



Mapping Insecticide Resistance in Dengue Vectors in the Northern Viet Nam, 2010-2013

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Abstract

By using WHO standard procedures bioassay for susceptibility of mosquitoes to insecticides, the study determinate susceptible and resistance of mosquito populations from 101 sites of 12 provinces/cities in Northern Viet Nam. The widespread insecticide resistance status of dengue vectors of the Northern Viet Nam in the period from 2011-2013 were mapped. The data were collected from Ha Noi, Quang Ninh, Vinh Phuc, Bac Ninh, Cao Bang, Lang Son, Nam Dinh, Thai Binh, Hai Phong, Thanh Hoa, Nghe An and Ha Tinh provinces, which is updated of documentations on the distribution and insecticides resistance status of dengue vectors in Northern Viet Nam, especially pyrethroid resistance status.

Almost of *Ae. aegypti* populations from Ha Noi city were resistant to alphacypermethrin, cyfluthrin, deltamethrin, etofenprox, lambdacyhalothrin, permethrin and DDT, but susceptible to malathion; most of populations in other sites of the North are tolerant.

The majority of populations of *Aedes albopictus* in most studied sites in 12 Northern provinces of Viet Nam were resistant to DDT, but susceptible to alphacypermethrin, cyfluthrin, deltamethrin, permethrin, lambdacyhalothrin, Malathion, a few populations was tolerant.

Keywords

Viet Nam; Dengue fever; Susceptible; Resistance; Tolerance

Introduction

Dengue hemorrhagic fevers (DHF) are presently important public health problems in Viet Nam. The strategy for disease control is based on reducing population densities of vectors *Aedes aegypti* and *Aedes albopictus*. This is heavily depending on the use of chemical insecticides. However, long term and large scale use of insecticides will lead to the development of resistance of insects, including mosquitoes to insecticides [1]. In Viet Nam, *Aedes aegypti* was found to be resistant to a number of pyrethroids and DDT [2,3,4]. The high level of insecticide resistance is recorded in Southern Viet Nam where dengue endemicity is the heaviest. However, the development of insecticide resistance in dengue vectors is also reported in Northern Viet Nam. This may cause some difficulties to prevent and control

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Received: February 02, 2016 Accepted: March 07, 2016 Published: March 11, 2016

successfully dengue vectors. In response to the urgent need of dengue control program, a study on mapping insecticidal resistance of dengue vectors in 12 Northern provinces in Viet Nam was conducted from 2010 to 2013.

Materials and Methods

Study sites

The sites selected for this survey on dengue vectors in Northern Viet Nam, during the period of 2010-2013, are presented in Figure 1. Larvae and pupae of *Ae. aegypti* and *Ae. albopictus* were collected from containers around houses in over 101 sites (approximately 668 tests) covering 12 provinces of Northern Viet Nam Figure 1.

Test mosquitoes

Larvae, pupae and adults of *Aedes aegypti* and *Aedes albopictus* were collected from the field in 12 northern provinces namely Ha Noi, Quang Ninh, Vinh Phuc, Bac Ninh, Cao Bang, Lang Son, Nam Dinh, Thai Binh, Hai Phong, Thanh Hoa, Nghe An and Ha Tinh, from 2010-2013. After identification, these mosquitoes were colonized under laboratory conditions at $27 \pm 2^\circ\text{C}$ and 70-80% relative humidity (RH). Larvae were fed on cat food, and adults were fed on blood from Swiss mice twice a week. When optimum numbers of eggs were obtained, they were transferred into water containers to develop until adult's mosquitoes were emerged. The adults 2-5 days old of F1 progeny were prepared for susceptibility test according to WHO standard procedures [5].

Insecticide Concentrations used in susceptible bioassays

The concentration of insecticides treated on filter papers supplied by WHO are following

- Alphacypermethrin 30 mg/m²
- Deltamethrin 0.05%
- Lambdacyhalothrin 0.05%
- Permethrin 0.75%
- Cyfluthrin 0.05%
- Etofenprox 0.15%
- Malathion 5%
- DDT 4%

Susceptibility test of adult mosquitoes for insecticide

- The adults of 2-5 days old of F1 progeny were prepared for susceptibility test according to WHO standard procedures [5].
- Sets of five tubes each with 20 non blood fed female (total of 100 mosquitoes) were tested with each insecticide. An amount of 25 mosquitoes were used as control. Batches of mosquitoes exposed to insecticide and control were kept for one hour before readings. Mortality is determined after 24 h holding period. Both exposure and holding time were occurred at $27 \pm 2^\circ\text{C}$ and 70 - 80% RH.

Interpretation of susceptibility test results

The WHO recommendation on the following is applied [5]:

- 98-100% mortality indicates susceptibility
- 80-97% mortality suggests tolerance
- < 80 mortality suggests resistance

When control mortality is between 5% and 20%, the average observed mortality is adjusted by Abbott's formula:

$$\frac{\% \text{ test mortality} - \% \text{ control mortality}}{100 - \text{Control mortality}} \times 100$$

Data have been mapped per insecticide (alphacypermethrin, cyfluthrin, deltamethrin, lambdacyhalothrin, etofenprox, permethrin, Malathion and DDT) and per vector species by using MapInfo software.

Results and Discussion

In total, 668 tests over 101 sites covering 12 different provinces / cities have been carried out during the survey. All data have been validated and cross checked before entering to the data base. The results of the insecticide susceptibility tests of *Aedes aegypti* are summarized in Figures 2.

In all surveyed localities in Northern Viet Nam, *Ae. aegypti* has been found resistant to DDT and susceptible to malathion at all study. Pyrethroid resistance is widespread in Ha Noi. In other provinces, occurrence of cyfluthrin, deltamethrin, permethrin resistance is apparently lower than that of etofenprox, lambdacyhalothrin and alphacypermethrin. It is also showed that Hanoi study site was susceptible to Malathion Figures 2.

The results of the insecticides susceptibility of *Ae. albopictus* are summarized in Figure 3. The results in Figure 3 showed that

Aedes albopictus collected from different localities of Northern Viet Nam exhibited various levels of susceptibility to insecticides. In the surveyed sites, *Aedes albopictus* has been found resistant to DDT. In Vinh Phuc, Bac Ninh, Cao Bang, Lang Son, and Quang Ninh, Hai Phong, Thai Binh, Nam Dinh, Thanh Hoa, Nghe An, and Ha Tinh, it was revealed that mosquito species is still susceptible to alphacypermethrin, deltamethrin, permethrin, lambdacyhalothrin, malathion. In Hanoi city, *Ae. albopictus* developed various levels of resistant to alphacypermethrin, deltamethrin, permethrin, lambdacyhalothrin.

During the past 40 years the use of insecticides such as temephos, Malathion, permethrin, propoxur, and fenitrothion has led to development of resistance in dengue vectors in many countries [6]. It was clearly shown in the present study that *Ae. aegypti* exhibits various levels of resistance to alphacypermethrin, deltamethrin, lambdacyhalothrin, and permethrin. Fortunately, most of *Ae. aegypti* populations were still susceptible to malathion. This discrepancy in different regions was possibly due to the longer and more extended use of the insecticides of the pyrethroid group in malaria and dengue haemorrhagic fever control programmes and in agriculture in Viet Nam [7,8]. Cross-resistance to DDT and pyrethroids has been reported in most species of mosquitoes of public health importance resulting from knockdown resistance (kdr) gene [6,9,10]. Resistance to pyrethroids generally confers cross-resistance to other insecticides that limits the alternative choices of effective insecticides. In addition, contamination of breeding places around the house with agricultural insecticide also may influence development of resistance.

Low levels of resistance to alphacypermethrin, lambdacyhalothrin, permethrin, and deltamethrin have been reported in *Ae. albopictus* from various areas in Northern Viet Nam. *Ae. albopictus* populations in the survey were susceptible to all insecticides tested, except DDT and all cites in Ha Noi. This

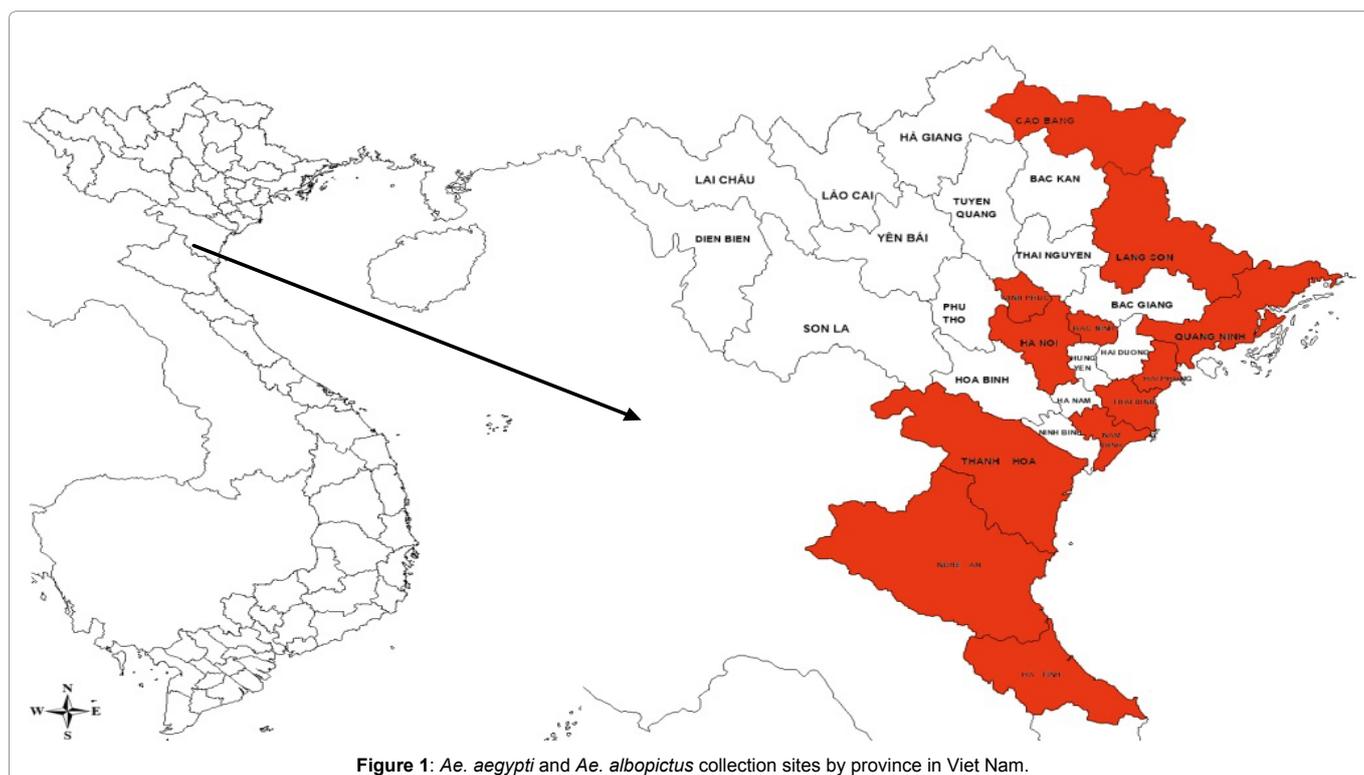
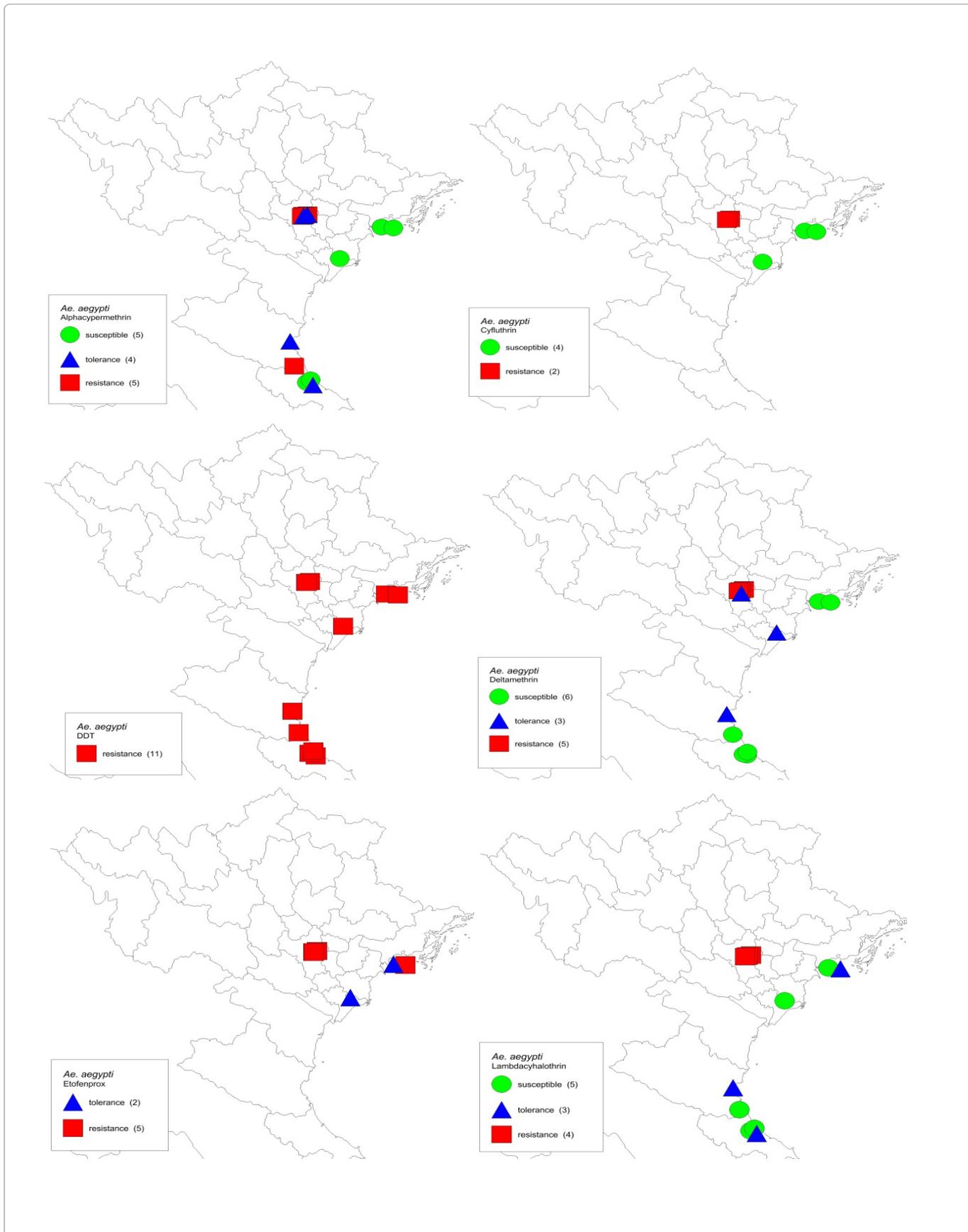
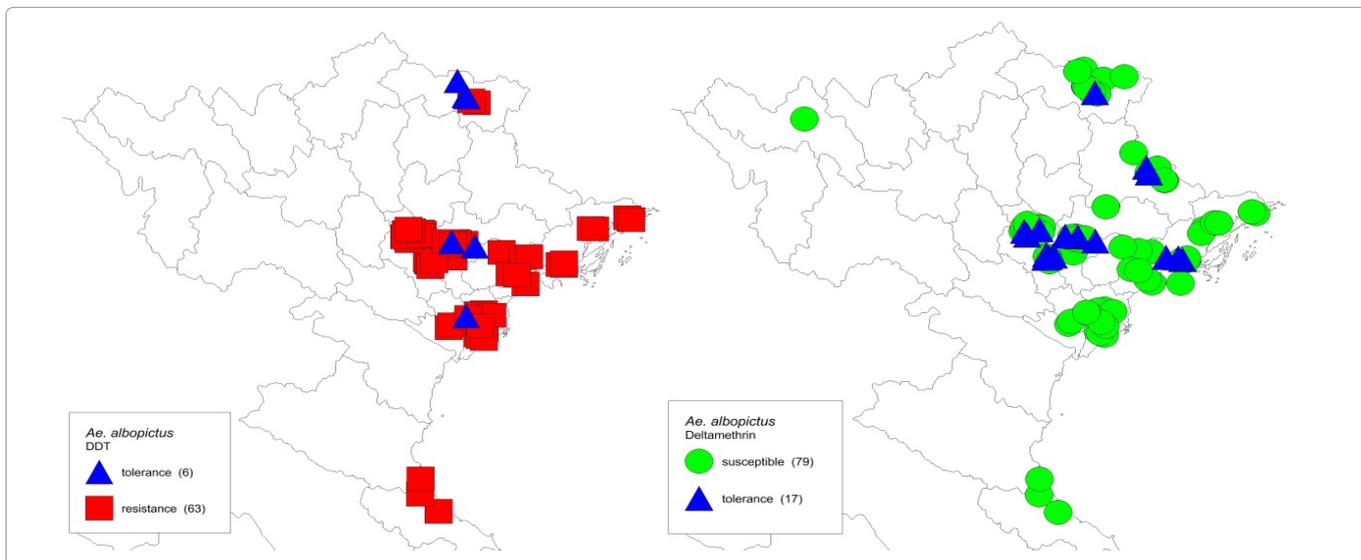
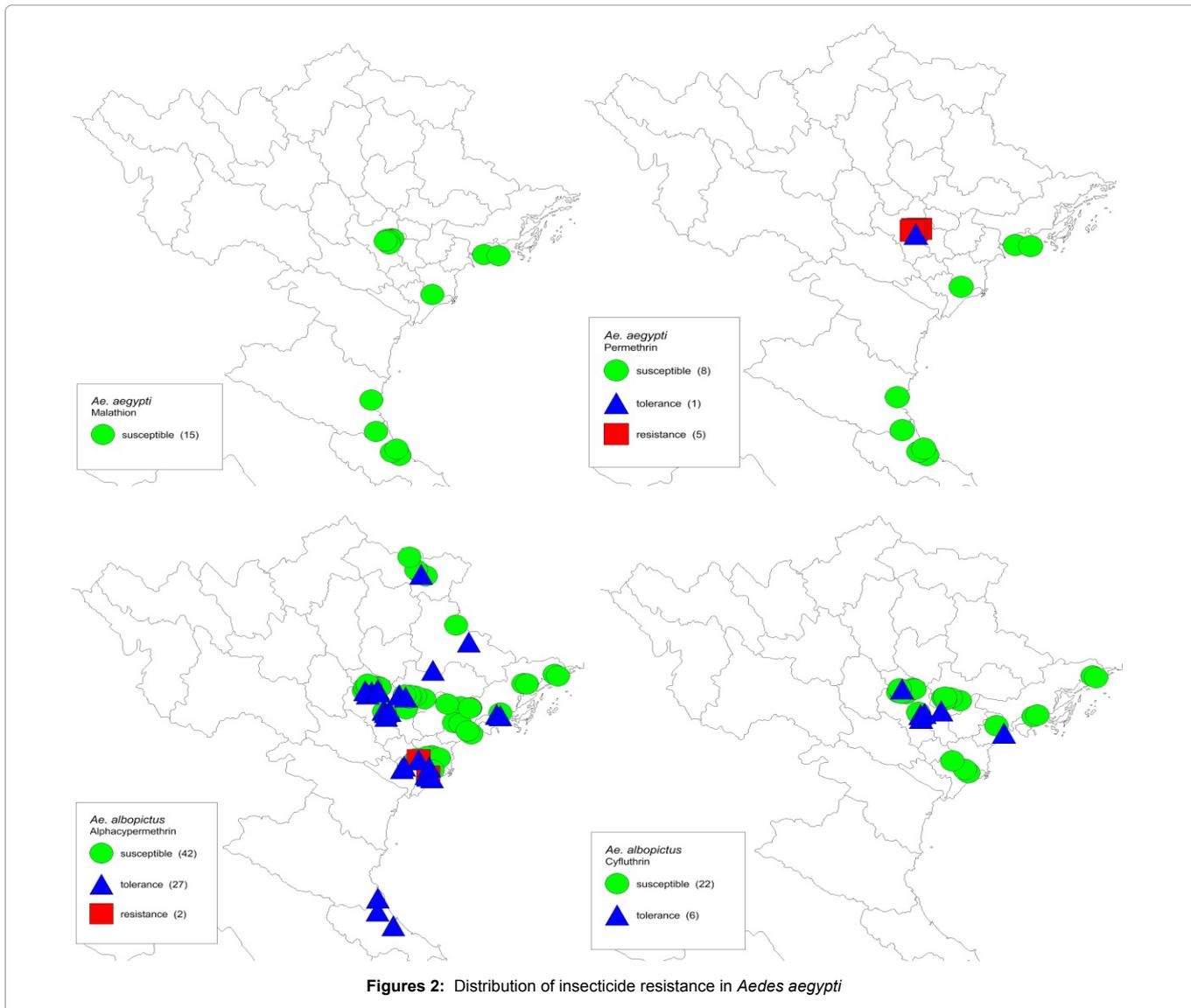
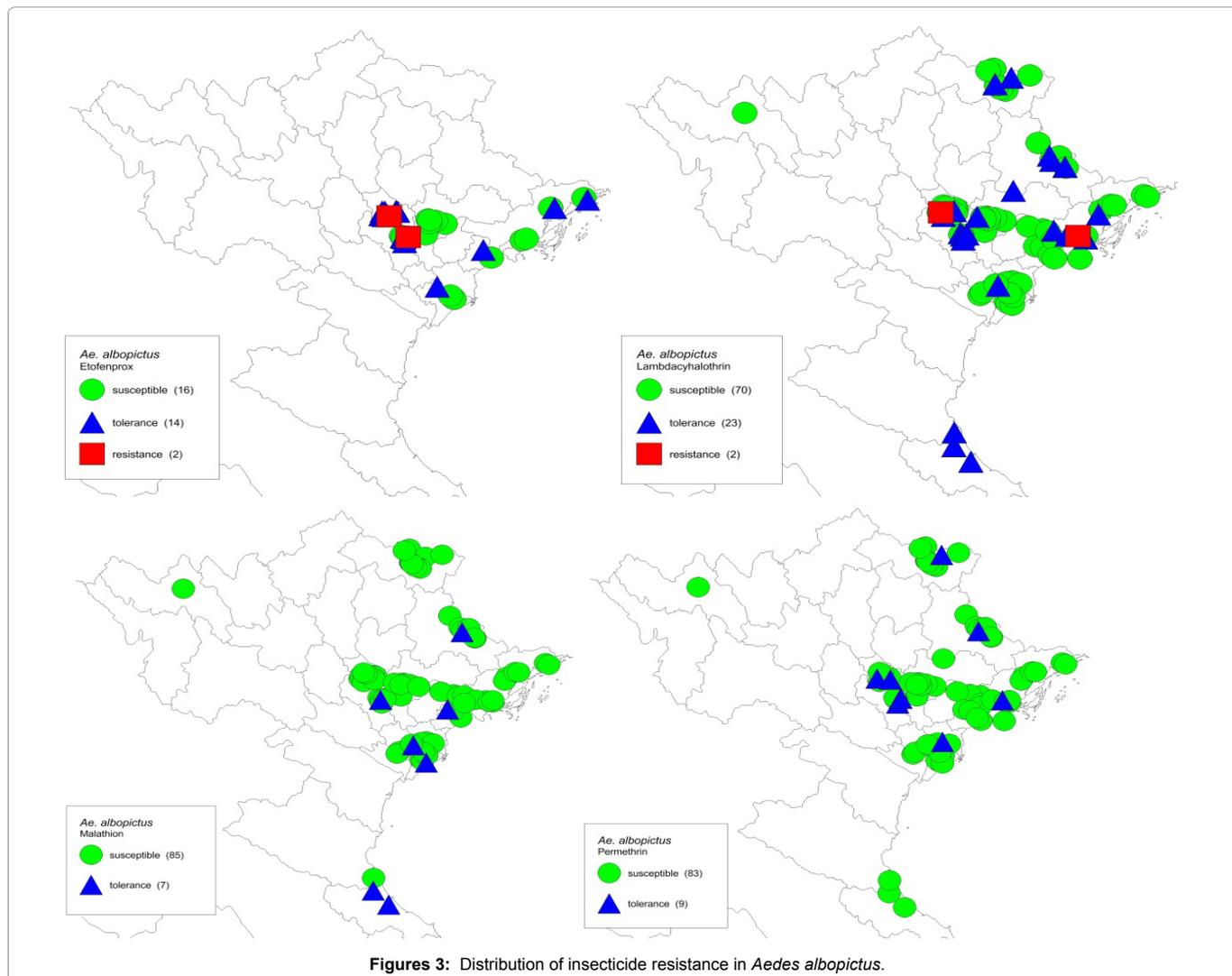


Figure 1: *Ae. aegypti* and *Ae. albopictus* collection sites by province in Viet Nam.







Figures 3: Distribution of insecticide resistance in *Aedes albopictus*.

could possibly be due to their different natural habitats, which were in less contact with insecticides used in the past. Their natural breeding places, usually in tree holes or natural containers, might have decreased and put pressure on them to breed in any possible containers which are close to humans. This is crucial because they could become an important dengue vector as well. Although *Ae. albopictus* in Asia is less susceptible to dengue virus than *Ae. aegypti* [11], *Ae. albopictus* could nevertheless become an important vector once their habitat has been changed, placing them in close contact with human.

It is important to understand the resistance status of insecticides used in the country. Based on this information the selection and frequency of insecticide can be strategist. This may contribute to increase the efficacy of vector control with less cost

Conclusion

Ae. aegypti from Ha Noi capital was resistance to alphacypermethrin, cyfluthrin, deltamethrin, etofenprox, lambdacyhalothrin, Permethrin and DDT, but susceptible to malathion.

Ae. albopictus were still susceptible to alphacypermethrin,

deltamethrin, permethrin, lambdacyhalothrin, malathion in most sites in 12 northern provinces, except in Ha Noi where this mosquito species was resistant to DDT.

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