

The mosquito *Anopheles dirus*: at present the only vector that transmits malaria parasites to humans in Khanh Phu commune (Central Vietnam)

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Previous studies in Khanh Phu have shown that the two main vectors of malaria were *An. dirus* and *An. minimus* s.l. After the introduction of wide-scale use of insecticide treated bednets in 1998, *An. minimus* s.l. virtually disappeared and so far it has not recovered. Since then the transmission of malaria in the Khanh Phu area must have been mainly maintained by *An. dirus*. However, among the 29 Anopheline species present in Phu Khanh some others have since long been suspected as 'secondary vectors' in Vietnam. Therefore vector surveillance was routinely been continued, focusing on all the species whose densities and human biting habits would enable them to transmit malaria parasites: *An. dirus*, *An. minimus*, *An. aconitus*, *An. maculatus*, *An. peditaeniatus* and *An. sinensis*. This report is based on data collected in Khanh Phu in six years, from 2006-2011.

In the 2,459 nights of human landing catches over six years (2006-2011) in Khanh Phu forest and plot, *An. dirus* was always the most numerous biting mosquito among the six species, with an average density of 4.4 bites per person per night. This is tens to hundreds of times higher than all the other five species. This mosquito species bites cows with lowest number a comparison with others (only 3 specimens/68 nights were caught in two years 2006-2007). *An. dirus* is one among three species that show the highest longevity as shown by a high parity rate between 68-76%. But it was the only species in which sporozoites were found in the salivary glands (the annual average ranged from 1.0 - 2.3%). Further it was shown that *An. dirus* carried sporozoites during all months of the year. These results show that as long as *An. minimus* does not return *An. dirus* acts as the only vector of human malaria.

In the period from 2008 to 2010 a total of 102 sporozoite positive salivary glands of *An. dirus* were successfully analyzed by PCR in which 40 (39%) showed an infection with *P. knowlesi*. In the same period this malaria parasite was detected by the same molecular methods in the blood of 30 people in Khanh Phu (Marchand R. et al, 2011). When capturing mosquitoes (by Human Landing Catch

method) around the monkey cage placed in the forest fringe, *An. dirus* was again found as the most numerous mosquito with a density (3.9 specimens/night) which is tens of times higher than the combined number of other species. It is assumed but not yet proven by us that the *An. dirus* also bites the monkeys. The sporozoite rate of these mosquitoes was 2.1% and PCR analysis of 15 samples of positive salivary glands showed *P. knowlesi* in 9 cases (60%).

These results allow the conclusion that in the last six years the mosquito *An. dirus* was the only mosquito that transmits malaria parasites, including *P. knowlesi*, to humans in Khanh Phu. This implies that if we could effectively control *An. dirus*, malaria could be eliminated from this area.