POTENTIAL VECTORS OF BLUETONGUE IN AUSTRALIA


CSIRO Division of Animal Health, McMaster Laboratory,
Private Bag No. 1, Glebe, New South Wales, 2037

Bluetongue has only been isolated as yet from species of biting midges of the genus Culicoides, initially from Culicoides pallidipennis in South Africa by du Toit (1944) and then from C. variipennis in the United States of America by Price and Hardy (1954). More recently it has been isolated from C. pallidipennis, C. milnei and C. tororoensis in Kenya (Walker and Davies 1971), and from C. pallidipennis in Israel (Braverman and Galun 1973). It is for this reason that studies at the McMaster Laboratory have concentrated on biting midges, but not to exclusion of other groups of blood-sucking insects which attack stock.

Bluetongue is a disease of sheep, goats and cattle, and there is increasing evidence of other ungulates being infected with the virus. Consequently, the intensive studies on the insects which bite cattle, which have been in progress since the ephemeral fever epizootic of 1967-68 (Standfast and Dyce 1972a, 1972b), are as vital to our preparedness for the future as are studies on the insects which bite sheep.

Various techniques have been used in Australia to determine which midges bite sheep and cattle, and of them direct collection from sheep and cattle appears to be the most satisfactory (Dyce, A. L. and Muller, M. J., personal communication). Drop traps and tent traps have been used but some species do not enter such traps, and the engorged insects captured might not necessarily have fed on the bait animal within the trap. Truck trap and light trap collections frequently contain engorged females, and the source of the blood meal can be identified by the techniques described by Murray (1970).

Species of Culicoides, which bite cattle and buffalo and are likely to be important vectors of arboviruses are C. brevitarsis, C. marksi, C. dycei, C. victoriae, C. schultzei and C. peregrinus (Standfast and Dyce 1972b). The first four species also bite sheep (M. J. Muller, A. L. Dyce and M. D. Murray, unpublished data). There are several other species, such as C. marmoratus and C. multimaculatus, which bite sheep and/or cattle, and undoubtedly others will be added to the list in the future.

It is the female Culicoides which attacks stock, one blood meal at least being required for the completion of the ovarian cycle. Numerous factors determine the intensity of their attacks. Seasonal changes in climate influence their abundance; in southern Australia there is little if any activity in the winter, and it appears that larvae which have overwintered and reached the prepupal stage are stimulated to pupate in the spring. Adults emerge and several generations are produced before larval development is again arrested in the prepupal stage. In the far north of Australia adults are active throughout the year, and their varying seasonal abundance could be due to the expansion and contraction of suitable breeding sites that result from the monsoon rains. Elsewhere, the inland species appear to become more abundant as the summer progresses. However, specific requirements for a species must be expected within such generalisations, together with successions of species following major climatic events such as rain or floods. Australia is an arid continent with an irregularly distributed rainfall, and adaptations to survive adversity and exploit opportunity will be found. The recognition and definition of these features of the biology of the various species of Culicoides will greatly enhance our understanding of their role as vectors, and thus the understanding of the epidemiology of the diseases they transmit.

The daily activity of an insect seeking a blood meal is influenced by the intensity and rate of change of light, temperature, humidity and wind. The species listed are active from just before dusk to just after dawn when the weather is warm, humid and calm. However, the times of their peak activity can differ.

C. victoriae, a southern species, can be active when it is quite cool and even during the day when it is overcast. The activity of C. brevitarsis commences at about sunset, rises to a peak during dusk and falls during the first hour of darkness (Standfast and Dyce, 1968, 1972a). On an overcast day activity can commence earlier, and it can be suppressed by the slightest rain. C. marksi and C. dycei are inland species which are active at dusk, during the evening, and at dawn. Humidity becomes important in arid environments, and consequently peak activity may be greater at dawn. C. schultzei and C. peregrinus are tropical species, the former is active at dusk, during the evening
and at dawn, whereas the latter is active in the early hours of the morning when it is dark.

The site of attack on the host varies with the species. The head and ears of sheep are usually attacked. The hair coat of cattle enables the whole body to be attacked; some species, *C. marksi* and *C. schultzei*, attack the under parts of the body; others, *C. brevitarsis* and *C. peregrinus*, attack the back and upper sides.

It is generally thought that one blood meal is necessary for the development of each batch of eggs within the female and that about five days elapse before the insect feeds again. Insects can be disturbed, and consequently feed twice or more before they are fully engorged. This might take place on the original host or a new host which may be of the same or a different species. The tenacity of a feeding *Culicoides* is such that double feeding would not be expected; however, there is evidence to suggest that it might be more common in *C. marksi* than appreciated (Muller and Murray, unpublished data). If this is proven, it has considerable implications for the understanding of

the epidemiology of certain arbovirus diseases, for not only are the chances of the vector becoming infected more frequent, but so also are the opportunities for it to infect more hosts. This would greatly facilitate the spread of virus within and between populations of hosts.

Much has to be learned of the host range and preferences of these potential vectors of bluetongue, and Table 1 summarises our present knowledge. Clearly, the host ranges of *C. marksi* and *C. victoriae* are wide.

Since the ephemeral fever epizootic of 1967-68, a major effort has been made to complete a general survey of the distribution of *Culicoides* spp. in Australia with the assistance of officers of all States and Commonwealth Territories. The localities from which over a thousand collections have been made are shown in Figure 1. There are still gaps in our knowledge, but it is possible to describe the overall distribution on the continent of most species. As described previously (Murray and Dyce 1970), some species are associated with maritime situations, others with savannah extending to the deserts and others with dry or wet sclerophyll or tropical forests. There is a southern fauna and another in the extreme north which contains many species also found in Oceania and south-eastern Asia, even across southern Asia to Africa. These fauna are joined by a group of species distributed throughout the inland savannah and another which is found in the rain forest along the eastern coastal ranges.

*Culicoides victoriae* (Figure 2) is a southern species which breeds in the margins of fresh water creeks, rivers, lakes and swamps. It is abundant

<table>
<thead>
<tr>
<th>Species</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. brevitarsis</em></td>
<td>Sheep, ox, buffalo, and man</td>
</tr>
<tr>
<td><em>C. dycei</em></td>
<td>Sheep, ox, horse and rabbit</td>
</tr>
<tr>
<td><em>C. marksi</em></td>
<td>Sheep, ox, buffalo, horse, dog, marsupial, man, bird</td>
</tr>
<tr>
<td><em>C. peregrinus</em></td>
<td>Ox and buffalo</td>
</tr>
<tr>
<td><em>C. schultzei</em></td>
<td>Ox and buffalo</td>
</tr>
<tr>
<td><em>C. victoriae</em></td>
<td>Sheep, ox, horse, dog, rabbit, marsupial and man</td>
</tr>
</tbody>
</table>

*Based on Lee et al. (1962), Standfast and Dyce (1972b) and M. D. Murray and M. J. Muller (unpublished data).*
in Tasmania, southern Victoria and South Australia, and south-western Western Australia. In New South Wales it is found on the coastal plains and Dividing Range along which its northerly distribution in Queensland may become confined. The reported presence of this species in Papua (Tokunaga 1962) requires confirmation.

*Culicoides dycei* (Figure 3) is an inland species which usually breeds in the margins of rivers and creeks of the ranges and ridges rather than of the plains. It has been found in north-eastern Tasmania but is rare; north of the Dividing Range in Victoria it becomes abundant, particularly in Queensland and across the north to the Kimberleys in Western Australia.

*Culicoides marksi* (Figure 4) is a widespread species which has not been found in Tasmania and rarely to the south of the Dividing Range in Victoria. It breeds in the margins of creeks, rivers, lakes, dams and swamps of the foothills and plains, and can be closely associated with the watering places of stock. Collections of particular interest are those from bores along the stock route across the Tanami Desert from the Kimberleys to Alice Springs. It would appear that this species may be found wherever there is a water hole visited by large mammals, and consequently may be found in "oasis" situations in deserts. Near to Darwin it breeds in the margins of dams together with *C. schulzei*, a tropical species, and in the south it may breed together with *C. victoriae*. *C. marksi* is present in Papua (Tokunaga 1962; Murray unpublished data).

*Culicoides brevitarsis* (Figure 5) is of particular interest as it is considered to be conspecific with *C. pallidipennis* (W. Wirth, cited by Standfast and Dyce 1972a), a known vector of bluetongue virus in Africa. It breeds in cow dung (Cannon and Reye 1966) and many hundreds may bite a beast each evening (Standfast and Dyce 1968) sometimes causing an allergic dermatitis known as "Queensland itch" in horses (Riek 1954). It is found across northern Australia and into northern New South Wales where it extends southwards to Sydney along the coastal plains and even further south when conditions are favourable. *C. brevi-

*Considered to be synonymous with *C. imicola* by some workers.

---

*Australian Veterinary Journal*, Vol. 51, April, 1975
Culicoides schultzei (Figure 6) is a tropical species in Australia, and appears to be confined to the Top End of the Northern Territory where it breeds in the margins of fresh water swamps, dams and water holes. It is found in Papua, New Guinea, New Britain and New Ireland, Timor and Indonesia, throughout south-eastern and southern Asia, Africa and around the Mediterranean. Culicoides schultzei is becoming increasingly recognised as a vector of diseases of stock.

Culicoides peregrinus (Figure 7) appears to be associated with the flood plains of the north coast of the Northern Territory where many hundreds can bite a beast each night. It is a common species throughout the lands to the immediate north and in south-east Asia.

The overall distributions shown in Figures 2-7 may expand or contract over several years, or within a single year. C. brevitarsis is closely associated with cattle and breeds in their dung. The increase in the numbers of cattle and the milder winters and moister summers of the last two years has probably enabled a southerly extension of the distribution of this species in eastern Australia. The network of bore drains throughout New South Wales and Queensland has undoubtedly extended the breeding sites of many species, just as the proliferation of dams to water stock has probably favoured C. marksi. Agricultural and water conservation practices can influence greatly the distribution and abundance of Culicoides. Superimposed upon this is the ability of some species to disperse over long distances by wind. The revelation of two main pathways in eastern Australia by the 1967-68 epizootic of ephemeral fever (Murray 1970) emphasises the need to discover the vector or vectors of this disease so that it may be determined whether bluetongue could spread in a similar manner.

Culicoides which bite sheep and cattle have been found throughout Australia, and one species, C. brevitarsis, is considered to be conspecific with a known vector of bluetongue. Elegant techniques (Dyce 1969; Dyce et al 1972) have been devised for the collection of these insects in excellent condition for virus recovery. Several arboviruses have been isolated, demonstrating the potential of Australian species to transmit exotic diseases (Doherty et al 1973). The current changes in stock composition and density are increasing the "reservoir" cattle populations over large areas, and there is an increasing capacity to conserve and redistribute water throughout the land; however, much basic data on seasonal abundance, activity and breeding sites are available, and the species likely to be important are known, so the effects of these changes can be appraised. Rapid spread of disease by infected vectors being transported by wind appears likely, and an even more rapid spread of infected hosts as movement restrictions for stock have been eased since the eradication of contagious bovine pleuropneumonia.
The overall picture is one of a vulnerable continent, a prospect which at times may dismay those entrusted with the onerous task of preparing measures for the containment, control and eradication of bluetongue. But surely it is better to have accepted the challenge and have determined the magnitude of the problem, for now the entomological components can be defined more clearly and solutions can be sought.

Acknowledgments

I should like to thank all officers of the States and Commonwealth Territories who have assisted with the survey. The enthusiasm with which they have helped has been most stimulating. I should also like to express my appreciation to my colleagues A. L. Dyce and M. J. Muller for their criticisms, and to Mrs. J. Edwards for her untiring technical assistance.

CONTROL OF BLUETONGUE IN AN EPIZOOTIC SITUATION: AUSTRALIAN PLANS

W. A. GEERING, M.V.Sc., M.A.C.V.Sc.

Commonwealth Serum Laboratories, Parkville, 3052, Victoria

Introduction

Howell (1963) was of the opinion that once bluetongue (BT) had entered a country there was little hope of eliminating it. This view has certainly been substantiated by experience in the Middle East, Indian sub-continent and the United States. Nevertheless, there has been one notable exception. Bluetongue broke out in Portugal for the first time in 1956 (Manso-Ribiero et al. 1957) and spread to Spain within a month (Lopez and Botija 1958). The epizootic was particularly severe, and within the first four months 46,000 sheep had died in Portugal and 133,000 in Spain (75% mortality in affected flocks). Both countries immediately instituted quarantine measures, and in addition the Spanish authorities slaughtered infected sheep. Within a few months both countries had produced sufficient vaccine to be able to institute an emergency ring vaccination campaign. From 1957 onwards there was compulsory annual vaccination of all sheep in both Spain and Portugal. These measures led to a dramatic reduction in the incidence of the disease, such that only 51 deaths were reported in Portugal in 1957, and 168 in Spain. The last outbreak occurred in Portugal in 1959 (Anon 1959) and in Spain in 1960 (Anon 1960). Vaccination ceased and the clinical disease has never recurred in either country.

The successful campaign in the Iberian peninsula encourages one to believe that eradication is at least worth attempting, despite the many difficulties that this disease presents, and that this should be the goal in the control of an epizootic of BT in a previously free region or country. It is the policy in Australia to pursue an eradication programme, either to a successful conclusion, or until it is no longer economically tenable to continue.

Diagnosis

It is reasonable to assume that a rapidly spreading outbreak of the classical disease, with associated high mortality, might be brought to the notice of veterinary authorities early and a diagnosis made. This may not be the case with an outbreak that spreads slowly or is caused by a virus strain of intermediate or low virulence. In such circumstances, BT was not conclusively diagnosed as such until four years after its incursion into the United States of America (McKercher et al. 1953). During this time it had spread over a large area of Texas and California.

Unless a diagnosis can be made early in a BT epizootic, when it is confined to a small geographical area, eradication is an almost hopeless proposition. It is therefore of paramount importance that veterinary practitioners and field veterinary officers be familiar with the essential clinical, pathological and epidemiological features of the disease. Furthermore, farmers should be warned, by extension programmes, of the nature and seriousness of BT and of the need to seek veterinary help promptly for any unusual disease outbreaks.

The methods to be used for the diagnosis of suspected BT in Australia have been published (Anon 1972). The Chief Veterinary Officer of the state or territory is to be notified immediately and he will arrange for a diagnostic team to investigate the disease. Laboratory diagnosis is based on the detection of a viraemia in febrile sheep. Blood samples are inoculated into groups of susceptible sheep in insect-proof quarters. These are observed