Fruit flies of economic importance in Tucumán Province

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Chapter II

The existence of species of pest insects for agriculture limits the economic regional development, since they cause direct damage to the crops in which they develop or prevent their commercialization due to quarantine restrictions.

Within the Diptera order, the Tephritidae family is one of the largest and comprises approximately 4,000 species (Christenson and Foote, 1960). The larvae of many of them develop in soft fruits, including many species of commercial value and causing loses in the production of the latter (White and Elson-Harris, 1994). In addition to the direct damage they produce, the impact caused when limiting the export of fresh fruits and vegetables to countries free from these pests should be considered (Malavasi *et al.*, 1994). The quarantine costs increase even more the impact of these pests on regional economies. Within this family, the genuses *Anastrepha* Schiner, *Bactrocera* Macquart, *Ceratitis* MacLeay, *Rhagoletis* Loew and *Toxotrypana* Gerstaecker are considered as those of greatest economic importance (Aluja and Liedo, 1993).

In northwestern Argentina, comprised by the provinces of Salta, Jujuy, Tucumán and Catamarca, there are only two fruit flies of economic importance: the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) and the South American fruit fly *Anastrepha fraterculus* (Wiedemann).

Origin and distribution

From its place of origin in equatorial Africa, *C. capitata* has colonized, in the last 150 years, the region surrounding the Mediterranean Sea (1842), the South of Africa (1889), Australia (1887), South America (1901), Hawaii (1910) and Central America (1955) (Fletcher, 1989; Sheppard *et al.*, 1992) distributing in regions with tropical, subtropical and temperate climate. In our country, it was first recorded in 1904 in Buenos Aires home orchards (Vergani, 1952). In 1934 it was reported in the surroundings of Concordia, and foci appeared later in Cuyo and in northwestern Argentina (NOA). It was first recorded in Tucumán in 1945 (Domato and Aramayo, 1947), and the last region colonized in the country was the north of the Patagonia.

A. fraterculus is native of South America and it is found only in the American continent from the south of the United States to Argentina (Salles, 1995; Steck, 1998). It distributes in regions with tropical and subtropical climate. In South America, it occurs in two apparently

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unconnected bands, one of them along the coast of the Pacific Ocean and the other one along the coast of the Atlantic Ocean. In the first it can be found in lowlands as well as at a height of over 2,000 m (Colombia, Ecuador, Perú and Venezuela). In Argentina, it occurs mainly in the humid regions of northwestern Argentina (NOA) and northeastern Argentina (NEA). Although its distribution is more limited than that of *C. capitata,* due to climate restrictions, it may be also found in certain irrigated valleys from areas with temperate climate. In Tucumán, it was first cited for oranges at the early 20th century (Rust, 1918). By that time, damages to apricots, peaches, custard apples and plums were also reported (Rust, 1919; Schultz, 1938). At the beginning of the 1950s, this species prevailed in trap captures. This situation reverted and gradually a prevalence of *C. capitata* over *A. fraterculus* was seen (Ratkovich and Nasca, 1953; Costilla, 1967; Costilla *et al.,* 1975).

At present, in Tucumán, *C. capitata* is mainly found in urban and periurban areas, while *A. fraterculus* occurs in areas with a prevalence of native vegetation.

Biology and life history

C. capitata is considered as the species of fruit flies that causes the greatest damage in the world (Robinson and Hooper, 1989). This is mainly due to its wide distribution and to its ability to adapt to various climates and infest over 250 hosts (Christenson and Foote, 1960; Liquido *et al.,* 1991). It is the most studied species within the Tephritidae family, and hence it is possible to dispose of numerous studies on its biology, many of which are referred to in bibliographic revisions (Thristenson and Foote, 1960; Bateman, 1972; Robinson *et al.,* 1999) and in books edited with the participation of investigators in every area of study (Cavalloro, 1989; Robinson and Hooper, 1989a,b; Aluja and Liedo, 1993; White and Elson-Harris, 1994; McPheron and Steck, 1996; Aluja and Norrbom, 2000; Tan, 2000).

Knowledge on the biology of *A. fraterculus* is scarce if it is compared with other fruit flies, a broad discussion existing on its taxonomic status (Steck, 1998). Females lay their eggs on over 80 fruit species (Norrbom and Kim, 1988), mainly within the Myrtaceae family. This species shows a significant morphologic variation between populations, genetic discontinuities in the isoenzyme and DNA analysis, differences in the hosts used in different regions and caryotipical differences (see Steck, 1998 for a revision and, then, Smith-Caldas *et al.,* 2001; Hernández-Ortiz *et al.,* 2004; Selivon *et al.,* 2005); that is why it was postulated that it would correspond to a complex of cryptic species. Studies carried out in different populations of Argentina showed that no evidence of ethologic isolation exists (Petit-Marty, 1999; Petit-Marty *et al.,* 2004a); and no evidence of post-zygotic reproductive barriers either, such as female differential mortality or sterility in hybrids, was found (Petit-Marty *et al.,* 2004b). The results arrived at in both types of studies allow to postulate that in Argentina, *A. fraterculus* is a single species, a fact supported by studies carried out at the genetic level (Basso and Manso, 2001; Alberti *et al.,* 2002; Basso, 2003; Alberti, 2004).

Hosts

As it was previously mentioned, *C. capitata* exhibits a higher quantity of fruit species as hosts than *A. fraterculus* (Liquido *et al.,* 1991; Norrbom and Kim, 1988; Norrbom 2004). The original host for *C. capitata* is considered to be *Argaria espinosa* (L.) that belongs to the Sapotaceae family. For *A. fraterculus* it will surely be found in the Mirtaceae family, since it prefers the plants of this family rather than others, the guava (*Psidium guajava* L.) being the preferred host plant (Aluja 1999).

Although both species can use sweet citrus as hosts, they are considered as unsuitable hosts (revised in da Silva-Branco *et al.,* 2000). In the case of lemon, Back and Pemberton (1915) reported that *C. capitata* does not develop in that fruit while it remains in this plant, unless the fruit is damaged. Spitler *et al.,* (1984) showed that the "Eureka" and "Lisboa" cultivars of California are resistant to the infestation from this fly. However, some isolated records exist on the detection of larvae of *C. capitata* in lemons. Quayle (1938) reported fruit with larvae in packing house in Sicily and Liquido (1990), in fruits collected from the ground in Hawaii. More recently the United States intercepted lemons cv. "Verna" harvested during summer and in Spain with *C. capitata* live larvae (APHIS, 2006). For *A. fraterculus*, Norrbom and Kim (1988) do not report lemon as a host. In 1995, Salles published a list of multipliers and alternative hosts for the region of Pelotas in Rio Grande do Sul state, Brazil and mentions the "Limão-crioulo" as alternative host. The scientific name provided was "*Citrus lemon*" without mentioning the common name in other language (i.e. English or Spanish). This work was taken from Norrbom

(2004) to include lemon, as *C. limon* (L.) Burm. f., in the hosts list of *A. fraterculus*, considering the plant species was misspelled. In his work, Salles (1995) does not mention whether the record comes from a commercial variety, the name of the plant taxonomist performing the identification, the number of fruit revised, the fruit phenology, the number of larvae or pupa recovered, whether adults were obtained, or other relevant data for what unfortunately it is not possible to evaluate this work with the level of rigor that Norrbom and Kim (1988), Aluja (1999) and Ovruski *et al.* (2003) recommend to consider a plant species as a host. Cases such as this, which constitutes the only references to fundament a host status (note that the other reference from Norrbom (2004) is Zuchi (2000) where it refers to Salles (1995), should be taken with outmost caution at the time of including them in a host list; all the more since they could be used as a scientific evidence at the time of establishing negotiations for the commercialization of the plant species in question.

Productive and phytogeographic characterization of Tucumán

The province of Tucumán presents a diversity of agricultural commercial exploitations distributed in different agroecological areas (Table 1, Fig. 1). The main fruit crops are lemon, oranges (*Citrus sinensis* (L.) Osbeck) and avocados (*Persea americana* Miller). These crops are located on the piedmont, where other horticultural crops also exist, mainly strawberries (*Fragaria* x *anannassa* L.), tomatoes (*Lycopersicum esculentum* Miller) and peppers (*Capsicum annuum* L.). In the last few years production diversification led to the inclusion of new crops such as blueberries (*Vaccinium corymbosum* L.). In this same area and in that of the valleys, stone and pip fruit species are grown. The Yungas forest extends along the Aconquija range, including the piedmont, where indigenous species grow such as the native walnut (*Juglans australis* Grisebach), myrtle (*Eugenia uniflora* L.) and "mato" (*Myrcianthes mato* (Berg) Legrand), as well as foreign species such as guavas (*Psidium guajava* L.), blackberries (*Morus alba* L. and *M. nigra* L.) and peaches (*Prunus persica* (L.) Batsch). In the plain sugar cane (*Saccharum officinarum* L.) is grown along with soybean (*Glycine max* (L.) Merr.), wheat (*Triticum vulgare* Vill.) and corn (*Zea mays* L.). In urban areas fig trees (*Ficus carica* L.), mangoes (*Mangifera indica* L.), medlars (*Mespilus germanica* (Thunb) Lindley) and citrus trees, mainly sour orange (*Citrus aurantium* L. (Rootstock)) are grown in the street and home backyards.

Fruit bearing periods

The fruit bearing periods of the different host species occurs at different times throughout the year. The stone fruit trees begin to ripen

Table 1. Main crops in the province of Tucumán and areas in which they are found.

Scientific name	English common name	Area sown (ha)	Region where it is found
Glycine max, Triticum vulgare, Zea mays	Soybean, Wheat, Maize	310,000	Plains
Saccharum officinarum	Sugar cane	203,170	Plains
Citrus limon	Lemon	34,000	Piedmont
Persea americana	Avocado	1,600	Piedmont
Citrus sinensis	Orange	1,200	Piedmont
Vaccinium corymbosum	Blueberry	1,000	Piedmont
Capsicum annuum	Pepper	1,000	Piedmont
Lycopersicum esculentum	Tomato	700	Piedmont
Fragaria x anannassa	Strawberry	650	Piedmont and valleys
Prunus persica	Peach	400	Piedmont and valleys
Citrus reticulata	Tangerine	200	Piedmont
Citrus paradisi	Grapefruit	100	Piedmont

Data from the Economics and Statistics Section of the EEAOC available at www.eeaoc.org.ar.

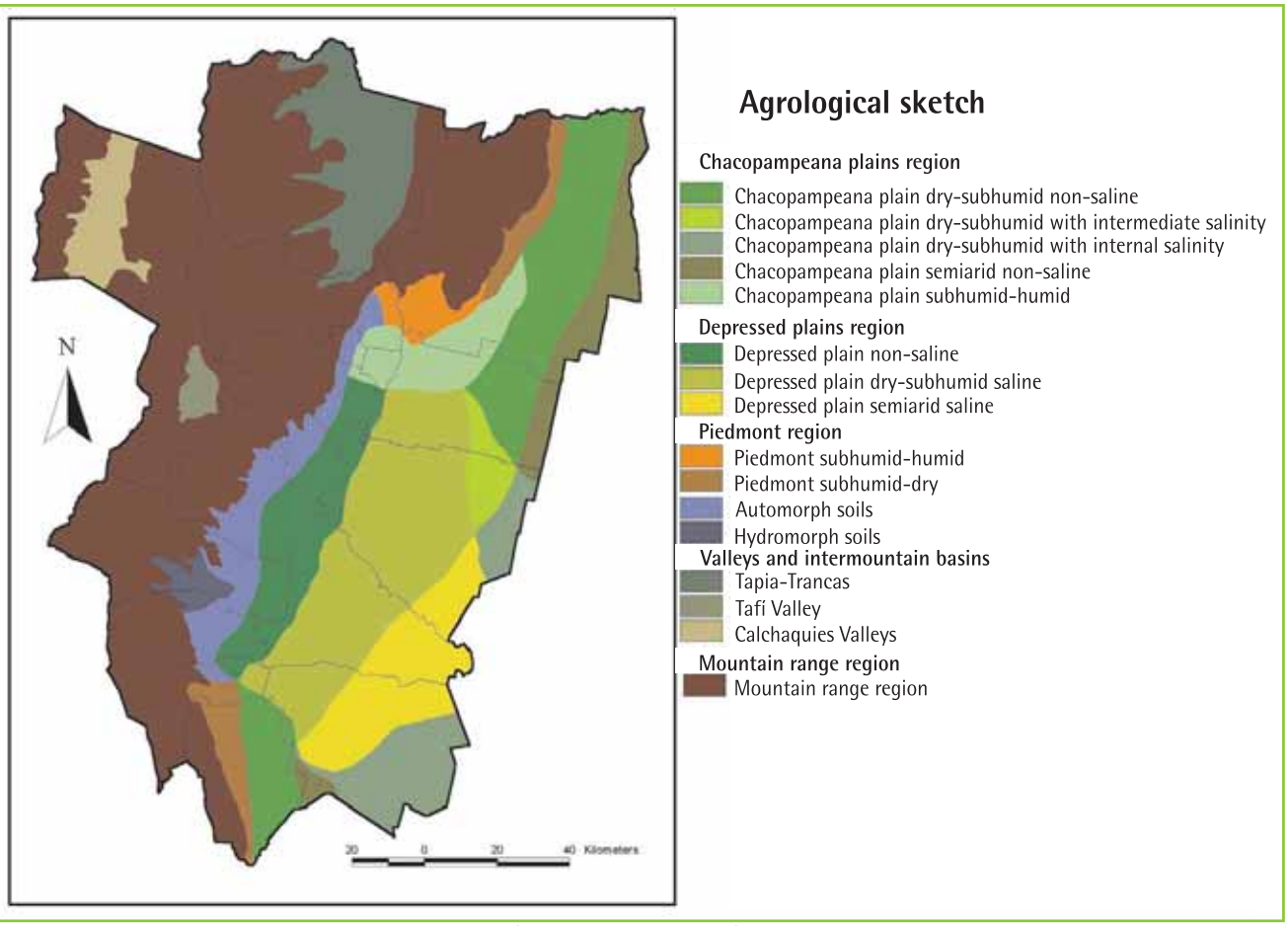

Figure 1. Agrological regions in the province of Tucumán (Zuccardi y Fadda, 1985).

at the end of spring. In the valleys, where temperatures are lower, maturation occurs in the summer months. Figs and mangoes also ripen during this period while guavas do so towards the end of the season. The ripening of citrus starts at the end of summer and goes on throughout the winter. The first to ripen are grapefruit (*Citrus paradisi* Macfadyn), followed by oranges and tangerines (*Citrus reticulata* Blanco). Lemons presents fruit throughout the year; the largest production (90%) occurs in the fall-winter (March to September) and it is mainly exported. The remaining 10% is harvested in the summer and it is commercialized in the local market.

Population dynamics

The presence of host trees associated with homes, where control measures against fruit flies are seldom carried out, together with the abundance of wild host species along the slopes of the Aconquija range (piedmont area), allow the populations of both species to find hosts for their development and propagation. However, despite the diversity and availability of fruits, the weather conditions, the fruit bearing periods and the preferences towards certain hosts will condition the degree of infestation as well as the abundance of the species. For instance, *C. capitata* populations are practically undetectable in winter (see Chapter VI), a time during which the greatest offer of sweet citrus fruits occurs. Moreover, although *A. fraterculus* adults can be captured in traps during the whole year, this species seems to be much more conditioned to the presence of certain hosts since it predominates in the native species and, within the foreign ones, in guavas, plums, peaches and apricots found in environments scarcely changed by the action of man. The first population peak of this species, after the winter months, is greatly conditioned by the start of the spring rains (Jaldo, 2001).

FINAL CONSIDERATIONS

The productive and climatic conditions of the province of Tucumán have a significant impact on the populations of these two fruit fly species.

The province of Tucumán has over 550,000 ha with crops, out of which 200,000 correspond to sugar cane, 280,000 to corn and, within the fruit and vegetable production, the largest area is covered with species such as lemons and avocados of the "Hass" variety. The condition of these two plant species as natural hosts for several fruit flies is questioned.

The surface with hosts is then limited. Within commercial plantations it would not be greater than 2,500 ha, where oranges, tangerines, grapefruit and other avocado varieties are mainly found. These species ripen in winter, at which time fruit fly populations are low. The presence of multiplying hosts in the spring is limited to stone fruit trees, which exist only in a small scale. During the summer months native hosts are found in areas with wild vegetation and the hosts present in home orchards.

All these factors make the distribution of flies concentrate within certain areas and condition it strongly by the ripening phenology of the hosts and by the preference of the fruit flies towards one host in particular. In addition, the climatic characteristics affect the population abundance, which in the case of *C. capitata* results in practically undetectable populations during the winter and in *A. fraterculus* limits it to wet areas.

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