An Outbreak of Ross River Virus Disease in Southwestern Australia

More than 540 serologically confirmed cases of Ross River (RR) virus disease have been reported from the southwest region of Western Australia since November 1995 (Figure 1). Most affected by the mosquito-borne disease are communities on the Swan Coastal Plain south of Perth. Cases have also been reported from towns farther south or inland and from Perth itself. These regions were foci of RR virus activity during previous southwest outbreaks in 1988–89 and 1991–92 (1,2); however, the current outbreak differs somewhat in the timing and location of virus activity. This article is a preliminary overview of the incidence of disease, mosquito and virus activity, and environmental conditions before and during the outbreak.

Monitoring of the incidence of human disease provided no indication of abnormally high levels of RR virus activity until mid-December 1995 when the number of reported cases began to rise sharply. In contrast, monitoring of mosquito breeding sites, adult mosquito populations, and environmental conditions in late October and November 1995 showed a potential for high levels of virus transmission.

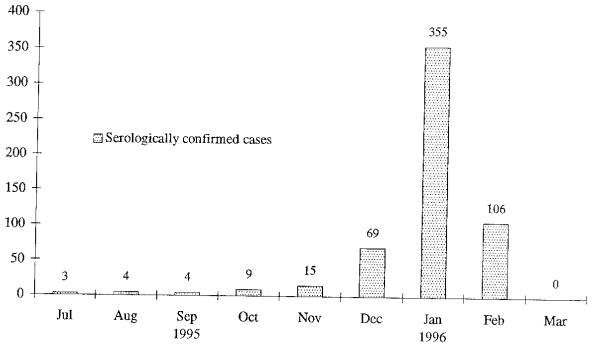

Figure 1. Serologically confirmed cases of Ross River virus disease, by month of onset, in the southwest of Western Australia, July 1995 to February 1996, as reported by doctors to the Health Department of Western Australia (when possible, case follow-up questionnaires were administered by environmental health officers from relevant local authorities). Only a small number of cases diagnosed by state and private laboratories, although the patient was not notified, have been included. Consequently, the number of cases shown is almost certainly an underestimate of the true number of serologically confirmed cases. Almost 65% of cases have dates of onset in January 1996. However, further notifications and analysis of follow-up questionnaires that have not yet been carried out for many January/February cases may alter this pattern. Previous southwest outbreaks also peaked in January or February but were considerably less acute.

The areas affected most, in terms of numbers of cases and attack rates (not shown), are coastal towns and communities around the Leschenault Inlet (including the city of Bunbury), between 165 and 190 km south of Perth and in the shires of Capel and Busselton, as well as on the coast between 190 and 245 km south of Perth (Table 1). These regions are popular tourist destinations during the summer holidays. It appears that many holiday-makers from elsewhere in the southwest, as well as local residents, were exposed to infected mosquitoes in these regions during the Christmas–New Year period.

Many of the Perth cases are from semirural, outlying suburbs, but some are from suburbs closer to the city center, often near the Swan and Canning rivers or fresh water wetlands and lakes. Follow-up questionnaires indicate that a considerable proportion of metropolitan cases were in persons exposed in the southwest, particularly in the Leschenault, Capel, and Busselton regions. However, many cases from Perth also appear to have been locally acquired. Locally acquired cases were also present during the two previously reported outbreaks.

Many cases have also been reported from the Peel region, 70 km to 130 km south of Perth, surrounding the Peel Inlet and Harvey Estuary. However, considerably more cases had been reported by late February in the Peel region during the 1988–89 and 1991–92 outbreaks. Also, during 1988 and 1991 virus activity in the Peel outbreaks commenced earlier than in the Leschenault and Capel-Busselton regions; this is apparently not the case during the current outbreak (Table 1). The reasons for these differences are not yet clear, but extensive control of saltmarsh mosquito breeding has been carried out in the Peel region this season.

Large saltmarshes and brackish wetlands in the Peel, Leschenault, Capel, and Busselton regions provide an ideal breeding habitat for *Ae. camptorhynchus* mosquitoes (5,6). This species is the major vector of RR virus in the southwest of

Table 1. Cases of Ross River virus disease, by month of onset and geographic region, in the southwest of Western Australia, July 1995 to February 1996[a]

Southwest region	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Totals
Metro. area	1	1			6	23	99	17	147
Peel		1	3	1	1	8	34	9	57
Leschenault	2			1	3	9	114	30	159
Capel/Busselton				2	1	26	73	20	122
Inland/south coast		2		1	2	3	30	27	65
North/east of Perth			1	4	2		5	3	15
Totals	3	4	4	9	15	69	355	106	565

[a]Cases are recorded by region in which exposure most likely occurred, where available (from case follow-up questionnaires), or by region of residence. Data are incomplete. Case follow-up questionnaires are available for many January/February cases but have not yet been analyzed, and most pathology laboratory reports (nonnotified serologically confirmed patients (i.e., figures represent underestimate of true number of confirmed cases) are not included.

Western Australia. Surveillance during previous outbreaks has clearly shown that the risk for RR virus transmission in coastal regions of the southwest increases markedly if large populations of adult *Ae. camptorhynchus* persist into late spring and summer (1,2). Adult mosquito populations and RR virus activity are monitored routinely by our laboratory at up to 40 sites between Rockingham and Dunsborough (50 km to 260 km south of Perth) each fortnight through spring and summer. In addition, saltmarsh mosquito breeding sites are regularly monitored by local authorities and the health department.

Widespread breeding of *Ae. camptorhynchus* (larvae) was observed in the Capel—Busselton region in late October 1995 and prompted a health department warning of an increased risk for RR virus transmission in the southwest. However, almost no activities to control mosquito larvae were carried out in the worst-affected regions. The adult mosquito monitoring program subsequently showed that extremely large populations of *Ae. camptorhynchus* survived through November and December. (Figures 2 and 3). The number of mosquitoes collected per trap per night in the Capel–Busselton region during November and December 1995 (up to 10,000 mosquitoes per trap at some sites) is unprecedented in the 5 years of surveillance in the region. Similar results were obtained in the Leschenault region where the number of *Ae. camptorhynchus* mosquitoes collected during December 1995 and January 1996 were similar to those observed during the 1991–92 outbreak. These observations, along with the expected seasonal exodus of city dwellers to these areas during the Christmas holidays, prompted a second warning by the health department in December 1995.

Fourteen isolates of RR virus were obtained from *Ae. camptorhynchus* mosquitoes collected at a major wetland west of Busselton on December 7, 1995 (Figure 3). Large populations of potential vertebrate hosts (western gray kangaroos, *Macropus fuliginosus*) were also observed in close proximity to this site throughout the spring and summer. Case follow-up questionnaires indicate thata large percentage of Busselton patients were exposed in this locality. The last time RR virus was isolated from this site was during the 1991-92 outbreak in the region.

Mosquito populations in the Capel–Busselton region (Figure 3) and most areas of the Leschenault region dropped rapidly by mid-January 1996. However, further cases with dates of onset in February have been reported (Table 1), which suggests a high infection rate in the remaining adults. The results of processing of adult mosquitoes collected in February are, therefore, eagerly awaited.

Several isolates of RR virus were also obtained from mosquitoes collected in the Peel region (Table 2). The recent isolations from *Ae. vigilax* are of particular concern. This species is regarded as the major vector of RR virus in coastal areas of northern and eastern Australia (3,4), but until now it has had little or no role in transmitting RR virus in the southwest (1,2). *Ae. vigilax* has become the

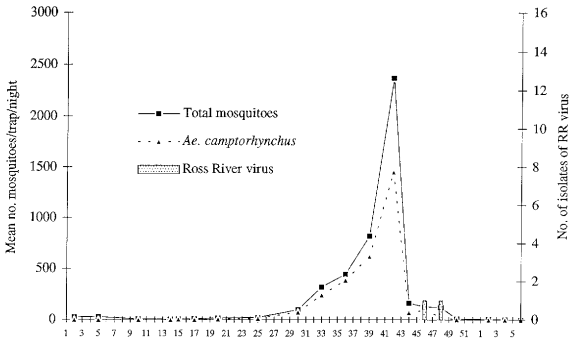

Figure 2. Mean number of adult mosquitoes (total population and dominant species) and isolations of Ross River virus from mosquitoes at Capel–Busselton region, wetland site, January 1994 to April 1995.

Table 2. Isolations of Ross River (RR) virus from mosquitoes collected in the Peel region: 1995–96 season

Date	Species	Isolates of RR virus
14-Sep-95	*Ae. camptorhynchus*	1
24-Oct-95	*Ae. camptorhynchus*	2
7-Dec-95	*Ae.camptorhynchus*	1
27-Dec-95	*Ae. camptorhynchus*	5
15-Jan-96	*Ae. camptorhynchus*	2
15-Jan-96	*Ae. vigilax*	3

dominant species in the Peel region between December and March since the opening of the Dawesville Channel. This mosquito is a vicious biter, even during the day if weather conditions are suitable, and is known to disperse considerable distances from breeding sites. Thus, the potential for interaction between infected mosquitoes and humans in the Peel region may be greater and occur over a wider area than originally thought.

Analyses of environmental conditions before and during the outbreak are not yet complete. However, record-high daily rainfall was recorded in October at numerous centers in the southwest. Above-average rainfall occurred in November in Perth and Mandurah and in December in Mandurah, Banbury, and Capel-Busselton. These were accompanied by above-average October and November temperatures at many southwest centers. A series of extremely high tides was also recorded along the Peel–Leschenault region coast around December 20. This resulted from unusually early cyclonic activity (three cyclones) along the north and west coasts of Western Australia during December. Clearly, a combination of some or all of these factors enabled widespread breeding and survival of vector mosquito species. Late spring and summer rains, a short-term rise in sea level (accompanied by higher tides), and mild spring and summer temperatures were predisposing factors during previous outbreaks in the southwest (2,4).

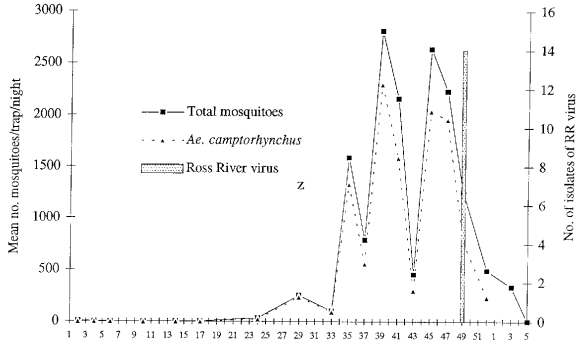

Figure 3. Mean number of adult mosquitoes (total population and dominant species) and isolations of Ross River virus from mosquitoes at Capel–Busselton region, wetland site, January 1995 to January 1996.

Preliminary analysis of the location of virus activity (measured as either human cases or isolations from mosquitoes) shows that activity is far less likely in regions in which virus activity was detected in the previous season. Thus, length of time since the previous outbreak also appears to be a predisposing factor for higher levels of virus activity in the southwest. The reason for this is not yet known but may be due to higher levels of immunity in recently infected populations of enzootic or amplifying vertebrate hosts. This may help explain the comparatively reduced numbers of cases in the Peel region this season following moderate levels of virus activity last year, which coincided with the opening of the Dawesville Channel.

A small number of cases of Barmah Forest virus infection have been diagnosed during the current outbreak. Numerous cases of a RR virus-like disease have also been reported, as in the 1988-89 and 1991-92 outbreaks. Serum from these patients has been tested for IgM antibody to RR and Barmah Forest viruses but is negative for both viruses. Some of these cases may be in persons that had not seroconverted at the time of the first blood sample. However, many have since provided further samples, all of which have had negative test results. Sera from these patients are being tested against a wide range of other Australian arboviruses, and more blood samples will be sought to ensure that the phenomenon is not due to an extremely delayed immunologic response to RR virus.

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