

## Seasonal abundance of *Culicoides imicola* and *C. obsoletus* in the Balearic islands

M.A. Miranda, C. Rincón & D. Borràs

Department of Biology, University of the Balearic Islands, Cra. Valldemosa km 7.5, CP:07122, Palma de Majorca, Spain

### Summary

An outbreak of bluetongue (BT) was declared on the Balearic islands of Spain in September and October 2000. In 2001 and 2002, an intensive survey was conducted on cattle farms in Majorca and Minorca for the principal vectors in the Mediterranean Basin, *Culicoides imicola* and *C. obsoletus*. Adult *Culicoides* were collected once a week between June 2001 and December 2002 using CDC light traps. The results from 348 light-trap collections revealed that, in addition to other species of the genus *Culicoides*, both *C. imicola* and *C. obsoletus* appear to be well established on both Majorca and Minorca. Furthermore, both species showed a different seasonal abundance pattern: peak adult populations of *C. obsoletus* occurred in July, while those of *C. imicola* peaked in October. These findings indicate that the principal vector in the outbreak of BT in the Balearic islands in 2000 was probably *C. imicola*.

### Keywords

Balearic islands – Bluetongue – *Culicoides* – Majorca – Minorca – Spain.

### Introduction

The disease of ruminants known as bluetongue (BT) is caused by a virus of the genus *Orbivirus* (family *Reoviridae*) and in the Mediterranean Basin is mainly transmitted by the species of biting midge *Culicoides imicola* Kieffer and *C. obsoletus* (Meigen) (Diptera; Ceratopogonidae) (1, 6, 7). Recently, another species, *C. pulicaris* (Linnaeus), has also been incriminated as a vector following the isolation of BT virus (BTV) from field specimens (3).

There are 24 serotypes of the virus distributed worldwide. Of these, at least six (1, 2, 4, 6, 9 and 16), occur in the Mediterranean Basin.

In Europe, BT mainly affects sheep, but cattle and goats could act as reservoirs of the virus, without showing clinical signs of the disease. There have been previous incursions of the disease into the Mediterranean Basin, for example into Cyprus and Israel in 1943 and into the Iberian Peninsula between 1956 and 1960, causing high mortalities in sheep. However, in the last seven years (1998-2004), BT has spread massively around the Mediterranean Basin (17), affecting countries including Algeria, Bulgaria,

France Greece, Italy, Morocco, Spain, Tunisia and Turkey.

In the case of Spain, the recent outbreak of BT was detected in September 2000 in the Balearic islands (9), firstly on Majorca, and then on Minorca. The virus involved was serotype 2, the same as that identified in Corsica, Sardinia and Sicily and which probably originated from Tunisia where it appeared in 1999. Subsequently, serotype 9 was also identified on mainland Italy, but was never to reach the Balearic islands.

Since BT is one of the 'List A' diseases of the Office International des Épizooties (OIE), the declaration of the epizootic had important consequences on livestock farming in the Balearic islands, especially in Minorca, since movement of animals amongst the islands was prohibited and also because many animals were slaughtered in an effort to stop the disease spreading further.

During the first outbreak, the number of foci totalled 391 in Majorca and 114 in Minorca (M.J. Pourtau and M.J. Rubio, personal communication) thus demonstrating the efficiency with which the vectors transmitted the virus from

one animal to the next over a short period of time. Accordingly, an intensive survey of the major vectors was conducted on cattle farms. The results demonstrated, for the first time, that *C. imicola* and *C. obsoletus* occur on Majorca and Minorca (8). The former has been reported recently in other areas in which previous surveys had not revealed its presence, for example on some islands of Greece and in Italy (7). This may suggest that *C. imicola* has been spreading into new areas of the Mediterranean Basin in the past eight years.

The seasonal abundance of vectors has been broadly correlated with the transmission of the virus. In this sense, transmission is enhanced under optimal climatological conditions for virus replication, vector development and activity. Large numbers of *C. imicola* and *C. obsoletus* have been linked to the recent BT outbreaks recorded around the Mediterranean Basin, as well as with previous BTV and African horse sickness virus (AHSV) incursions in Portugal and southern Spain.

In this study, data is reported for the first time on the seasonal abundance of *C. imicola* and *C. obsoletus* in the Balearic islands.

At the time of writing, October 2003, a new outbreak of BT was detected in Minorca.

## Material and methods

Midges were captured on four cattle farms in Majorca and on three in Minorca (Table I); the farms were selected in collaboration with the *Conselleria d'Agricultura i Pesca* (Government of the Balearic islands). All farms were situated in the area affected by BT during the outbreak of 2000.

**Table I**  
Location of farms and number of animals involved in the study of *Culicoides* vectors on the islands of Majorca and Minorca, Spain, 2001-2002

Island	Site name	Location	No. of animals (bovines)
Majorca	Ca'n Centes	39°27'N 3°14'E	90
	Ca'n Roig Nou	39°29'N 3°05'E	111
	Sa PlanaVella	39°27'N 3°16'E	155
	Ses Veles	39°39'N 3°26'E	261
Minorca	Algaiarens	40°03'N 3°57'E	125
	Son Gornes	39°58'N 4°00'E	107
	Cases Noves	40° 02'N 4°05'E	77

A CDC (Centers for Disease Control) UV 4W light trap provided with a suction fan (blacklight model

912, John Hock Company) was placed outside stables at a height of between 1.7 and 2 m from the ground. Traps were powered by 220 V using a transformer and all were located close to where the livestock remained during the night (less than 7 m from the animals). Collections were made one night per week from June 2001 to December 2002. The traps were operated from one hour before sunset to one hour after sunrise. Insects collected were transported to the laboratory in the same trap mesh and preserved in 70% ethanol. *Culicoides* species were separated from other insects. *C. imicola* was classified by using the wing pattern, and confirmed by microscopic examination using the methods described by Wirth and Marston (16) and Delécolle (4). Due to the difficulty encountered in the differentiation of *C. obsoletus* females from other similar species (such as *C. scoticus*) these were classified, using the wing pattern, as the *C. obsoletus* group.

## Results and discussion

A total of 348 light-trap collections were made, 242 from Majorca and 106 from Minorca. *C. imicola* and species of the *C. obsoletus* group were captured on all the farms sampled and on both islands. The total number of *C. imicola* found on Majorca was 5 934 (25.5 adults per night per trap), whereas on Minorca the total was 595 (5.6 adults per night per trap). For the *C. obsoletus* group, 5 191 (21.45 adults per night per trap) were collected on Majorca and 590 (5.6 adults per trap per day) on Minorca.

Of the total *Culicoides* captured on Majorca, *C. imicola* comprised 37%, *C. obsoletus* 32.3%, and other *Culicoides* spp. 30.7%. On Minorca, the respective data were 9.3%, 9.2% and 81.5%.

Results showed that *C. imicola* is the predominant species on Majorca, but its numbers did not differ significantly from those of *C. obsoletus*. However, on Minorca, they clearly are not the predominant species; instead *C. newsteadi* Austen, represented a high percentage of the captures (data not shown). We also found important differences between the abundances of *C. imicola* and *C. obsoletus* on Majorca and Minorca. Different farming practices, or differing environmental conditions, should be investigated to find the explanation. If low populations of both vectors are confirmed on Minorca, this would clearly show that low numbers of vector midges are sufficient to cause epizootics of BT.

The low predominance of *C. imicola* and *C. obsoletus* found in this survey differed from other studies conducted in the Iberian Peninsula during the AHS

epizootics that occurred in the 1990s, when *C. imicola* clearly predominated (10, 11). Recently, extensive surveys performed in BTV-affected areas, such as mainland Italy, Sicily, Sardinia, Corsica and some of the Greek islands, have demonstrated a high prevalence of this vector, despite the fact that it had been proved absent during previous surveys. It is widely accepted that the area of spread of *C. imicola* has been increasing in recent years (7). Furthermore, due to its spread into the Iberian Peninsula, the geographic range of this species has recently been extended on account of the presence of a single female in Catalonia (15); at this site, *C. obsoletus* was the predominant species. On the other hand, *C. imicola* has not been detected in other areas of the Mediterranean; for example, in Bulgaria and in parts of mainland Greece which have experienced BT epizootics, and where the predominant species were *C. obsoletus* and *C. pulicaris* (7).

Regarding the seasonal abundance of both species, periods with high numbers of adults were observed in both years, indicating that *C. imicola* and *C. obsoletus* are well established in the Balearic islands. Since no previous surveys had been conducted in this area, it is impossible to establish whether *C. imicola* has been introduced recently.

The seasonal abundance of vectors has important implications in the efficiency of virus transmission and the occurrence of outbreaks. It is recognised that the peak in vector population determines the optimum period for transmission (5). The seasonal abundances of *C. imicola* and of the *C. obsoletus* group on Majorca and Minorca are shown in Figures 1 and 2, respectively.

Our results from 2001 and 2002 indicate that the seasonal abundance of *C. imicola* was highest during September and October, whereas *C. obsoletus* showed a period of peak abundance between April and July. High abundances of *C. imicola* during the summer and autumn months were also reported in different areas within the Iberian Peninsula, for example southern Spain (11, 12, 13) and Portugal (2). The *C. obsoletus* group was also recorded in high numbers during spring in southern Spain (12, 13) and in Catalonia (15). We also found that the seasonal occurrence of *C. obsoletus* extended longer than that of *C. imicola*. Adults of *C. obsoletus* were captured almost throughout the year, confirming the observations of Rawlings and Mellor (14). This could be explained by the fact that *C. obsoletus* is a cool-adapted Palearctic species, whereas the seasonal and geographic occurrence of *C. imicola*, an Afrotropical species, is limited by lower temperatures when compared to *C. obsoletus* (14).

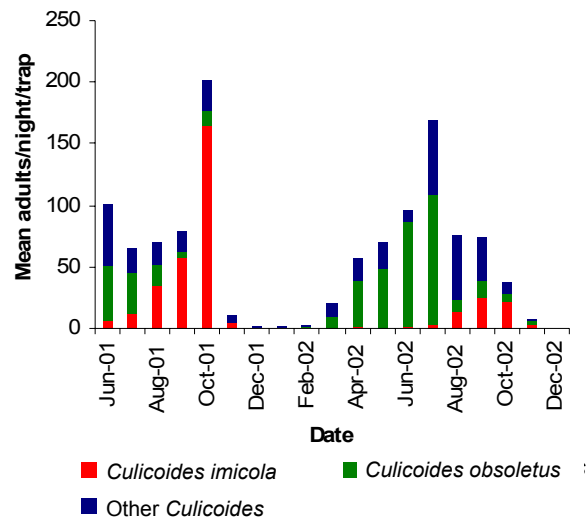


Figure 1  
Seasonal fluctuation of *Culicoides imicola*, *C. obsoletus* and *Culicoides* spp. adult populations on the island of Majorca, Spain

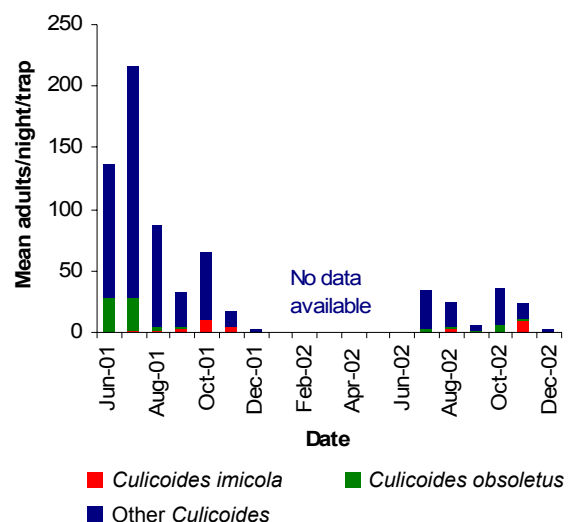


Figure 2  
Seasonal fluctuation of *Culicoides imicola*, *C. obsoletus* and *Culicoides* spp. adult populations on the island of Minorca, Spain

Results obtained in this study indicate that the BT outbreak that occurred in the Balearic in 2000 coincided with maximum abundances of *C. imicola* indicating it to have been the principal vector at that time. *C. imicola* has been also linked to the recent BT outbreaks in mainland Italy, Sardinia, Sicily and Corsica. However, in areas such as mainland Greece and Bulgaria where *C. imicola* has not been detected, *C. obsoletus* appears to be the main vector, although some laboratory studies have indicated this species to be a less efficient vector (5). Furthermore, in previous studies conducted in the Iberian Peninsula

and in relation to the epizootics of AHS, *C. imicola* was also the predominant species in the months of September and October (11).

Considering data for 2002 alone, *C. imicola* was first detected on Majorca in April and persisted until December; for the *C. obsoletus* group, the first specimens were captured in January with activity ceasing in November. The situation is unknown for Minorca as insufficient light-trap collections were made. These preliminary results indicate that proven vectors of BTV, such as *C. obsoletus*, overwinter in the Balearic islands and probably also *C. imicola*, depending on the severity of the winter. The possibility of *C. obsoletus* overwintering in the Iberian Peninsula was mooted earlier by Rawlings and Mellor (14).

## Acknowledgements

We would like to thank the staff of *Sanitat Animal* in the *Conselleria d'Agricultura i Pesca* (Government of the Balearic islands) and the *Consell Insular de Menorca* for providing us with the insect collections, especially to Antonio Riera, Carlos Aranga, Alexandra, Maria José Rubio, Federico Martín, Lucía Tascón, Cristina Ramos and Maria José Portau. This study was supported by the *Instituto Nacional de Investigación Agropecuaria* (INIA) and the *Conselleria d'Agricultura i Pesca*.

## References

- Boorman J., Jennings M., Mellor P.S. & Wilkinson P. (1985). – Further data on the distribution of biting midges in southern Europe and the Mediterranean area, with special reference to *C. imicola*. In *Bluetongue and related orbiviruses* (T.L. Barber, M.M. Jochim & B.I. Osburn, eds). Proc. First International Symposium, Monterey, California, 16-20 January 1984. A.R. Liss, Inc., New York, 187-190.
- Capela R., Sousa C., Pena I. & Caeiro V. (1993). – Preliminary note on the distribution and ecology of *C. imicola* in Portugal. *Med. Vet. Entomol.*, **7**, 23-26.
- Caracappa S., Torina A., Guercio A., Vitale F., Calabro A., Purpari G., Ferrantelli V., Vitale M. & Mellor P.S. (2003). – Identification of a novel bluetongue virus vector species of *Culicoides* in Sicily. *Vet. Rec.*, **153**, 71-74.
- Delécolle J.-C. (1985). – Nouvelle contribution à l'étude systématique et iconographique des espèces du genre *Culicoides* (Diptera: Ceratopogonidae) du nord-est de la France. PhD dissertation. Université Louis Pasteur de Strasbourg, UFR des sciences de la vie et de la terre, Strasbourg, 238 pp.
- Mellor P.S. (1992). – *Culicoides* as potential orbivirus vectors in Europe. In *Bluetongue, African horse sickness and related orbiviruses* (T.E. Walton & B.I. Osburn, eds). Proc. Second International Symposium, Paris, 17-21 June 1991. CRC Press, Boca Raton, Press, 278-283.
- Mellor P.S., Jennings D.M., Wilkinson P.J. & Boorman J.P. (1985). – *Culicoides imicola*: a bluetongue virus vector in Spain and Portugal. *Vet. Rec.*, **116**, 589-590.
- Mellor P.S., Boorman J. & Baylis M. (2000). – *Culicoides* biting midges: their role as arbovirus vectors. *Ann. Rev. Entomol.*, **45**, 307-340.
- Miranda M.A., Borràs D., Rincón C. & Alemany A. (2003). – Presence of *Culicoides imicola* and *Culicoides obsoletus* in the Balearic islands. *Med. Vet. Entomol.*, **17**, 1-4.
- Office International des Epizooties (2001). – Bluetongue in Spain. *Dis. Info.*, **13**, 181.
- Ortega M.D. & Holbrook F.R. (1994). – Presence of *Culicoides imicola* (Diptera: Ceratopogonidae) in Jaen, Spain. *J. Am. Mosquito Control Assoc.*, **10**, 463.
- Ortega M.D., Lloyd J.E. & Holbrook F.R. (1997). – Seasonal and geographical distribution of *Culicoides imicola* Kieffer (Diptera, Ceratopogonidae) in southwestern Spain. *J. Am. Mosquito Control Assoc.*, **13**, 227-232.
- Ortega M.D., Mellor P.S., Rawlings P. & Pro M.J. (1998). – The seasonal and geographical distribution of *Culicoides imicola*, *C. pulicaris* group and *C. obsoletus* group biting midges in central and southern Spain. *Arch. Virol.*, **14**, 85-91.
- Ortega M.D., Holbrook F.R. & Lloyd J.E. (1999). – Seasonal distribution and relationship to temperature and precipitation of the most abundant species of *Culicoides* in five provinces of Andalusia, Spain. *J. Am. Mosquito Control Assoc.*, **15**, 391-399.
- Rawlings P. & Mellor P.S. (1994). – African horse sickness and the overwintering of *Culicoides* spp. in the Iberian peninsula. *Rev. Sci. Tech. Off. Int. Épiçz.*, **13**, 753-761.
- Sarto i Monteys V. & Saiz-Ardanaz M. (2003). – *Culicoides* midges in Catalonia (Spain), with special reference to likely bluetongue virus vectors. *Med. Vet. Entomol.*, **17**, 288-293.
- Wirth W. & Marston N. (1968). – A method for mounting small insects on microscope slides in Canada balsam. *Scientific Notes*, **61**, 783-784
- Wittmann E.J., Mellor P.S. & Baylis M. (2001). – Using climate data to map the potential distribution of *Culicoides imicola* (Diptera: Ceratopogonidae) in Europe. *Rev. Sci. Tech. Off. Int. Épiçz.*, **20**, 731-740.