrus paradisi";* "sweet lime, *Citrus aurantifolia"*, and "sour orange, *Citrus aurantium"* should be removed as regulated hosts of *Anastrepha obliqua* in 7 CFR 301.98-2.

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