Spatial Distribution of Ticks in Thailand: A Discussion Basis for Tick-Borne Virus EXTENT Assessment

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Abstract
A wide variety of viral infectious diseases are transmitted to humans through the ticks. Ticks are one of the key vectors for viruses coming from reservoirs such as wild or domestic animals. In certain cases, diseases resulting from tick-borne viruses can be very acute like encephalitis or haemorrhagic fevers. Within the framework of a research programme on emerging viral diseases carried out by the Development Research French Institute (IRD) in partnership with several counterparts in South-East Asia and more particularly in Thailand (Centre for Vectors and Vector-borne Diseases - Mahidol University), a location-based inventory of ticks using Global Positioning System technology appeared indispensable to attempt a first assessment of tick-borne viruses spatial distribution. Concurrently a literature review of acarology studies conducted through out Thailand over the entire 20th century was completed. Hence, an almost exhaustive spatial distribution of existing ticks in Thailand was mapped. This Geographical Information System-aided analysis undertaken using SavGIS©, a freeware GIS developed by IRD, is underpinned by a thorough knowledge on tick-borne arboviruses in Asia. This research represents a starting point for assessing tick-borne virus spatial distribution in Thailand.

1. Introduction

The first known surveys about ticks in Thailand were carried out in 1899 by Neumann who started an inventory for this kind of arthropods. More recently, an almost exhaustive faunistic and ecologic study was conducted in Thailand by Tanskul et al., 1983. Thanks to these studies and to those of Aeschlimann (1965), Hoogstraal (1956, 1965, 1968, 1973, 1984,), Petney et al., (1995, 1996), and Wassef et al., (1983, 1984, 1986), 53 species were identified in Thailand.Our observations started in May 1998 and were focused on the spatial distribution of ticks of "medical interest", which are ticks likely to transmit virus to humans. Ticks on domestic and wild animals were analysed in different zones in Thailand. Until now an overall of 55 species were identified. This investigation was carried out within the framework of research programme on emerging diseases in South-East Asia by the Development Research French Institute (IRD) in partnership with several counterparts in South-East Asia and more particularly in Thailand (Centre for Vectors and Vector-borne Diseases – CVVD– at Mahidol University - Bangkok). The role of different types of vectors and particularly the role of ticks as potential vector for viruses are being investigated as a wide variety of viral infectious diseases are transmitted to humans through the ticks. In certain cases, diseases resulting from tick-borne viruses can be very acute like encephalitis or haemorrhagic fevers. The main purpose of our research was to get an overall insight into the spatial distribution of ticks in Thailand. This study represents a starting point for assessing tick-borne virus spatial distribution. To know the present species and their related viruses which are pathogenic to humans allows public health stakeholders to adopt effective measures focused on prevention in order to avoid epidemics.

2. Materials and Methods

2.2 Ticks Collection

Tick's specimens were collected (1) on alive or dead domestic or wild animals, (2) using a sledge (Cornet et al., 1984), or (3) picking them manually on herbaceous plants. Depending on the collection site, ticks were taken to lab in two different ways: (1) ticks were transported alive and were afterwards identified on a cold top, or (2) placed first into cryotubes stored in liquid nitrogen. To determine specimens, were used 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).

2.3 Integration of Field Data into the Location-Based Dataset

Geographic coordinates of the collection sites were obtained with GPS. For the ticks collected before 1998, the geographic coordinates of the closest locality to the collection area were used. These waypoints 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. This software is downloadable at the following website: www.savgis.org. Spatial queries (such as geo-aggregations) were built to elaborate the hereafter maps.

3. Results and Discussion

3.1 Location of Ticks Collection Sites in Thailand

From 1899 to 2005, ticks were collected in 56 provinces out of 76 (See figure 1). New species were censed in 30 provinces. The Nakhom Ratchasima province, located at the North-East of Bangkok, gathers up to 28 species.

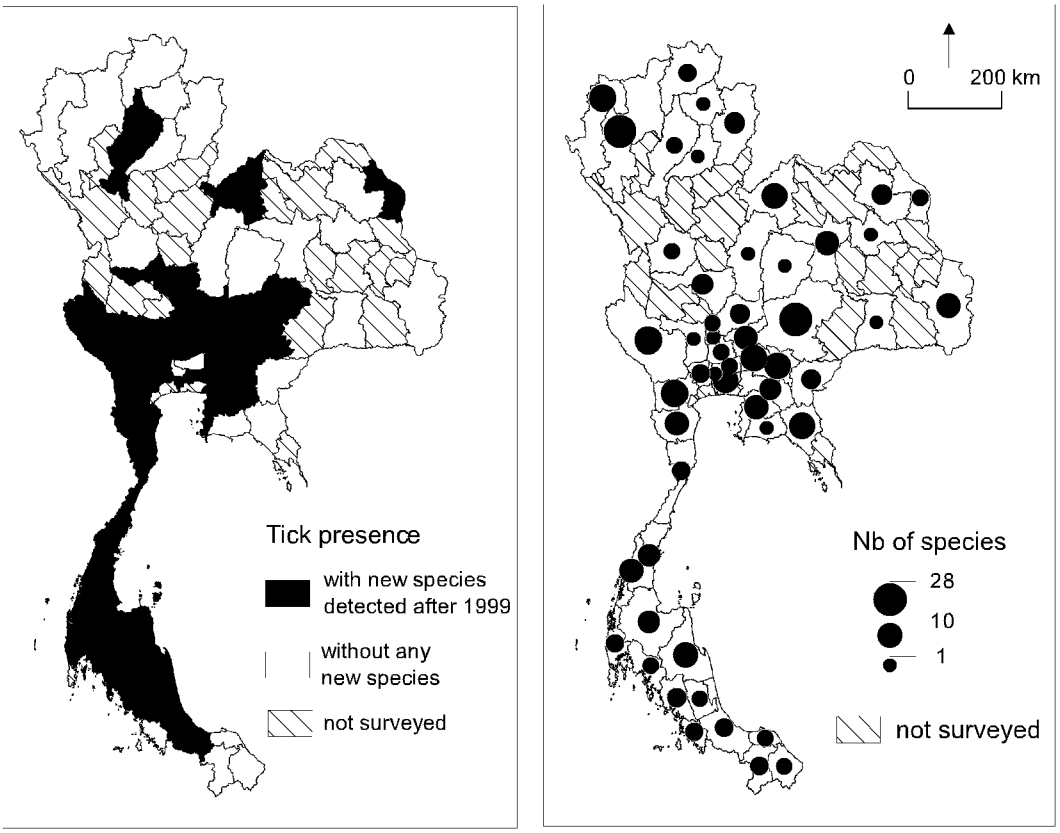

Figure 1: Spatial distribution of ticks' collection sites in Thailand (1899-2005)

3.2 Spatial Distribution of Ticks and Potential Tick-Borne Viruses Extent in Thailand

Table 1 presents an overview on pathogenic to humans viruses which were isolated from ticks in Central Asia and Siberia (Paleartic 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 specie liable to bear one or more viruses is underlined. Amblyommidae are the most common ticks in Thailand. They are present from cool template zones to the equatorial latitudes.

- The genus *Haemaphysalis* is the most ancient and the most cosmopolite which seems to come from the Far-East. The sub-genus *Ornithophysalis* parasitizes birds and more particularly migrating birds, participating hence to virus 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 liable to bear three arboviruses highly pathogenic to humans: the virus of the Kyasanur Forest Disease (KFD), the virus of the Omsk Haemorrhagic Fever (OHF), the virus of the Russian Spring Summer Encephalitis (RSSE), all three of them responsible for encephalitis and/or haemorrhagic syndromes.
- *Aponomma* parasitizes mainly reptiles. None of them were reported until now on human.

While most of the tick-borne viruses were isolated in Europe, Africa, Far-East and in the Indian peninsula, they are liable to be evidenced in South-East Asia as well because potential vectors are widely spread.

For instance, the virus Langat (Tick-Borne-Encephalitis) first isolated in 1956 in Malaysia, were reported 20 years later in Thailand. Migratory birds and bats are important hosts for viruses such as Chikungunya, Sindis, KFD and West Nile viruses, because during viremic phase, these viruses infect ticks. This situation is likely to lead to a risk of emergence and viruses' spread. Apart from tick-borne viruses, other pathogenic agents like the borreliosis (Lyme disease), the rickettsiosis (tick typhus), the ehrlichiosis and the Francisella tularensis infection (Tularemia) should be cautiously considered. Indeed some of them were isolated from ticks in Thailand (Hirunkanokpun et al., 2003; Parola et al., 2003). On another hand, most of the tropical wide spread ticks are undoubtedly present in Thailand, considering the biogeographic conditions which fit with a lot of tick species habitat. For this reason, new tick species are to be found in Thailand. Nevertheless, it should be noted that due to the massive deforestation which occurred in Thailand during the 20th century (Cropper et al. 1997), ticks distribution may have changed to a certain extent (ticks which were once collected in woody areas may not be present any longer).

Table 1: Pathogenic to humans viruses isolated from ticks in Central Asia and Siberia (Paleartic Biogeographic Region), and in South-East Asia (Oriental Biogeographic Region)

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

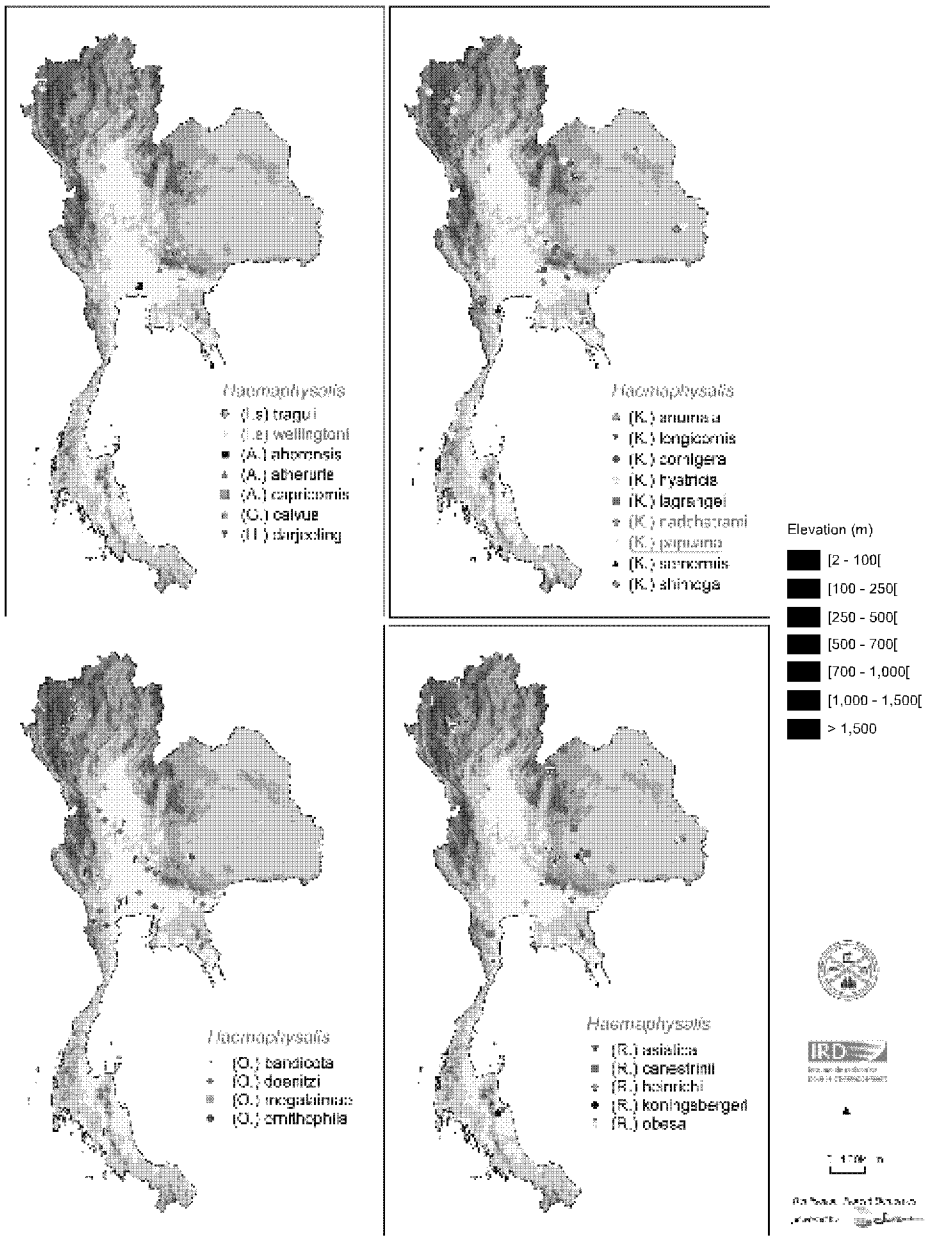

Figure 3: Spatial distribution of ticks and potential vector ticks in Thailand

4. Conclusion

The main purpose of this paper was to get an overall insight into the spatial distribution of ticks in Thailand. This study represents a starting point for assessing tick-borne virus spatial distribution and thus shows light on the diseases liable to be transmitted by ticks to humans. Further investigations should focus (1) on the prospecting for new tick species in the unexplored provinces, (2) on the confirmation of their presence in the deforested areas, (3) on the isolation of their virus, and (4) on their potential transmission to humans.

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References

Cornet, J. P., Degalier, N., and Hervé, J. P., 1984, Description of sledge for sampling (Acarina: Ixodina). *Acarologia*, 25(1), 17-19

Cornet, J. P., and Gonzalez, J. P., 2001, Nouvelles observations sur la bio-écologie des tiques en Thaïlande : données récentes sur les espèces présentes dans la Plaine Centrale. *Acarologia* 41(3), 287-294.

Cornet, J. P., Chauvancy, G., Neveu, P., Yoksan, S., and Gonzalez, J. P., 2002, Ectoparasitisme par *Amblyommidae* chez *Echinosorex gymnurus*, en Thaïlande. *Acarologia* 42(3), 227-228.

Cornet, J. P., Parola, P., Wongsrichanalai, C., Gonzalez, J. P., in press, Hôtes nouveaux de Dermacentor (Indocentor) steini Schulze 1933 et de Dermacentor (Indocentor) compactus Neumann 1901 (Acari : Ixodidae) en Thaïlande et au Vietnam. *Acarologia*.

Cropper, M. L., Griffiths, C. W., and Mani, M., 1997, Roads, Population Pressures, and Deforestation in Thailand, 1976-89. *World Bank Policy Research Working Paper* Washington, DC, No. 1726.

Davies, F. G., Casals, J., Jesset, D. M., and Ochieng, P., 1978, The Serological Relationships of Nairobi Sheep Disease Virus. *Journal of Comparative Pathology*, 88, 519-523.

Hirunkanokpun, S. P., Kittayapong, S. P., Cornet, J. P., and Gonzalez, J. P., 2003, Molecular Evidence for Novel Tick-Associated Spotted Fever Group Rickettsiae from Thailand. *Journal of Medical Entomology*, 40, 230-237.

Hoogstraal, H., 1956, African Ixodoidea, in Ticks of the Sudan (Cairo).

Hoogstraal, H., and Kohls, G. M., 1965, Southeast Asian *Haemaphysalis* Ticks (Ixodoidea, Ixodidae). *H. Bandicota* Sp.N. from Bandicoot Rats in Taiwan, Thailand, and Burma.

Hoogstraal, H., Kaiser, M. N., and Kohls, G. M., 1968, The Subgenus *Persicargas* (Ixodoidea, Argasidae, Argas). *Argas (P.) robertsi*, New Species, A Parasite of Australian Fowl, and Keys to Australian Argasid Species. *Annals of the Entomological Society of America*, 62(2), 535-539.

Hoogstraal, H., Clifford, C. M., Saito, Y., and Keirans, J. E., 1973, *Ixodes (Partipalpiger) ovatus* Neumann, Subgen. Nov.: Identity, Hosts, Ecology, and Distribution, *Journal of Medical Entomology*, 10(2), 157-164.

Hoogstraal, H., and Wassef, H. Y., 1984, *Dermacentor (Indocentor) compactus* (Acari: Ixodoidea: Ixodidae): Wild Pigs and other Hosts and Distribution in Malaysia, Indonesia and Borneo, *Journal of Medical Entomology*, 21(2), 174-178.

Morel, P. C., 1969, Contribution à la connaissance de la distribution des tiques (Acariens, Ixididae et Amblyommidae) en Afrique éthiopienne continentale, PhD. Thesis, Orsay

Neumann, L. G., 1899, Révisions de la famille des Ixodidés (3ième mémoire), *Mémoire de la Société Zoologique de France*, 12, 107-294.

Parola, P, Cornet, J. P., Sanogo, Y. O., Miller, R. S, Thien, H. V., Gonzalez, J. P., Raoult, D., Telforf, III S. R, and Wongsrichanalai, C., 2003, Detection of Ehrlichia spp., Anaplasma spp., Rickettsia spp., and other eubacteria in ticks from the Thai-Myammar border and Vietnam. *Journal of Clinical Microbiology*. 40: 1600-1608.

Petney, N., and Keirans, J. E., 1995, Ticks of the Genera Amblyomma and *Hyalomma* from South-east Asia. *Tropical Biomedicine* 12: 45-56.

Petney, N., and Keirans, J. E., 1996, Ticks of the genera *Boophilus*, *Dermacentor*, *Nosomma* and *Rhipicephalus* (Acari: Ixodidae) in South-East Asia. *Tropical Biomedicine*, 13: 73-84.

Tanskul, P., Stark, H. E., and Inlao, I., 1983, A checklist of ticks of Thailand (Acari:Metastigmata: Ixodoidea). *Journal of Medical Entomology*. 20(3): 330-341.

Tanskul, P., and Inlao, I., 1989, Keys to the Adults Ticks of *Haemaphysalis* Koch, 1844, in Thailand with Notes on Changes in Taxonomy (Acari: Ixodoidea: Ixodidae). *Journal of Medical Entomology*. 26(6): 573-601.

Toumanoff, C., 1944, Les tiques (Ixodoidea) de l'Indochine. *Institut Pasteur de l'Indochine*, S.I.L.I., Saigon.

Wassef, H. Y., and Hoogstraal, H., 1983, *Dermacentor (Indocentor) compactus* (Acari: Ixodoidea: Ixodidae): Identity of male and female. *Journal of Medical Entomology*. 20(6): 648-652.

Wassef, H. Y., and Hoogstraal, H., 1984, *Dermacentor (Indocentor) auratus* (Acari: Ixodoidea: Ixodidae): Identity of male and female. *Journal of Medical Entomology*. 21(2): 169-173

Wassef, H. Y., and Hoogstraal, H., 1984, *Dermacentor (Indocentor) atrosignatus* (Acari: Ixodoidea: Ixodidae): Identity of male and female. *Journal of Medical Entomology*. 21(5): 586-591.

Wassef, H Y., and Hoogstraal, H., 1986, *Dermacentor (Indocentor) Steini* (Acari: Ixodoidea: Ixodidae): Identity of male and female. *Journal of Medical Entomology*. 23(5): 532-537.