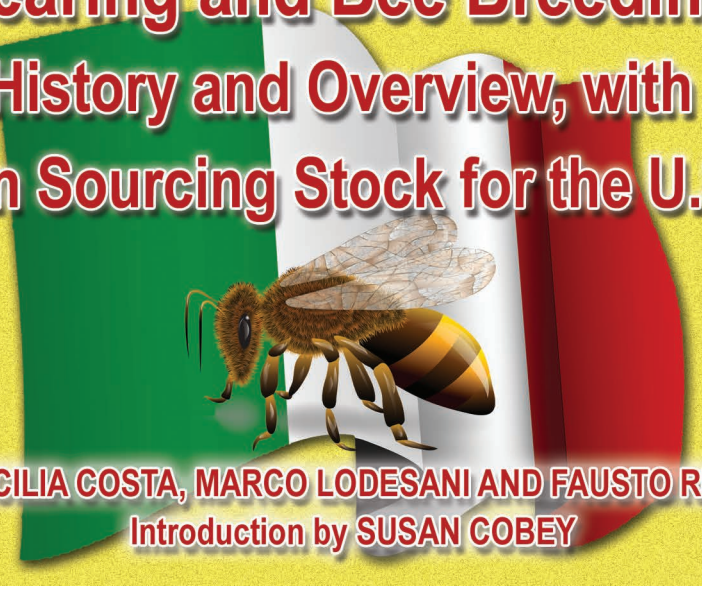
Queen Rearing and Bee Breeding in Italy: A Brief History and Overview, with a Focus on Sourcing Stock for the U.S.



by CECILIA COSTA, MARCO LODESANI AND FAUSTO RIDOLFI
Introduction by SUSAN COBEY

Introduction

Beekeeping in Europe is largely focused on maintaining a region's native subspecies. Research institutes, queen producers and beekeeping organizations collaborate to select and test colony performance of a specific subspecies. Each group is devoted and concentrates on maintaining pure racial characteristics with known pedigrees. The exception is the Buckfast program, where several subspecies have been selected and hybridized to maintain this strain.

Unlike European beekeeping, the general honey bee population in the U.S is racially mixed. Honey bees are not native to America and additional importations have been restricted since the 1922 regulation imposed to prevent the introduction of tracheal mites. A small sampling of several subspecies were imported before this ban, and some of this has been propagated to establish the beekeeping industry we have today. Over time, this population was subject to genetic drift, beekeeper selection and continuing bottleneck events, including the impact of parasitic mites and "Colony Collapse Disorder".

Considering the limited founding population introduced into the U.S. and given the challenges the beekeeping industry faces today, Washington State University continues to be involved in an effort to diversify the U.S. gene pool. Under permit from the USDA-APHIS, WSU has imported honey bee germplasm from stocks collected within their original homelands. Importations, are limited to semen, to reduce the risk of introducing pests and pathogens potentially carried by live bees.

In cooperation with the California queen producers, the imported stocks are being incorporated into U.S. breeding stocks to benefit the industry. Dr. Cecilia Costa and Dr. Marco Lodesani from the Ministry of Agriculture (CRA-API) and Fausto Ridolfi, active member of the Italian Bee Breeders Association, have been key in helping WSU source Italian stocks in Italy. This article provides a historical overview and methods used to select and maintain Italian honey bees in Italy.

The Beginning of Queen Production in Italy

About 150 years ago, in the area surrounding the historic city of Bologna in the region Emilia-Romagna, a group of beekeepers became specialized in intensive queen bee production. The extent of these enterprises became important economically both at the national and international level.

The specialization in queen production occurred shortly after the introduction of boxes with movable frames and thus with the spread of the so-called "rational beekeeping". The commercial activity at first involved swarms and colonies in natural hives, then developed into the sale of small swarms with just a few hundred bees which were removed from natural hives for honey extraction, which would otherwise simply have been culled. With the stimulus of growing requests, this demand developed into specialized queen rearing operations. Due to the excellent qualities of the *Apis mellifera ligustica* queens, which were sold together with a small colony, many beekeepers in Italy and abroad replaced their

Sue Cobey collecting honey bee semen and wiping the brow of Fausto Ridolfi exhausted from collecting drones from breeding stock in his apiary.

A toast to the Italian honey bee, new friends and a successful collection trip. Left, from front to back: Elisa, Manuele Cantoni, Jackie Park-burris, Sue cobey. Right, from front to back: Daniele Alberoni, Steve Sheppard, Fausto Ridolfi.

queens with Italian queens originating from the Bologna area. These highly desirable bees became the founding basis of stock in breeding enterprises in other parts of the world.

Among beekeepers, those who were most active in developing and establishing new beekeeping techniques during this pioneering stage deserve to be recognized and remembered. These include Lucio Paglia (began activity in 1870), Enrico Tortora (began activity in 1878), Enrico Penna (began activity in 1903), and Gaetano Piana (began activity in 1910). It is with thanks to these beekeepers that the intensive queen rearing and breeding in the Bologna area began.

These early queen rearing operations were visited in September 1913 by the famous C.P. Dadant. Dadant stated in a letter, (according to the beekeeping journal L'apicoltore, vol 47, issue 6, p.113) that he had seen Enrico Penna's apiary and described it as the absolute best queen rearing operation in the world. He also noted that the other Bolognese operations were similar to this high quality level.

Indeed, the demand for Italian queens was so high that the conditions promoted the establishment of additional queen breeders, especially for the internal market.

The rearing system was especially developed keeping in mind the colony's natural growth and reproduction: the "Italian way" and thus produced high quality queens. During these early years there were many initiatives in the field of queen rearing and many ingenious ideas concerning long-distance transport methods and ways to ensure successful introduction of the queens into new colonies. Thousands of Italian queens were posted worldwide with the collaboration of the postal services, which at the time offered an excellent service.

With the international movement of bees, the need for sanitary control was recognized. Between 1920 and 1925 many countries established sanitary barriers due to the fear of tracheal mite disease, which was thought to have caused heavy colony losses in the United Kingdom. Many of these restrictions and regulations aimed at preventing the spread of foulbrood and other pathogens are still in place today.

In 1935 the National Apiculture Institute was founded and based in Bologna, with the aim of certifying the sanitary control for the export of the Italian queen bees. Over the years it has widened its scope and is now a unit of the research body of the Ministry of Agriculture (CRA-API), but still has among its aims the preservation and improvement of the Italian honey bee, *Apis mellifera ligustica*.

In 1935, due to the autarchic and colonial aspirations of the ruler Mussolini, severe restrictions on foreign trade were imposed in Italy. Then, during the years of the war (1940-1945) the honey bee population and the beekeeping sector were devastated. After the war, beekeeping operations started almost from scratch.

The new queen breeders all used the Doolittle system, which involved a more intensive production of queen cells per rearing unit, and also allowed for royal jelly production.

These were bleak years and many breeding operations in the world evolved towards great dimensions and cross-race breeding. In the 1970s and 1980s Italian breeders could rely on pure *A. m. ligustica* populations present in the Appenine mountains and valleys and in most of the Po Plain. At the end of the 1980s the arrival of the varroa mite caused great losses and beekeepers bought bees wherever available. This, together with faster and better vehicles which increased the practice of migratory beekeeping, placed *A. m. ligustica* breeders in a constant alert situation .

Today, many threats upon the integrity and purity of *A. m. ligustica* exist. However, there are many initiatives stemming from the institutions, research bodies, breeders and beekeepers associations, to protect and improve the Italian bee that nature gave to Italy as a great gift, so that it may be in the future what it was in the past.

A favorite Breeder Queen selected by Fausto Ridolfi

The National Registry for Italian Queen Breeders

Among the initiatives to safeguard the Italian bees in Italy, there is the National Registry for Italian Queen Breeders and Bee Producers, founded in 1997 by the Ministry

Enrico Penna's catalogue from 1910.

Bologna, Italy 1913. From the left: Gaetano Piana, Enrico Penna, Carlo Carlini, C.P. Dadant.

of Agriculture. This extended the regional experience of the Emilia Romagna Registry of Queen Breeders (founded in 1991), to a national level. The ultimate aim of the Registry is to protect and improve the autochthonous Italian honey bee races: *Apis mellifera ligustica* and *Apis mellifera siciliana*, by coordinating and supporting breeding and conservation activities.

In Italy, as in most European countries, keeping bees of the autochthonous races is not obligatory, and trade of *Apis mellifera* queens and package bees between European Union countries is regulated on the basis of health requirements, similarly to trade out of the EU. However, a study based on molecular tools on 360 colonies across the country showed that Italian honey bees still have unique genetic characteristics typical of the subspecies *A. m. ligustica*, which deserve to be conserved (Dall'Olio et al., 2007). Another study considered performance and productivity of different *A. m. ligustica* populations and highlighted the presence of genotype-environment interactions, which indicate the existence of specific adaptations to local environment (Costa et al., 2012).

Thus, the Registry provides breeders who are keen on conserving and improving the local Italian bees with some tools to support their work. Enrollment is voluntary and based upon certain requirements. To register, breeders must be professional or semi-professional beekeepers (commercial registration), managing at least 100 colonies, with technical infrastructure suitable for queen production, and have been producing queens/package bees/artificial swarms for at least 3 years (for sale or for own enterprise). Admission is decided upon by the Registry's executive committee, composed of 9 members representing the Ministry of Agriculture, the Ministry of Health, the Regional administrations, the enrolled breeders, the queen breeders association (www.aiaaregine.com), and expert bee scientists or technicians working in public institutions. Admission is decided upon after a field inspection has taken place by the Registry's central office, which is represented by CRA-API staff, who collect samples representative of the breeder's population and verify that the infrastructure is adequate. Collected samples are analyzed to check that they conform to the morphometric standards of *A. m. ligustica* or *A. m. siciliana*.

Once they are enrolled, breeders send samples of their breeding stock at least every other year to the central office, to check conformity with race standards. Furthermore, samples of queens representing the breeding lines undergo performance testing. These activities have the double role of providing the breeder with information on their stock, which can be certified, and of monitoring the quality of the breeders stock and breeding operation.

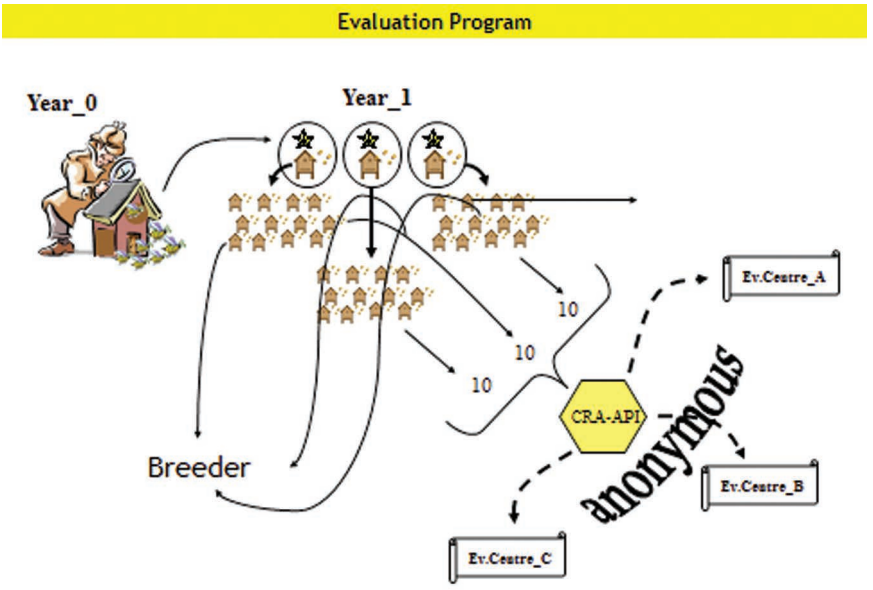
The performance testing is carried out on groups of sister queens. Each breeder chooses 1 – 3 breeding lines from which to send 10-15 daughters each to the Registry's central office. The queens are marked with unconventional colors, so that later the Registry queens can be distinguished from other queens, and are all packed in the same kind of queen cage (Nicot), to guarantee anonymity. All breeders whose queens are going to be tested send the queens to the Registry's

Mating station belonging to Enrico Penna 1920.

Logo of the Registry of Italian breeders

central office on the same day (give or take one). There, the queens are coded and prepared for distribution to the testing centers. These are beekeeper associations that have agreed to test the queens according to a common protocol and with a small compensation.

The breeders themselves also test part of their queens, and some breeders test other breeders' queens also. The exchange of queens is carried out every year during the first week of July. Each tester receives at least 10 queens, and these usually belong to several different breeding lines. To allow for genotype-environment interactions, choice of testing location of queens takes into account location of queen origin, so as to make sure that queens are tested in their area of origin, as well as partly outside the area of origin. The caged and coded queens are inserted into newly formed nucleus colonies, starting from package bees or specially made nucleus colonies with 3 frames of brood and two frames of honey. Different testers use different methods for starting the colonies, but the important thing is that the same method be applied in the same apiary, which represents the testing unit. Within each apiary the colonies are treated, inspected and tested in the same way, while between apiaries conditions may vary.



Evaluation program of Registry queens: groups of sister queens from 1-3 breeding mothers are sent to the CRA-API (at least 10 per line) who distributes them anonymously to evaluation centers (expert beekeepers). Breeders keep part of the sister queens for self evaluation.

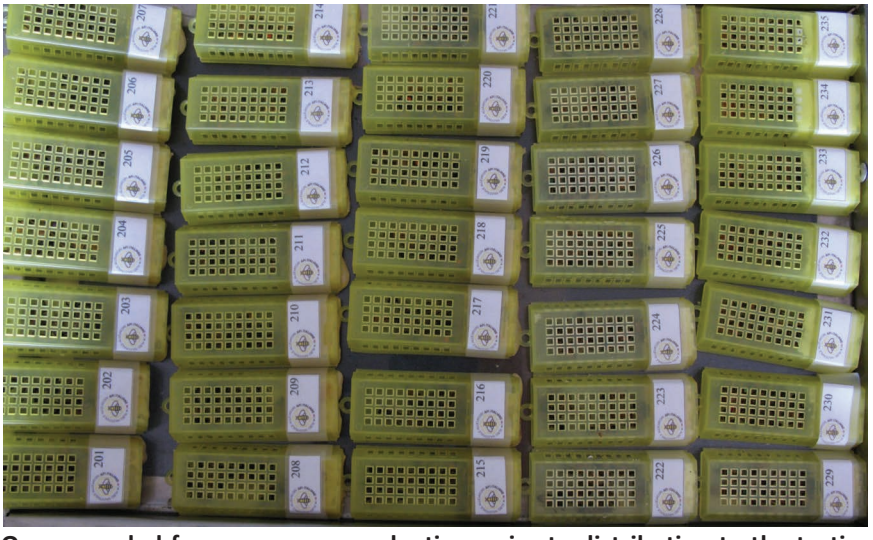
The main traits that are considered in the testing are honey production, swarming tendency and defensive behavior. In recent years some breeders have shown interest in selection for hygienic behavior, and this is evaluated in some testing centers. The method currently used is the freeze-killed brood assay with liquid nitrogen, however this has proven quite difficult to manage for many breeders and testers.

The colonies are evaluated for performance starting from the following spring and throughout the whole season. In the fall, the evaluation data from the testing centres and from the breeders are collected by the Registry's central office, which performs check and validation and inserts the data into a centralized online database (**www.beebreed.eu**). Here they are processed according to a statistical model used for other animals (the BLUP Animal Model) especially modified for bees by Bienefeld et al. (2007).

Thus, for each queen inserted into the registry, breeding values are produced for each trait. The advantage of these breeding values is that all known information is included in the prediction of the value of the queen as a breeder. This includes all the performances of her siblings and ancestors, which environments she was tested in, which queens she was tested with. This model is applied only on the maternal side, as none of the Registry's breeders uses a single paternal line with controlled mating, but rather, they tend to maximize variability by producing drones from many different lines. These breeding values are published online and can be consulted by anyone, either via the webpage set up by the German Bee Institute in Hohen Neuendorf, which manages the processing of the breeding values also for other races, associations and institutions, or via the webpage of the Registry hosted by the CRA-API website (**www.cra-api.it/**....). The breeding values obtained from the performance testing of each spring-summer are usually available by the following mid-February.

The CRA-API manages at least one performance testing station per year and coordinates activities with the other centers. Thus, it was the ideal place for Susan Cobey and Steve Sheppard when they started looking for Italian colonies to use to enrich the genetic diversity of the American "Italian bee" population, as each testing station contains a mixture of stock from different breeders.

This article will be followed by a series of articles looking at the incorporation of



Queens coded for anonymous evaluation, prior to distribution to the testing centers.

imported germplasm from three subspecies of European honey bee stocks into U.S. bee breeding programs. As discussed here, this includes the Italian honey bee, *Apis mellifera ligustica*. Importations of *Apis mellifera carnica*, to enhance the New World Carniolan stock and importations to *Apis mellifera caucasica* to re-establishment the Caucasian bee, will also be presented.

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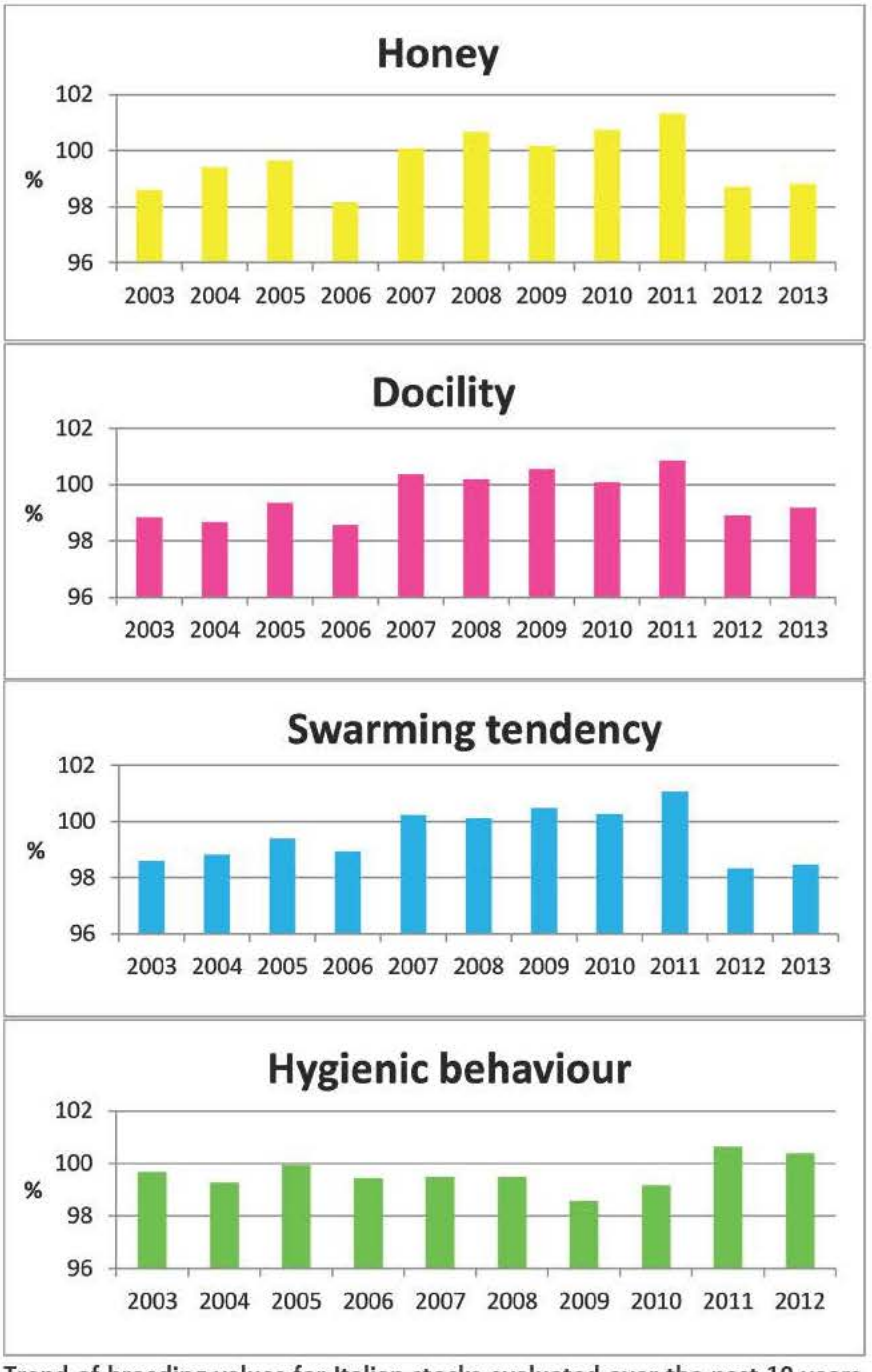

Trend of breeding values for Italian stocks evaluated over the past 10 years, based on selection for honey production, docility, reduced swarming tendency and hygienic behavior.