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**SPATIAL DISTRIBUTION OF TICKS IN THAILAND: A
DISCUSSION BASIS FOR TICK-BORNE VIRUS SPREAD
ASSESSMENT**

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ABSTRACT:

A wide variety of viral infectious diseases are transmitted to humans by ticks and in certain cases, these diseases can lead to a severe encephalitis or haemorrhagic fever. Within the framework of a research programme on emerging viral diseases carried out by the French Institute of Research for the Development (Institut de Recherche pour le Développement, IRD) in partnership with the Centre for Vectors and Vector-borne Diseases, Mahidol University (Thailand), the spatial distribution of ticks in Thailand was investigated. An exhaustive review of studies of acarology conducted over the 20th century on Thailand was completed. We derived from this review the geographic coordinates of sites where ticks were collected in the past. In complement, we realised field works to collect ticks on unexplored sites. The location of these sites was obtained with a GPS (Global Positioning System). Hence, we were able to build up a location-based inventory of ticks covering almost the whole Thailand. These data were then processed in a GIS to assess in every region the presence of tick species and to map the distribution of species known as potential vectors of viruses which are likely to be pathogenic to humans. All the GIS processings were undertaken using *SavGIS*[®], a GIS freeware developed by IRD. This research represents a starting point for assessing tick-borne virus spread and the related risk of zoonosis¹ in Thailand.

KEY WORDS: Ticks, arbovirus, spatial distribution, GIS, *SavGIS*[®], Thailand

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¹ A zoonosis is any infectious disease that is able to be transmitted (in some instances, by a vector) from other animals, both wild and domestic, to humans.

1. INTRODUCTION AND PURPOSE

1.1 Prior ticks surveys in Thailand

The first known inventory of ticks in Thailand was carried out at the end of the 19th century (Neuman, 1899). During the second part of the 20th century, an almost exhaustive faunistic and ecologic study was conducted by several teams and 53 species were identified in Thailand (Tanskul et al., 1983; Aeschlimann, 1965; Hoogstraal, 1956, 1965, 1968, 1973, 1984; Petney et al. ,1995, 1996; Wassef et al. 1983, 1984, 1986).

1.2 Current ticks survey within the research programme “Fundamentals & Domains of Disease Emergence”

Our observations started in May 1998 focusing on the spatial distribution of ticks of “medical interest”, which are the ticks likely to transmit viruses to humans. Ticks on domestic and wild animals were collected in different areas in Thailand. Until now, 55 species of ticks have been identified. This investigation was carried out within the framework of research programme on emerging diseases in South-East Asia held by the French Institute of Research for the Development (IRD) in partnership mostly with the Centre for Vectors and Vector-borne Diseases at Mahidol University, Bangkok (Thailand).

1.3 Objective: toward a first assessment of tick-borne virus potential spread in Thailand

The main purpose of our research was to get an overall insight into the spatial distribution of tick species in Thailand. This knowledge is essential to assess in the future tick-borne virus potential spread, as tick-borne viruses are specifically restricted to tick species. The information about the presence of tick species in a given area and a given time and the information about their related human pathogenic viruses are crucial as they allow public health stakeholders to define strategies in order to prevent virus emergence and diffusion.

2. MATERIALS AND METHODS

2.1 Ticks collection

Tick specimens were collected (1) on alive or dead domestic or wild animals, (2) using a sledge (Cornet et al., 1984), or (3) by picking them manually on herbaceous plants.

Depending on the collection site, ticks were taken to lab in two different ways: (1) transported alive and afterwards identified on a cold top, or (2) placed first into cryotubes stored in liquid nitrogen before reaching the lab. For specimens identification, taxonomic keys developed by Aeschlimann (1965), Hoogstraal (1956, 1965, 1968, 1973, 1984), Petney et al. (1995, 1996), Tanskul (1989), Toumanoff (1944) and, Wassef et al. (1983, 1984, 1986) were used.

2.2 Integration of field data into the location-based dataset

Geographic coordinates of the collection sites were obtained during field work with a Global Positioning System device (GPS). For the ticks collected before 1998, the geographic coordinates of the closest locality to the collection area were used. These coordinates were afterwards integrated into the location-based dataset handled in partnership with the CVVD. This location-based dataset works under *SavGIS*[®], a Geographical Information System (GIS) freeware developed by the IRD (<http://www.savgis.org/en/>). Several queries (such as spatial joins and aggregations) were used to calculate in every region the presence of tick species and to elaborate the hereafter maps.

3. RESULTS AND DISCUSSION

3.1 Location of ticks collection sites in Thailand

From the year 1899 to 2005 ticks were collected in 56 provinces out of the 76 ones of Thailand (See figure 1). Newly reported species were censused in 30 provinces. The Nakhom Ratchasima province, located at the North-East of Bangkok, yielded up to 28 species.

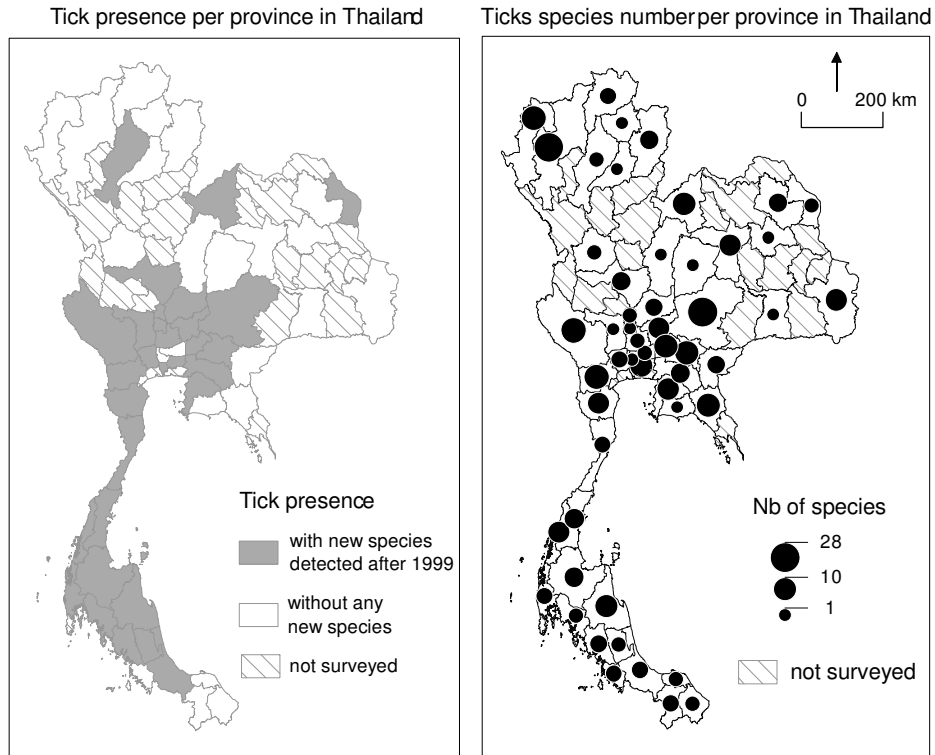


Figure 1: Spatial distribution of tick collection sites in Thailand (1899 - 2005)

3.2 Spatial distribution of ticks and tick-borne viruses potential spread in Thailand

Table 1 presents an overview of the human pathogenic viruses isolated from ticks in Central Asia and Siberia (Palearctic Biogeographic Region) and, in South-East Asia (Oriental Biogeographic Region). Figures 2 and 3 portray the spatial distribution of ticks in Thailand. Every tick genus and species, likely to bear one or more viruses, is underlined.

Family	Genus	Virus	Common vertebrate hosts	Vector
Togaviridae	Alphavirus	Chikungunya	birds, bats	Argas sp.*(2)
Flaviviridae	Flavivirus	Karshi	rodents	Alectorobius tholozani , capensis* ; <i>Hy.asiaticum</i> ; <i>Dermacentor marginatus</i> ; <i>Al.tartakovskyi</i>
		Kyasanur F.D.	rodents, birds, bats, primates	8 species of <i>Haemaphysalis</i> of which <i>Ha.spinigera</i> , <i>Ha.turturis</i> , Ha.wellingtoni* ,
		Langat	rodents	Ix.granulatus* ; <i>Ix.persulcatus</i> ; Ha.papuana*
		Omsk Haemorrhagic Fever (OHF)	rodents	<i>De.marginatus</i> ; <i>De.reticulatus</i> (=pictus), De.sp* ; <i>Ix.persulcatus</i>
		Ticks' Encephalitis	rodents, birds	<i>Ix.persulcatus</i> ; <i>Ix.ricinus</i> , Ix. sp* ; <i>De.marginatus</i> ; <i>De.reticulatus</i> (=pictus); <i>Ha.japonica douglasi</i>
		TBE=RSSE West Nile	rodents, migrating birds, bats (1 isolation)	<i>Ha.concinna</i> . <i>Ar.hermani</i> ; <i>Hy.m.marginatum</i> (=plumbeum); <i>Hy.asiaticum</i> ; <i>Hy.detrutum</i> ; <i>Ix.ricinus</i> ; <i>De</i> . <i>daghestanicus</i> ; <i>De.marginatus</i> ; <i>Rh.bursa</i> ; <i>Rh.turanicus</i> ; <i>Al.maritimus</i> (=Or.capensis) <i>Al.tholozani</i> (=Or.tholozani)
Bunyaviridae	Nairovirus	CCHF	rodents, bovine, caprine, ovine	<i>Amblyomma variegatum</i> ; <i>Hy.sp.</i> ; Rh.sanguineus*
		Ganjam = NSD (1)	ovine, caprine	<i>Ha.intermedia</i> ; Ha.wellingtoni*
Bunyaviridae		Bhanja	rodents, bovine, caprine, ovine, insectivorous	Ha.sp.* ; <i>Ha.intermedia</i> ; <i>Ha.punctata</i> ; <i>Hy.detrutum</i> ; <i>Hy.m.marginatum</i> (=Hy.p.plumbeum)
		Kaisodi	birds	<i>Ha.spinigera</i> , Ha.wellingtoni* ; <i>Ha.turturis</i>
		Lanjan	rodents	Ha.nadchatrami* ; Ix.granulatus*
Orthomyxoviridae		Thogoto	bovine, caprine, ovine	Rh.sp* ; <i>Hy.anatolicum anatolicum</i>

Table 1: Human pathogenic viruses isolated from ticks in Central Asia and Siberia (Palearctic Biogeographic Region), and in South-East Asia (Oriental Biogeographic Region).

(1) The Ganjam virus was found to be identical to the Nairobi Sheep Disease virus (NSD) (Davies et al., 1978); (2) Bold-typed species were reported in Thailand.

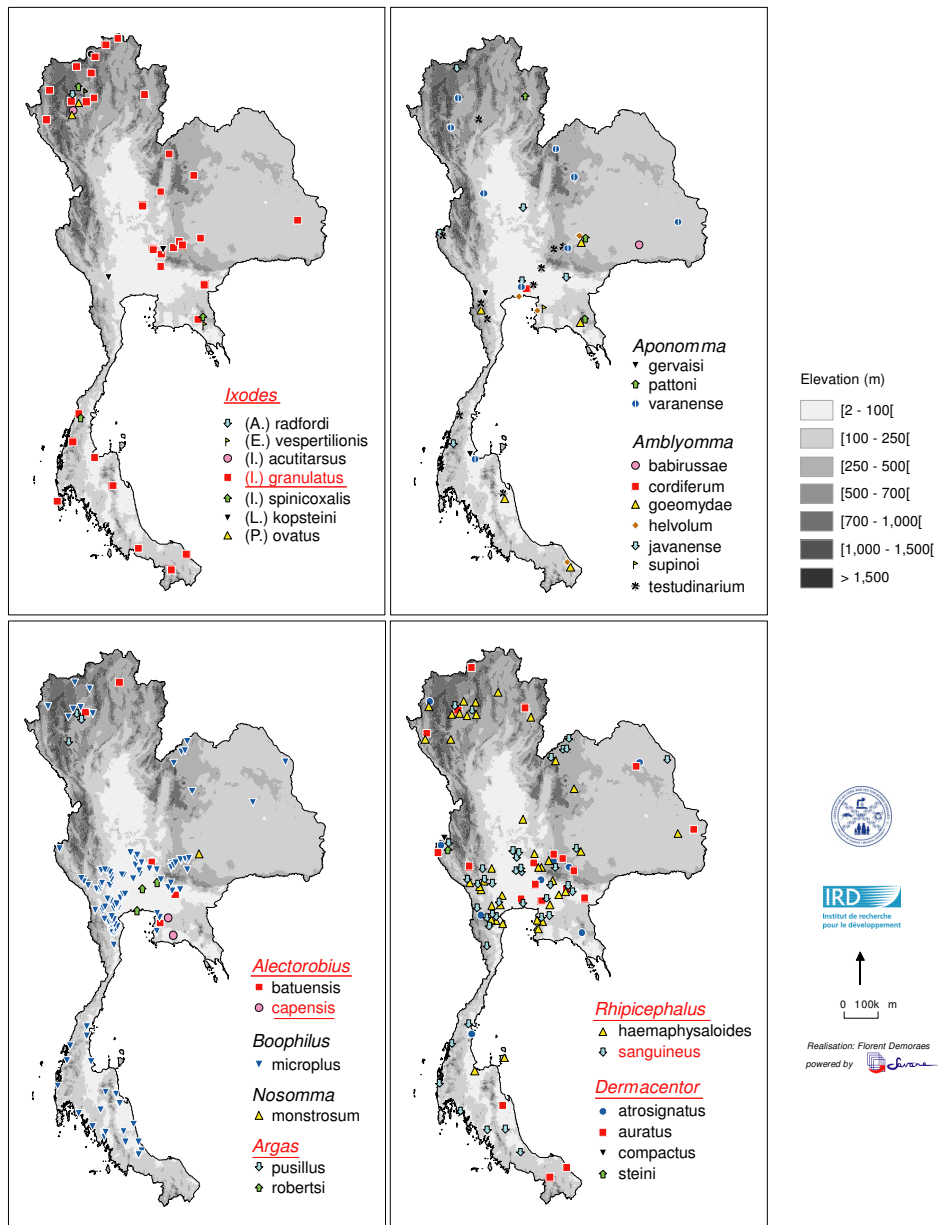


Figure 2: Spatial distribution of ticks in Thailand (a).

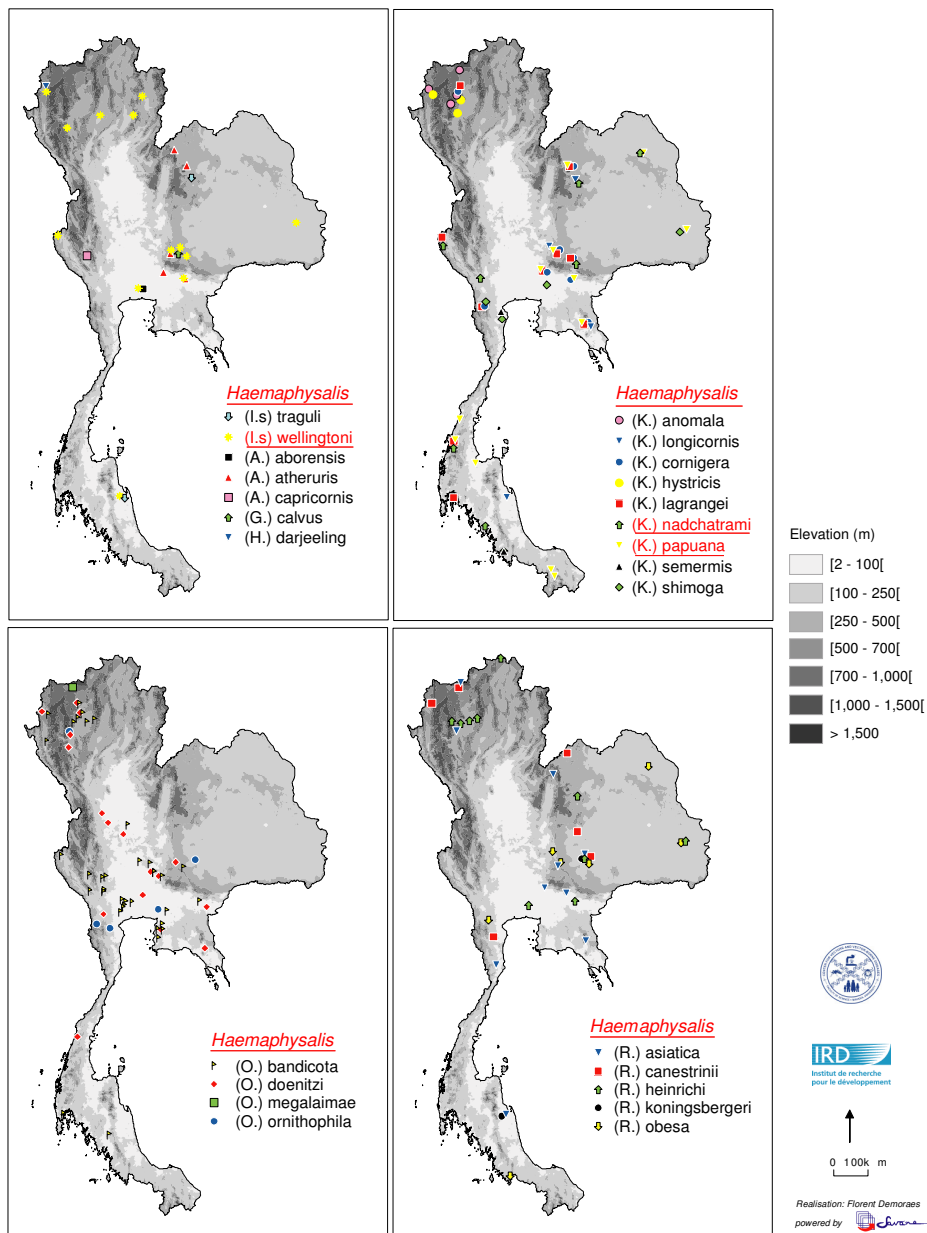


Figure 3: Spatial distribution of ticks in Thailand (b).

Amblyomidae is the most common tick species in Thailand. They are present from cool temperate zones to the equatorial latitudes.

- The genus *Haemaphysalis* is the most ancient and cosmopolite which seems to come from the Far-East. The sub-genus *Ornithophysalis* parasitizes birds and more particularly migrating birds, participating hence to viruses diffusion (See table 1).

- *Amblyomma* is typically associated with tropical latitudes. It can occasionally parasitize humans.
- *Rhipicephalus* is the most abundant and cosmopolite tick parasitizing domestic dogs.
- *Boophilus* is spread only in warm zones from Ancient World (Morel, 1969). In South-East Asia, only one species exists, *Bo.microplus* (Canestrini, 1888) which parasitizes mostly domestic or wild ungulates. However, *Bo.microplus* was also found on humans in Thailand and represents thus a potential vector for zoonosis due more specifically to Seletar and Wad Medani viruses.
- *Dermacentor* parasitizes mammals and humans. It is able to bear three arboviruses highly pathogenic to humans: the virus of the Kyasanur Forest Disease (KFD), the virus of the Omsk Haemorrhagic Fever (OHF), and the virus of the Russian Spring Summer Encephalitis (RSSE), all three of them responsible for encephalitis and/or haemorrhagic syndromes.
- *Aponomma* parasitizes mainly reptiles and has never been reported feeding on human.

While most of the tick-borne viruses were isolated in Europe, Africa, Far-East and in the Indian peninsula, they are likely to be evidenced in South-East Asia as well because some ticks which are potential viruses vectors have been identified in several South-East Asian countries, among them Thailand (see table 1). For instance, the virus Langat (Tick-Borne-Encephalitis) was first isolated in 1956 in Malaysia and, reported twenty years later in Thailand on *Ixodes granulatus* specimens.

Furthermore, migrating birds and bats are important hosts for viruses such as Chikungunya, Sindis, KFD and West Nile virus. As they occasionally develop viremic² phases, they can easily infect ticks when the latter bite. This situation may contribute at the same time to the spread of ticks and to the diffusion of tick-borne viruses.

² Presence of virus in the blood stream.

Apart from tick-borne viruses, other pathogenic agents like the borreliosis (Lyme disease), rickettsiosis (tick typhus), ehrlichiosis or *Francisella tularensis* infection (Tularemia) should be also cautiously considered. Indeed, some of them have been isolated from ticks in Thailand (Hirunkanokpun et al., 2003; Parola et al., 2003).

Moreover, most of the tropical wide spread ticks are undoubtedly present in Thailand as the diversity of biogeographic conditions in Thailand fits with a lot of tick species habitat. However, due to the massive deforestation which occurred in Thailand during the 20th century (Cropper ML et al. 1997), ticks distribution has changed to a certain extent. Ticks which were once collected in woody areas may not be present any longer.

4. CONCLUSION

The main purpose of this paper was to get an overall insight into the spatial distribution of different tick species in Thailand. The study represents thus a starting point for new researches on viruses which are potentially associated with the spatial distribution of vector tick species. Further investigations should aimed at (1) completing the tick species inventory of yet unexplored provinces, (2) attempting virus isolation from the known tick species of medical interest found in the explored areas and, (4) undertaking subsequent serological surveys in order to detect virus circulation among human populations (and or animal population) potentially exposed to the infected vectors.

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