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Development of an experimental geographic information system for bee-keeping in the Marche region of Italy

Guido Cordoni[1] & Loreta Maria Spagnuolo[2]

Summary

Bee-keeping in the Marche region of Italy is an ancient tradition. Besides the production of honey and other products of the apiary (wax, propolis, royal jelly, bee bread and venom), bees also play a fundamental role in the pollination of cultivated and natural plants. For these reasons, and to update information on the status of apiculture in the Territorial Zone 7 (TZ 7) of the Marche Region of Italy, a survey was conducted in 2005 using geographic information system (GIS) technology. A CD-Rom was developed in html; this tool enables the visualisation of data using any operating system and browser. We collected information on the health status of 57 apiaries out of 169 for a total of 1 570 hives. Samples of honey were tested for the presence of antibiotics and pesticides. The data collected on American foulbrood showed that this disease is endemic in the area and the extent of spread appears to be largely under-estimated. No antibiotics were detected in any of the honey samples tested using the bacterial growth inhibition method. Similarly, high performance liquid chromatography did not detect any pesticide residues. Further research will be conducted by geo-referencing all apiaries in the same area and in apiaries located in other territorial zones of the Marche region.

Keywords

American foulbrood, Bee-keeping, Geographic information system, Honey sampling, Italy, Marche region.

Sviluppo di un sistema informativo geografico sperimentale per l'apicoltura nella Regione Marche in Italia

Riassunto

L'apicoltura nella Regione Marche vanta antiche tradizioni. Oltre alla produzione di miele e degli altri prodotti dell'apiario (cera, propoli, pappa reale, polline e veleno) le api hanno anche un ruolo fondamentale nell'impollinazione di piante colturali e selvatiche. Per queste ragioni, allo scopo di incrementare la conoscenza dello stato dell'apicoltura nella Zona Territoriale 7 (ZT7) della Regione Marche, è stata condotta un'indagine nell'anno 2005 usando la tecnologia GIS. È stato creato un CD-Rom in linguaggio HTML, questo strumento rende possibile la visualizzazione dei dati usando qualsiasi sistema operativo e qualsiasi browser. Abbiamo raccolto informazioni circa lo stato di salute di 57 apiari su 169 per un totale di 1.570 arnie ed abbiamo prelevato campioni di miele che sono stati testati per la presenza di antibiotici e pesticidi. I dati raccolti riguardanti la peste americana evidenziano che la patologia è endemica nel nostro territorio e, a nostro avviso, è largamente

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sottostimata. Fortunatamente non sono stati rilevati antibiotici in nessuno dei campioni di miele testati con il metodo dell'inibizione della crescita batterica. Allo stesso modo l'HPLC non ha rilevato residui di pesticidi. In futuro verranno condotte ulteriori ricerche georeferenziando tutti gli apiari nella stessa area ed estendendo la georeferenziazione agli apiari che si trovano nelle altre Zone Territoriali delle Marche.

Parole chiave

Apicoltura, Campionamento del miele, Regione Marche, Peste americana, Sistema informativo geografico.

Introduction

Bee-keeping is an ancient practice in the Marche region of Italy. Since 1883, bee-keeping has been the subject of a specialist review, *Le api e I Fiori*. In 1903 a congress of bee-keepers founded a national federation for apiculture in Osimo. This federation became an official institution a year later in Ancona (Fig. 1) (2). Besides the production of honey and other products of the apiary (wax, propolis, royal jelly, bee bread and venom) bees play an essential role in the pollination of cultivated and natural plants (3). Bee-keeping can be considered an important source of income for small and middle-size farms and it is considered an 'animal husbandry' activity, as confirmed by the fact that bee diseases are included in the list of notifiable animal diseases of the World Organisation for Animal Health (OIE: Office International des Épizooties). In 2005, we conducted a survey to update information on the status of apiculture in Territorial Zone 7 (TZ 7) of the Marche region (Fig. 2).

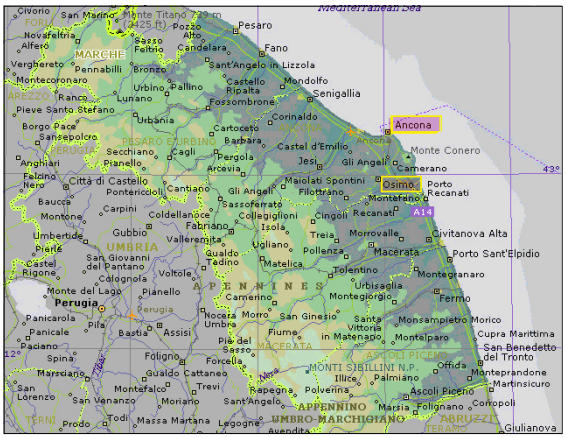

Figure 1
The Marche region: the city of Ancona and the town of Osimo are highlighted

Figure 2
The Marche region (in yellow) on the Adriatic coast of Italy, showing the territory under Territorial Zone 7 jurisdiction

The TZ 7 had set following general objectives:

- gain the confidence of bee-keepers
- control and reduce the incidence of diseases of the apiary
- oversee the correct application of therapeutic and prophylactic treatment
- control the quality of honey.

To achieve these objectives the TZ 7 included the following activities:

- locating bee-keepers present in the territory under TZ 7 jurisdiction
- geo-referencing the apiaries
- verifying the health status of the apiaries
- posting of health and technical advertisements
- sampling of honey produced
- creating a geo-referenced map linked to a database containing the data obtained from bee-keepers.

Materials and methods

The study was conducted between July and November 2005 in the municipalities belonging to TZ 7 (Table I; Fig. 3). Bee-keepers in TZ 7 were identified on the basis of their registration at the *Consorzio Apistico Provinciale*

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(Provincial Consortium of Bee-Keepers) in Ancona.

Table I
Hive distribution by municipality

Municipality	Number of hives
Agugliano	75
Ancona	615
Camerano	28
Camerata Picena	100
Castalfidardo	90
Chiaravalle	10
Falconara Marittima	30
Loreto	0
Monte San Vito	90
Montemarciano	54
Numana	22
Offagna	51
Osimo	320
Polverigi	0
Sirolo	85

The bee-keepers were contacted by telephone to arrange interviews. To keep costs at a minimum, we only contacted bee-keepers who had more than ten hives. Visits were made during the annual honey extraction period.

A standard form was designed prior to our visits to the bee-keepers, which included the following information:

- name and last name
- registration number used (or given) by at the *Consorzio Apistico Provinciale*
- address of bee-keeper
- address of the apiaries
- number of hives
- latitude and longitude of the apiaries
- type of marketing of the honey (i.e. domestic use, producer-consumer, consortium)
- existence of an authorised laboratory for honey extraction
- treatments applied
- problems encountered in the management of the apiaries
- advice to bee-keepers
- notes.

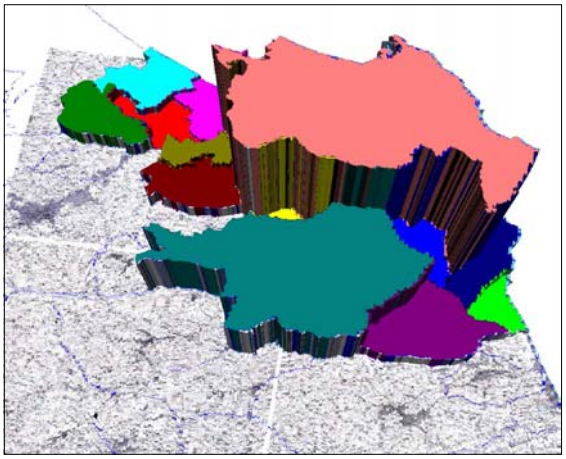

Figure 3
Municipalities the Territorial Zone 7 Asur Marche, according to the number of hives

When we visited the bee-keepers, we tried to overcome the natural mistrust many breeders sometimes have in public institutions by explaining to them that the aim of the interview was for purely cognitive purposes and was not intended for inspection or repression.

After completing the form in the presence of the bee-keeper, we discussed the situation of his/her apiaries, offering, when relevant, technical and health recommendations.

We collected honey samples from the ripener. Each sample was subdivided into four parts of 250 g. Samples were collected using an airtight container. Within 24 h, three parts were delivered to the *Istituto Zooprofilattico Sperimentale dell'Umbria e delle Marche* for laboratory analyses and one part was stored by the bee-keeper for possible subsequent analyses.

Samples of honey were tested for the presence of antibiotics and pesticides. After sampling, we visited the apiaries and established the geographic coordinates with a global positioning system (GPS). The GPS instrumental error (minimum 20 m) was not corrected since the level of accuracy of the instrument was adequate for the scope of the study (1).

We obtained maps (1:25 000) of the territory under TZ 7 jurisdiction from the Marche region Cartographic Institute; these maps were scanned and imported using GIMP2 software. MapInfo® was used to create a geographic information system (GIS) database. For geo-referencing, the scanned maps used the coordinates of five points that were easy to

recognise on the maps (churches, monuments, railway stations, etc). A vectorial map showing TZ 7 municipality borders was overlapped on the raster map.

We visited 57 apiaries out of 169 for a total of 1 570 hives. The number of hives per apiary ranged from 5 to 100, with an average of 27.5 (standard deviation: 18.4). Nine of 57 bee-keepers reported having problems with American foulbrood which they hoped to have eliminated by burning the frames and disinfecting the hives with a sodium hypochlorite solution and flaming them with a burner. No typical American foulbrood signs were found when the suspect apiaries were inspected. Information on the consistency and spatial organisation of the apiary was collected during each interview; all interviews provided valuable insight in regard to local bee pathology.

The local prevalence of American foulbrood has been estimated at 15.79% (lower confidence limit [LCL]: 10.06%; upper confidence limit [UCL]: 24.26%); this value was calculated by taking into account only those bee-keepers who claimed to have encountered problems with the disease. This value was estimated using 'Campioni' software (*Istituto Zooprofilattico dell'Abruzzo e del Molise 'G. Caporale'*). Varroasis occurs in the entire area at various levels of infestation and the disease can be considered endemic. Information on the presence of authorised laboratories for honey production was also collected. On account of the flight-range of honey bees, we drew a ring buffer with a radius of 3 km around the apiary in which American foulbrood had occurred. This buffer area included 27 apiaries (Fig. 4). A CD-Rom called 'API-Info' was developed in html; all data obtained can be visualised with this tool, using any operative system and any browser (Figs 5a and b). No antibiotics were detected in any of the honey samples tested using the bacterial growth inhibition method. In addition, high performance liquid chromatography (HPLC) did not reveal any pesticide residues.

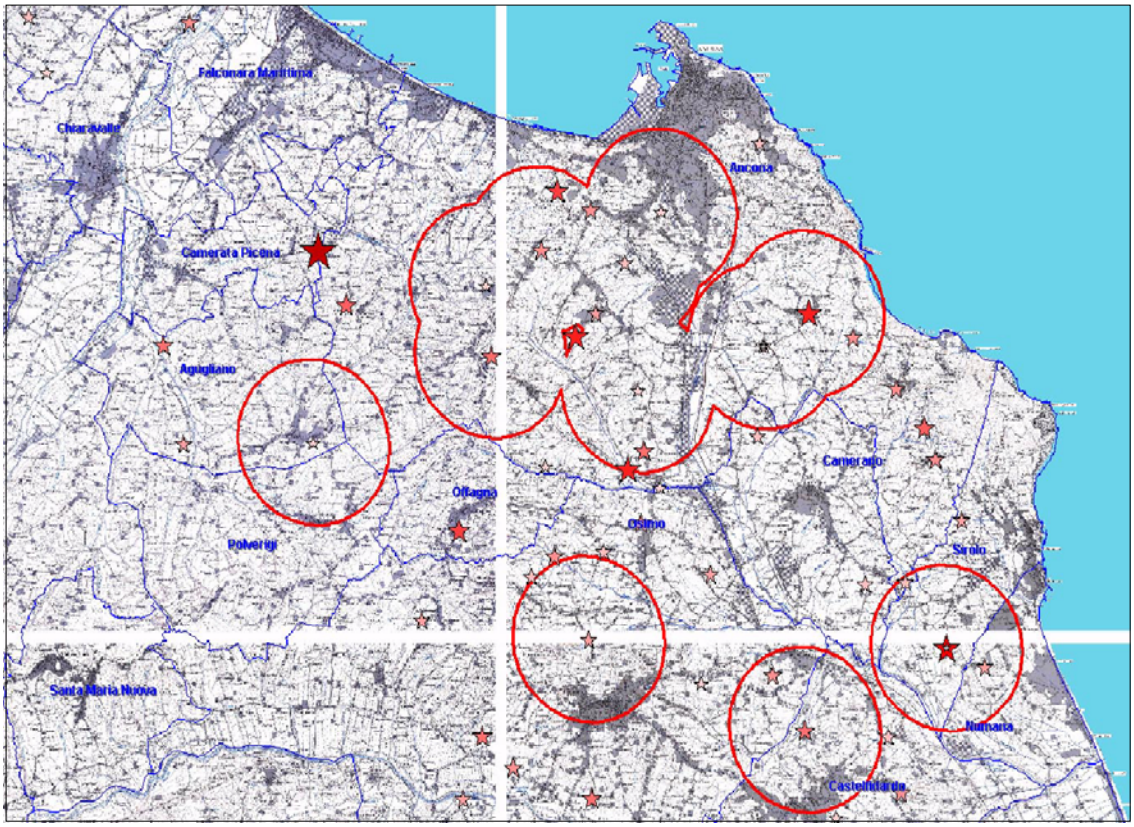

Figure 4
Cases of American foulbrood in Territorial Zone 7 ASUR Marche territory declared by the bee-keepers

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(a) Home page (b) Information sheet

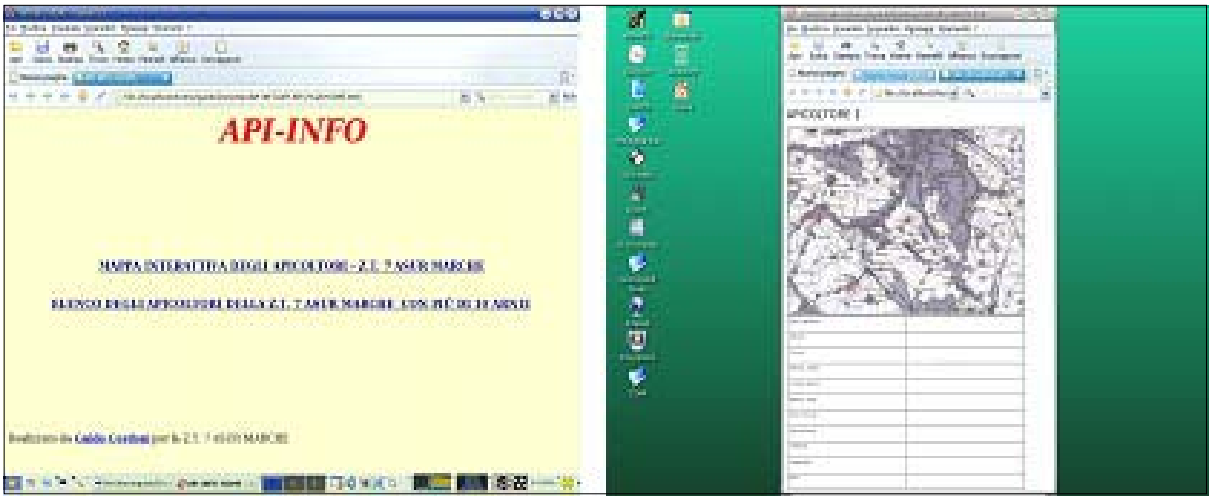

Figure 5
API-INFO on CD-Rom
These screenshots show API-INFO running under a Linux OS with Opera browser

Discussion

GIS proved to be a useful and flexible instrument for the monitoring and surveillance of infectious diseases (5) and the technology enabled us to highlight data that would not otherwise have been possible (6). Since the information was provided by a limited number of bee-keepers and on account of the fact that they offered the information on American foulbrood problems spontaneously, we feel confident in assuming that the prevalence of the disease in the region is far greater than estimated. Although there is relatively little information available, the data suggest that the disease is endemic.

Statistical data showed that the bee-keeping activities in the Marche region are mostly operated by non-professionals who are no less qualified in apiary management than the professionals, as demonstrated by their ability to control cases of American foulbrood without outside assistance.

Conclusions

In the future, it would be advisable to maintain the control of apiaries located within the ring buffer and to attempt to determine whether the disease is actually present or not. Attempts to enhance cooperation between bee-keepers and the TZ 7 veterinary services will be made, with a view to eradicating this severe bee disease. If these apiaries do become infected, disease prevalence would reach 47.37% (LCL: 37.87%; UCL: 57.40%). Further research will be conducted by geo-referencing apiaries with less than 10 hives in the same area and the area will be extended for geo-referencing of apiaries located in other territorial zones of the Marche region. As GIS systems are able to use both qualitative and quantitative data, they could become a powerful tool for political and disease control policies and would, at the same time, indicate the advantages and disadvantages of different control measures (4). Furthermore, the availability of a GIS system would be invaluable as it would prompt an early response in the case of a disease emergency (4).

It would advisable to extend the investigation of the TZ 7 apiaries to all similar premises in the Marche region. This would lead to a much improved understanding of the health status of bee-keeping in the entire region.

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