Domestic Pigs and Japanese Encephalitis Virus Infection, Australia

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To determine whether relocating domestic pigs, the amplifying host of Japanese encephalitis virus (JEV), decreased the risk for JEV transmission to humans in northern Australia, we collected mosquitoes for virus detection. Detection of JEV in mosquitoes after pig relocation indicates that pig relocation did not eliminate JEV risk.

Japanese encephalitis virus (JEV) is a major cause of viral encephalitis in Southeast Asia; >50,000 cases are reported annually (1). Ardeid wading birds are the primary maintenance hosts, pigs are the main amplifying hosts, and Culex mosquitoes are the primary mosquito vectors. Suppression of JEV disease in humans is generally considered to be best achieved through vaccination of humans or swine, mosquito control, or a combination of these strategies (2). An alternative approach of moving domestic pigs away from human habitation has been suggested as a potential method of reducing JEV transmission to humans (1,3). Although this strategy could be considered a logical way to limit human exposure to infected vectors, the actual effect that removing domestic pigs would have on mosquito infection rates has not been established.

Since the emergence of JEV in northern Australia in 1995, we (the authors) have investigated the ecology of JEV on Badu Island in the Torres Strait, where most human, pig, and animal infections have occurred. Intense transmission on this island has been linked to domestic pigs, which until late 1998 were housed in small backyard pens (Figure 1, panel A), and high populations of Culex sitiens subgroup mosquitoes (4). In Australia, members of the Cx. sitiens subgroup, from which Cx. annulirostris is considered to be the most important species, are the primary Australian JEV vectors (5). During an outbreak in 1998, the virus was shown to be widespread on Badu Island; isolates were obtained from mosquitoes collected throughout the community (6). A vaccination program initiated on the outer Torres Strait islands in 1995, including Badu Island, appears to have limited the number of human clinical cases (5).

To further reduce JEV risk for Badu Island residents, after the 1998 outbreak domestic pigs were removed from the Badu Island community to a piggery located ≈2.5 km away (Figure 1, panel B). This relocation led to a significant reduction in the proportion of Cx. annulirostris feeding on pigs, and speculation was that this might reduce the number of JEV-infected mosquitoes (7). We report on the effects of pig relocation away from human habitation on virus infection rate in Cx. sitiens subgroup mosquitoes.

The Study

In response to JEV activity, as evidenced by human clinical cases or the seroconversion of sentinel pigs, adult mosquitoes were collected on Badu Island during 1995, 1998, and 2003 (6,8, and this article, respectively). Badu Island is located at 10°07′S and 142°09′E in the central western region of the Torres Strait and is a granite island of ≈101 km²; its ecology has been described (6–8).

The mosquitoes were collected with Centers for Disease Control (CDC) miniature light traps (Model 512; John

Figure 1. Pig housing in Badu Island. A) Typical backyard pig pen in community before removal in 1998 and B) Badu Island piggery, where pigs have been housed since late 1998.
quitoes collected at the dump in 1998. Despite removal of
mosquitoes collected in 2003 showed that
mosquito infection rate with 95% con-
idence intervals indicates that
mestic pigs were present within the community, although
the slight overlap in 95% confidence intervals indicates that
this difference in infection rate was not significant.

Conclusions
We demonstrated that although removing domestic pigs from areas of human habitation may reduce contact between amplifying hosts and vectors (7), it does not elimi-
and the community on Badu Island. Solomon recommends
considerably farther than the 2.5 km between the piggery
and the community on Badu Island. The mean flight distance of
4.4 km; some females traverse up to 12 km (15), which is considerably farther than the 2.5 km between the piggery and the community on Badu Island. Solomon recommends that domestic pigs be moved >5 km from human habitation to limit JEV transmission to humans (3). Indeed, if infected mosquitoes were flying from the piggery to the community, then the data from our study support this recommendation. However, we suggest that domestic pigs be removed far enough away from human habitation to encompass the flight range of the local Culex vectors.

Figure 2. Aerial photograph of Badu Island showing the location of the community, piggery, and rubbish dump.
Table. Mosquito infection rates during 3 recognized incursions of Japanese encephalitis virus, Badu Island, northern Australia*

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<tr>
<td></td>
<td>Pigs located within community</td>
<td>Pigs relocated outside community</td>
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<tr>
<td></td>
<td>No.†</td>
<td>Infection rate (95% CI)</td>
<td>No.†</td>
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<tr>
<td>Community</td>
<td>2,871</td>
<td>8</td>
<td>3.02 (1.43–6.74)</td>
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<tr>
<td>Piggery</td>
<td>NS</td>
<td>NS</td>
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<td>Dump</td>
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*Mosquito infection rates determined by maximum-likelihood estimation; 1995, Apr 8–9 and 20–21, 30 trap nights; 1998, Mar 5–6, 25 trap nights; 2003, Mar 13–19, 92 trap nights; CI, confidence interval; NS, mosquitoes not sampled from this location during the year of collection.
†Total no. mosquitoes processed.
‡No. Japanese encephalitis virus–positive pools detected by virus isolation or TaqMan reverse transcription–PCR.

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References


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