African horse sickness and the overwintering of *Culicoides* spp. in the Iberian peninsula

P. RAWLINGS and P.S. MELLOR *

**Summary:** The presence at different latitudes and the seasonal distribution of two known or potential vectors of African horse sickness (AHS) virus – *Culicoides imicola* and *C. obsoletus* – were investigated in the Iberian peninsula using light trap collections. *Culicoides imicola* was present as far north as 41°N but not at 43°N (Asturias, Spain), whereas *C. obsoletus* was found at all latitudes. In the northern part of the distribution of *C. imicola*, adults of this species were present for only a few months of the year, but adults were continually present further south. *Culicoides obsoletus* could be found in all months of the year in the peninsula (as in southern Britain), despite cold winter conditions. These results were compared to data from the AHS outbreak in 1987-1990 in the Iberian peninsula, to indicate the potential for the disease to persist from year to year and expand more fully in the palaearctic regions of Europe.


**INTRODUCTION**

African horse sickness (AHS) is an arthropod-borne virus disease of equines. Serious outbreaks of the disease have occurred in Europe, notably in Spain in 1966 (9) and in Spain and Portugal between 1987 and 1990 (1, 14). During the more recent outbreak, entomological investigations were conducted to determine the identity of the arthropod vector(s) responsible for the transmission of the disease agent, AHS virus (AHSV). Elsewhere, it had already been established that AHSV and the related orbivirus, bluetongue (BT), were usually transmitted by various species of biting midges of the genus *Culicoides* (10). One such known vector species, *C. imicola*, had been discovered in the south of the Iberian peninsula (18, 20) only a few years before this latest outbreak of disease.

The 1987 AHS outbreak commenced in central Spain (14), spreading in succeeding years to southern Spain (1), Portugal and Morocco (3). Vector studies showed that the distribution of *C. imicola* closely followed the pattern of AHS incidence in the Iberian peninsula, and AHSV was isolated from this species on a number of occasions during the course of these disease outbreaks (21, 15). *Culicoides imicola* therefore appears to have been the principal vector of AHSV in the Iberian peninsula; this species is also the

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principal vector of both AHSV and BT virus (BTV) in Africa (10, 19, 25, 26) and of BTV in the eastern Mediterranean (6). Retrospectively, C. imicola was also presumed to be the vector responsible for the outbreaks of BT in Spain and Portugal between 1956 and 1960, all of which occurred in similar districts to the AHS outbreaks thirty years later (16).

However, during the AHS outbreaks in the late 1980s, AHSV was also isolated from mixed samples of two other species of Culicoides in addition to C. imicola, namely C. obsoletus and C. pulicaris (21). Furthermore, one of these species (C. obsoletus) is a close relative of C. imicola (13) and had previously been shown to be infected with BTV in Cyprus (17). Therefore, C. obsoletus may also have been involved in the AHS and BT outbreaks in the Iberian peninsula. The seasonal distributions of adult C. imicola and C. obsoletus in this region are likely to be markedly different, as the former species is basically Afro-Asiatic, while the latter is palaeartic. These variations in seasonal incidence and the differing levels of AHSV vector efficiency may help to explain why the disease outbreaks in central and southern Spain showed differing levels of persistence.

The initial outbreak of AHS near Madrid in 1987 lasted until mid-October but failed to survive the winter, whereas the subsequent outbreaks in the warmer southern provinces of Spain (Cadiz, Huelva and Seville) continued until November or December and then returned in July or August of the following year. This difference from the situation in central and southern Spain is linked to the short duration of viraemia in AHSV-infected equines (up to 27 days in zebra: 11). It has already been reported that, in the absence of adult Culicoides vectors, an AHS epizootic will be unable to persist for longer than the duration of the viraemia in the local susceptible vertebrate population (16). Therefore, for the disease to ‘overwinter’, adult vector Culicoides must be present for much or all of the winter period, so that the virus is able to infect new adult Culicoides before viraemia declines in the hosts. The preliminary investigations reported here are an attempt to identify differences in the seasonal distribution of two potential AHSV vectors in Europe and the likely impact of such differences on AHSV transmission and persistence.

**MATERIALS AND METHODS**

Samples of Culicoides spp. were collected in a number of different regions of Spain and Portugal using Pirbright miniature light traps. These traps were fitted with a 12 V car headlight bulb which attracted midges and many other flying insects into the down-draught created by a small 12 V fan. Insects were collected into a bottle mounted below the fan, containing water and a small amount of liquid detergent to reduce surface tension. Each light trap was operated from dusk until early morning. The insect samples were then preserved in 5% formalin until required for sorting under a binocular microscope. All Culicoides midges were removed and identified by species or species group. The present analysis is based on samples collected between 1988 and 1994, supplemented by data from the same sites in published articles (2, 8).

The seasonal distributions of C. imicola and of species within the C. obsoletus group were plotted as the monthly mean number of adults collected in each trap each night. Sites were usually single trap locations, except in Fana (43°N), Madrid (40°N) and Sotogrande (36°N) where catches from light traps operated within a 20 km radius were
combined. The data are presented as a set of graphs from two sites at each of six latitudes, except at 36°N as this is the most southerly point on the peninsula. Data from the two sites at each latitude are intended to be used together to indicate the presence or absence of adult *C. imicola* or *C. obsoletus* during any single month.

**RESULTS**

*Culicoides imicola* was detected at five of the six latitudes investigated and *C. obsoletus* was found at all six. *Culicoides imicola* has not yet been detected in the far north of Spain (43°N; Fig. 1a), but this species has been trapped at 41°N in some months during the autumn. At most latitudes, trap collection data are not available for a full 12 months of any year. Even so, it is clear that adult *C. imicola* can be found at 40°N from early summer through to the beginning of winter. From 38°N southwards this species appears to be present in almost every month of the year, although its presence may fall to very low levels during the early part of the calendar year, except in the warmest winter refuges, such as Sotogrande (Fig. 1f).

Adults of the *C. obsoletus* group were recorded at all latitudes (Fig. 2), but appeared more abundant in the north, especially in the wetter climates of Asturias (43°N; Fig. 2a). In most latitudes, this group of species was present in most months of the year – as is the case in southern Britain (Table I) – especially in areas which receive regular and frequent rainfall, such as Sotogrande and Asturias (Figs 2f and 2a, respectively). In central southern England, the abundance of *C. obsoletus* varies considerably over the year but, unlike some other species of *Culicoides*, *C. obsoletus* does not appear to diapause and can thus be present in every month of the year (Table I). Furthermore, the presence of

<table>
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<tr>
<th>Month</th>
<th>No. of midges/trap/night</th>
<th>Lowest minimum temperature</th>
<th>Lowest maximum temperature</th>
</tr>
</thead>
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<td>November</td>
<td>22.3</td>
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<td>6.7</td>
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<tr>
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<td>0.6</td>
<td>-8.3</td>
<td>1.1</td>
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<tr>
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<td>0.7</td>
<td>-7.8</td>
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<td>February</td>
<td>0.1</td>
<td>-2.2</td>
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</tr>
<tr>
<td>March</td>
<td>20.7</td>
<td>-4.4</td>
<td>3.9</td>
</tr>
<tr>
<td>April</td>
<td>6.8</td>
<td>-1.1</td>
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<tr>
<td>May</td>
<td>532.3</td>
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<td>1.0</td>
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<td>October</td>
<td>83.0</td>
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<td>8.8</td>
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Mean abundance of *Culicoides imicola* midges at various latitudes in the Iberian peninsula

**Fig. 1**

- (a) Fana, Oviedo (43°N)
- (b) Alijo, Freixo (41°N)
- (c) Vagos, Madrid (40°N)
- (d) Barrancos, Evora (38°N)
- (e) Milfontes, C. Marim (37°N)
- (f) Sotogrande (36°N)
Mean abundance of *Culicoides obsoletus* group midges at various latitudes in the Iberian peninsula
C. obsoletus in light trap collections frequently continues despite very low overnight minimum temperatures and low daytime temperatures, when recruitment and the flight of new adults to join the existing population would seem unlikely (Table I).

DISCUSSION

The distribution of C. imicola in western Europe seems to be restricted to the south-west quarter of Spain and to much of Portugal (excluding most of the Atlantic maritime climatic zones and higher sierras). Culicoides imicola is mainly present in tropical areas of Africa and Asia, and this is reflected in the limited ability of the adults to survive the winter further north (Fig. 1). Although C. imicola appears to be an efficient vector (24) of both BTV and AHSV throughout its range, the restricted European distribution of the species means that a resurgence of AHS solely within the known range of C. imicola (within Europe) could be contained with relative ease. Preliminary data suggest that C. imicola adults successfully overwinter only if the mean daily maximum temperatures in the coldest month are greater than 12.5°C (23). In the European context, this means that not only are AHS epizootics likely to persist in the south-western quarter of the Iberian peninsula, but (assuming the presence of populations of C. imicola) such outbreaks could also be expected to persist in southern Italy and much of Greece, areas which have not yet experienced outbreaks of this disease.

Species in the C. obsoletus group are typical of the palaearctic region (Fig. 2). This species group is present throughout the forest zone of Europe and the former Soviet Union (22), and in most Mediterranean countries from Portugal (19) and Spain (18) right through to Cyprus (17), Rhodes (4), Lesbos (5), Turkey (12) and Israel (7). The possibility that C. obsoletus may be involved in AHSV transmission (along with C. imicola) dramatically affects the potential significance of this exotic virus disease for Europe. If C. obsoletus group midges are able to operate as efficient AHSV vectors, containment would be extremely difficult, as this group of species is distributed virtually throughout Europe. Overwintering of adult C. obsoletus in the coldest parts of the European range of this species group is unlikely, due to the severity of the winter in these areas. However, C. obsoletus is present at all latitudes in the Iberian peninsula for most months of the year (Fig. 2), and overwintering of adults is likely to be possible in most areas of the peninsula. Adult overwintering is particularly likely in those areas influenced by the moderating effects of the Atlantic and Mediterranean weather systems. If this is the case, then a re-introduction of AHS into the area infested by C. imicola could be ‘handed on’ further northwards by less efficient but very abundant vectors, such as the C. obsoletus species group. In this context, the Iberian peninsula – and the species of Culicoides found in the central and northern regions of this area – may hold the key to the potential for AHS (or BT) epizootics to expand beyond the Mediterranean basin into the more northerly regions of Europe.

Overwintering of AHSV in Europe under the prevailing climatic conditions is always likely to be at a low level, as the adult vector Culicoides spp. populations are also invariably low during the colder periods of the year. However, transmission rates will increase as vector populations rise with the advent of warmer weather. In this way, an epizootic may appear to end in the autumn, but a recrudescence may then occur as Culicoides spp. abundance rises in the following spring. Figure 1 shows that in all the regions of the Iberian peninsula below 38°N, especially in the far south, C. imicola could be present for most of the year. At 40°N, no C. imicola midges have yet been trapped in
the first three or four months of the calendar year, but a programme funded by the European Community (EC) (Contract No. CT08001-CT91-0211) is currently monitoring more closely the seasonal incidence of adult *C. imicola* in this area.

At present, *C. imicola* is almost certainly the major vector of AHSV in southern and central areas of the Iberian peninsula, and the range of this species may be extending northwards in response to climate moderation. However, the likelihood of AHS outbreaks occurring in the more northerly regions of Europe (above 42°N) may not depend entirely on *C. imicola* extending its current distribution. The distribution of *C. obsoletus* overlaps that of *C. imicola* and the AHS outbreak areas. The efficiency of *C. obsoletus* as a vector is likely to be low, but this could be compensated for by the pervasiveness and abundance of these populations during spring and autumn. Some *C. obsoletus* populations might also be more efficient virus vectors than others. The persistence of adult *C. obsoletus* females on the wing throughout the winter could then perpetuate epizootics in northern climates and threaten the very large equine population of western and central Europe.

**ACKNOWLEDGEMENTS**

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**LA PESTE ÉQUINE ET L'HIBERNATION DE CULICOIDES SPP. DANS LA PÉNINSULE IBÉRIQUE.** – P. Rawlings et P.S. Mellor.


**MOTS-CLÉS :** Culicoides – Espagne – Hibernation – Peste équine – Portugal – Variations saisonnières.
LA PESTE EQUINA Y LA HIBERNACIÓN DE CULICOIDES SPP. EN LA PENÍNSULA IBÉRICA. - P. Rawlings y P.S. Mellor.

Resumen: Los autores han estudiado la presencia en distintas latitudes y la distribución según las estaciones de dos vectores reconocidos o potenciales del virus de la peste equina, Culicoides imicola y C. obsoletus, en la península ibérica. La colecta de los insectos se llevó a cabo con trampas luminosas. C. imicola estaba presente a una latitud máxima de 41°N y ausente a 43°N (Asturias, España), mientras que C. obsoletus se encontró en todas las latitudes. Los adultos de la especie C. imicola se encontraron sólo algunos meses por año en el norte, pero casi todo el año más al sur, y C. obsoletus persistió todo el año en la península, como ocurre en el sur de Inglaterra, pese a los inviernos fríos. Estos resultados fueron comparados con los datos sobre el brote de peste equina que asoló la península ibérica entre 1987 y 1990 para determinar las posibilidades de persistencia de la enfermedad de uno a otro año y los riesgos de una mayor propagación de ésta en las regiones paleoárcticas de Europa.


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REFERENCES


