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## **COASTAL ENVIRONMENT MANAGEMENT**

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***Si nous avons besoin de lui, lui,  
il n'a pas besoin de nous.  
Il se passe de l'homme à merveille***  
*Jules Michelet (Le mer, 1861)*

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# Environment and Mosquito Control in Coastal Areas

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## Abstract

Vast inhabited coastal settlements often border on natural or

semi-natural areas where large or very large mosquito populations breed. Their control may play a key role in the economic and social exploitation of these environments. A modern approach to mosquito control should envisage global environmental management and opt for low impact measures. The key factor should be larval control through the use of *Bacillus thuringiensis* subsp. *israelensis*, integrated microbiological treatments with all available techniques, including the limited use of chemioinsecticides.

This model of mosquito control was first developed and implemented in Italy, on the coastal areas south of the Po Delta (Northern Adriatic coast) and is now being extended to a vast area of north-western Sardinia, including the Asinara and Alghero Gulfs. The aim of this work is to describe the operative approach adopted in these two important areas of Italy.

## **Introduction**

Vast inhabited coastal settlements often border on natural or semi-natural areas where large or very large mosquito populations breed. In the past, mosquitoes were a serious health hazard, as malaria was transmitted by *Anopheles*; today *Aedes* and *Culex* infestations seriously affect the "quality of life" in neighbouring areas. As considerable economic interests are now vested in tourism, the presence of high density mosquito populations is unacceptable and requires the implementation of effective control measures.

Precise information on the different control methods available (chemical, physical and biological) can be found in the

specialised literature. However there are very few suggestions about how to integrate the various techniques to ensure effective management of the environment.

Mosquito control can play a key role in the economic and social exploitation of the coastal settlements. A well-designed management strategy must make such control compatible with the modern need to safeguard nature. The aim of this work is to describe the operative approach adopted in two important areas of Italy.

## **The traditional approach**

In the past the large-scale *Anopheles* control campaigns conducted in the lowlands of Mediterranean Europe envisaged widespread draining of wet coastal areas and extensive use of chemical products (first Paris green, a double arsenic and copper acetate salt, and subsequently DDT). Unquestionably the most spectacular example of such a campaign was the Sardinian Project promoted by the Rockefeller Foundation in the years immediately following the Second World War (1946-1950). In the summer of 1948, 30,000 people were mobilised in the treatment of 1,200,000 larval sites all over the island (Logan, 1953; for the political aspects see: Tognotti, 1995).

The first major experiment in mosquito control for reasons related to tourism and the economy was conducted on the French Mediterranean coast in Europe from the 1960s onwards. This resulted in the creation of the Languedoc-Roussillon EID (Interdepartmental Mosquito Control Agency). This organisation, which was joined several years later by analogous organisations on the Atlantic coast and in

other areas, rapidly became a cornerstone for operative organisation and scientific expertise. Recently Sinigre *et al.* (1993) summed up the results achieved over the last twenty years with some figures illustrating the region's development: 7 new tourist resorts, 996 hotel complexes, 772 camping sites, 750,000 beds for tourists, berths for 15,600 boats in 23 new ports and, above all, 8 billion francs revenue from tourism, only 0.3% of which was absorbed by the budget of the EID.

Today, even in the most advanced areas, the virtually indiscriminate use of chemical insecticides, albeit of low environmental impact, is the rule. Justifications in terms of costs certainly do not take account of the long-term effects of these substances. Moreover actions which seriously modify the environment, such as extensive draining of wet coastal areas, are no longer feasible, at least on a large scale.

Neither is the management of natural areas such as the Camargue (Rhône delta) entirely convincing. Here the natural protected area is seen as a reserve to be protected from all forms of human intervention, so this precludes even biological treatment. As a consequence, neighbouring areas are subjected to particularly intense chemical treatment to control the mosquitoes coming from the protected areas (Sinigre, 1990).

## **Global environmental management**

A modern approach to mosquito control should envisage global environmental management and opt for low impact measures. The key factor should be larval control through the use of *Bacillus thuringiensis israelensis* (Bti), integrating microbiological treatment with all available techniques,

including the limited use of chemioinsecticides.

This model of mosquito control was first developed and implemented in Italy, on the coastal areas south of the Po Delta (Northern Adriatic coast) and is now being extended to a vast area of north-western Sardinia, including the Asinara and Alghero Gulfs.

### ***The Po Delta Park (Emilia-Romagna)***

One of the largest systems of coastal wetlands in Italy extends south of the modern Po Delta as far as the city of Ravenna. It consists of freshwater and salt marsh lagoons - the Lagoon Valleys of Comacchio and surrounding areas - formed by the river and its movements through the centuries (see for example Bondesan, 1982). Large-scale drainage work, completed only in 1970, reduced the extension of these so-called lagoon valleys to 10,200 *ha* (the drainage of Mezzano alone involved approximately 18,000 *ha*).

In the early 1960s a number of tourist resorts grew up in the coastal area within the municipality of Comacchio. Twenty years later these had assumed major economic importance on a regional and national level. However the mosquitoes severely limited their exploitability for the purposes of tourism.

The first mosquito control operations began in the same period and were the result of local initiatives managed partly by the Comacchio municipal council and partly by private companies. The techniques used were fairly crude and the results unsatisfactory.

In 1991, faced by a generally problematical situation and with

the threat of further severe repercussions for the economic growth of the area, the Emilia-Romagna Regional administration passed legislation (L.R. [Regional Law] of 13 June 1991, no. 15; "Interventi di lotta ai Culicidi nelle località turistiche costiere inserite nell'area del Delta del Po" [Actions to control Culicidae in coastal tourist areas of the Po Delta]) approving financial backing "to contribute to a substantial improvement in the quality of urban life" of these areas (Schiff, 1993; Sandri, 1993).

The same year the local administrations (Emilia-Romagna Region and Municipality of Comacchio) drew up a mosquito control program. The "Guido Grandi" Entomology Institute of the University of Bologna was assigned responsibility for scientific management of the project; the Centro Agricoltura Ambiente of Crevalcore (province of Bologna) was placed in charge of experimentation and operative co-ordination; and public and private bodies were commissioned to conduct the disinfestation activities.

A number of Authors have already written on the strategies adopted and results achieved by the project - from the preliminary report of Pantaleoni (1993) to the subsequent papers of Celli *et al.* (1994), Bellini & Veronesi (1994), Veronesi *et al.* (1995) - and we refer to these for further information.

Larval control was the mainstay of the project work. The results of an entomological and ecological study spanning a number of years were used to map the entire area and to study the distribution of larval sites, seasonal variations and the density of the mosquito populations. Priority was given to interventions using microbiological insecticides based on Bti. Chemical products were used only in special cases, such as the treatment of road drains. Experiments in biological control using larvivorous fish (*Gambusia holbrooki*) were attempted

with satisfactory results.

The most important larval sites were located in natural areas, some of which were protected. Access difficulties, the fragility of the ecosystems and the presence of ecologically important fauna made it indispensable to use aeroplanes with negligible environmental impact.

In urban areas the resident and tourist populations were mobilised and provided with all the information and equipment needed for the treatment of domestic microsites.

An adult monitoring system based on CDC type attractive traps baited with dry ice were used to verify the overall results of the programme. By using an intervention threshold (Pantaleoni, 1996), this system allowed larvicide treatment to be integrated with selective adulticide treatment.

### *North-west Sardinia*

The coastline of this area of Sardinia is largely rocky. Low, sandy shores backing onto wetlands are found in just a few areas (Oggiano & Viridis, 1991). The first of these is the Calich salt marsh near Alghero. Further to the north a vast Würmian dune adjoining the beach of Porto Ferro has isolated a low-lying area from the sea, creating lake Baratz. On the eastern side of the Stintino peninsula there are areas of salt marsh (the Casaraccio, Pilo, Genano and other salt marshes) delimited by banks of dunes. Finally, the northern coast has two large flat areas, the Platamona salt marsh and the plain of Coghinas.

Malaria was extremely widespread in this area until the 1950s. During the aforementioned Sardinian Project, ERLAAS

(Regional Body for Anopheles Control in Sardinia) intervened with large-scale deployment of human and material resources. This operative organisation subsequently came under the control of the Sardinian regional administration, which first transformed it to CRAAI (Regional Anti-malarial and Anti-Insect Centre) and then more recently handed responsibility for it over to the provincial administrations.

A problem of an organisational rather than economic nature has arisen recently. Mosquito control had remained deeply entrenched in the methods of the past, with a set programme and routine actions. The techniques and products employed suffered from environmental drawbacks and the objectives required redefinition.

In 1995 the Assessorato all' Ambiente (Environment Council) of the Sassari provincial administration financed a working program which should lead within just a few years to a redefinition of the problems, objectives and strategies.

A closely-knit monitoring network (40 stations in the area taking a total of 2,489 samples) was immediately set up with CDC type adult traps baited with dry ice. The data obtained yielded precise guidelines for orienting future mosquito control programmes in the areas under study (Pantaleoni & Nuvoli, 1997).

Annoyance to the inhabitants was caused principally by small-scale infestations of *Culex* and to a lesser extent of *Aedes* and *Coquillettidia*. The following solutions were proposed:

- to train operatives to monitor and control the limited number of breeding sites of *Aedes*;
- to reduce the density of *Coquillettidia* through environmental management operations in the only large breeding site in the area (the Platamona salt marsh);
- to introduce larvivorous fish into the artificial microbasins

- used for agriculture;
- to abandon all adulticide treatment;
  - to initiate a campaign to mobilise the human population in the destruction of peridomestic *Culex* breeding sites.

The situation must naturally be controlled by a monitoring network which, while being less extensive, must nonetheless be able to detect new developments in infestation levels.

The information dissemination campaign began with the publication of an informative booklet (Pantaleoni, 1997) aimed at secondary schools.

## **Conclusions**

Even though the marked differences - both natural and man-made - between the two areas require specific approaches, the schemes designed for the two projects are very similar indeed. Local administrations are responsible for the financial and legislative aspects, for indicating the objectives to be attained and for co-ordinating and monitoring activities. A scientific body manages the technical and organisational aspects, directing public or private organisations in charge of the various operational roles. Bti treatment is implemented following meticulous mapping of mosquito breeding sites. A network for monitoring the adult mosquito population allows results to be checked and indicates when it is necessary to carry out chemical adulticide treatment. New techniques, some of which have already been partially tested, such as aerial spraying, modelling infestations, biological control by means of larvivorous fish, are studied with a view to future implementation, together with new ways of promoting awareness and information dissemination.

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