paper 3.12

Sterile Insect Technique to control *Aedes albopictus*

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The Asian tiger mosquito *Aedes albopictus* is present in almost all the islands of southwestern Indian Ocean including Madagascar, Mauritius, Mayotte, Seychelles, and La Reunion. In 2005, 2006 and 2010, this species, with its high vector competence combined with an efficient spreading behaviour, was the major vector involved in the Chikungunya virus outbreak which occurred in the region. Moreover, *Ae. albopictus* is also present in the Mediterranean area in Europe and was responsible for a Chikungunya virus outbreak in Italy in 2007 and of autochthonous Chikungunya and Dengue cases in 2010 in France and Croatia. Current control methods against the Asian Tiger mosquito consist of trapping, source reduction, public health education, and more particularly chemical or biological insecticide treatments. The major problem besides the persistence of insecticides in the field and their impact on non-targeted species is the rapid acquisition of insecticide resistance, like for *Aedes aegypti* in the French West Indies or *Ae. albopictus* in Thailand. In the context of an area-wide integrated vector management, the sterile insect technique (SIT) could be a suitable control method in La Reunion Island. The aim of this talk is to present the results of a 4 year feasibility study to assess the use of SIT as an additional tool to the different control methods that could lead to the suppression of the use of insecticide in La Reunion Island. We present several results obtained on the biology of *Ae. albopictus*, the sterilization treatment, the mass-rearing equipment and the mathematical modelling.

A series of experiment on the sexual behaviour of males *Ae. albopictus* were carried out in laboratory and in semi-field settings. In laboratory, we determined the sexual performance of a male and we demonstrated that the effect of irradiation on male *Ae. albopictus* decrease the quantity of sperm and the number of filled spermathecae without any influence on the number of inseminated females. Finally, we observed a two-fold reduction of the wild population's fertility with a competitiveness experiment between 5 days old wild and sterilized males in semi-field conditions. These overall biological results confirmed that, despite that the effect of irradiation on male mating ability could be detected, the results observed in semi-field conditions pointed up that a judicious release of older males might be synonymous of success for SIT. Moreover, we observed in the field the capacity of females to have multiple inseminations and a progeny coming from different males, which is a result of importance in order to assess the efficacy of a SIT programme.

In parallel of the characterization of the sexual behaviour, we determined the spatial and temporal heterogeneities of *Ae. albopictus* by studying larval and pupal density in situ. We showed a high variation of the population between the dry and the wet season and highlighted some specific areas where *Ae. albopictus* can be find at high density, and determined the density of males from 300 to 1500 males/ha depending of the season. At least, we defined a new and operational entomological index adapted to *Ae. albopictus* that appears easy to use with a gain of time for the control agents. More, our results on the productivity indicate the necessity to focus the control on productive breeding sites, easily distinguish with our index.

Temporal models have been developed to study the impact of periodic releases of sterile males and to improve the release procedure (the number of released males, the periodicity of the releases...). Then we have focused on spatio-temporal modelling to understand mosquito dynamic and to determine efficient SIT strategies (the place of the releases, the optimal period of releases along the year...) taking into account environmental factors, like wind and vegetation, in combination with the landscape Ecology study. The main difficulties came from the fact that we took into account the whole mosquito population

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(the aquatic stage, wild males, immature females, breeding females, resting females, feeding females, and sterile males), which leads to a complex system of nonlinear Partial Differential Equations with discontinuous parameters. Using appropriate numerical methods we provide interesting simulations that are helpful to discuss the best strategies to control the wild mosquito population, and where are the optimal places to release the sterile males.

During this project, important progresses were made in the development of mass-rearing technology for both larval and adult stage. We will present the rack-tray system, which gives a production of 1 million larvae-pupae mixture of *Ae. albopictus* on less than 1m2 and a mass rearing cage for adult to stock until 30 000 adults. In addition, a new larval diet was developed and tested on *Ae. albopictus* to ensure the production of good quality and competitive insects.

These overall results gave us some confidence that new strategies against *Ae. albopictus* such as the use of sterilized males could be a success story in La Reunion Island, and also in continental countries.