



First record of the sea snake tick *Amblyomma nitidum* Hirst and Hirst, 1910 (Acari: Ixodidae) from Taiwan

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ABSTRACT

The sea snake tick (*Amblyomma nitidum*) is a host specialist of snakes in the genus *Laticauda* and is one of the few ticks which could be regarded as semi-marine. Yet despite the attention this species has received due to its bizarre ecology, its distribution remains poorly known as geographic records of its occurrence through the Asia-Pacific are highly fragmentary. For the first time this species is recorded from Taiwan based on specimens collected from the yellow-lipped sea krait (*Laticauda colubrina*).

1. Introduction

Ticks, including *Amblyomma* species, are known to spread infectious diseases (Dantas-Torres et al., 2012), cause red-meat allergy (Kwak et al., 2018), induce tick-bite paralysis (Hanson et al., 2007; Kwak, 2017) and have also recently been shown to have value as forensic indicators (Kwak and Schubert, 2019). Therefore, it is essential to have accurate records of tick diversity and distribution, to inform public health policy, wildlife management, and forensic investigations. While there is some historical baseline data on tick diversity within Taiwan (eg. Robbins, 2005), the need to continue collecting abundance, distribution, and diversity records for Taiwan's tick species has never been more paramount due to the emergence and re-emergence of novel and known tick-borne pathogens which threatened both human and animal health. The most notable of these are *Rickettsia*, *Borrelia*, *Anaplasma*, *Ehrlichia* and *Babesia* which are being increasingly identified in Taiwan (Kuo et al., 2015; Chao et al., 2016; Kuo et al., 2017, 2018).

Within Taiwan, the tick genus *Amblyomma* is one of the least studied. Historically, four *Amblyomma* species have been recorded from Taiwan (Robbins, 2005). However, when the genus *Aponomma* was reclassified within *Amblyomma*, the species formerly known as *Aponomma varanense* was renamed *Amblyomma varanense*, thus bringing the total number of species in the genus to five, in Taiwan (*A. cordiferum*, *A. geoemydae*, *A. helvolum*, *A. testudinarium*, *A. varanense*). Though a number of these species occur in the neighbouring Ryukyu archipelago (*A. geoemydae* and *A. testudinarium*), the sea snake tick (*Amblyomma nitidum*) has never been recorded in Taiwan, despite occurring in

neighbouring Japan (Kwak, 2018a). To determine if this species occurs in Taiwan a collections-based museum survey was coupled with opportunistic field sampling.

2. Materials and methods

The herpetology collection at the National Museum of Natural Science, Taiwan was visited and the entire collection of alcohol fixed snakes of the genus *Laticauda* was examined for ticks. The tick collection housed at the museum was also examined and searched for any specimens of *A. nitidum*.

Wild sea kraits (*Laticauda* spp.) were also opportunistically sampled on Sansiantai Island, Taitung county, Taiwan (lat:23.125253740233855, long:121.42689660045335) on the 25th of May 2019 (Fig. 1). Two adult male ticks were collected from one yellow-lipped sea krait (*Laticauda colubrina*) and fixed in 70 % ethanol. The ticks were then examined using a M205C light microscope and identified to species level using keys by Voltzit and Keirans (2002) and compared with tick specimens in the personal tick collection of one of the authors (MLK).

3. Results

Despite one of the authors (MLK) having previously utilised museum collection-based surveys to collect *A. nitidum* from fixed *Laticauda* specimens in other museums, no ticks were collected from snakes held in the collections of the National Museum of Natural Science, Taiwan.

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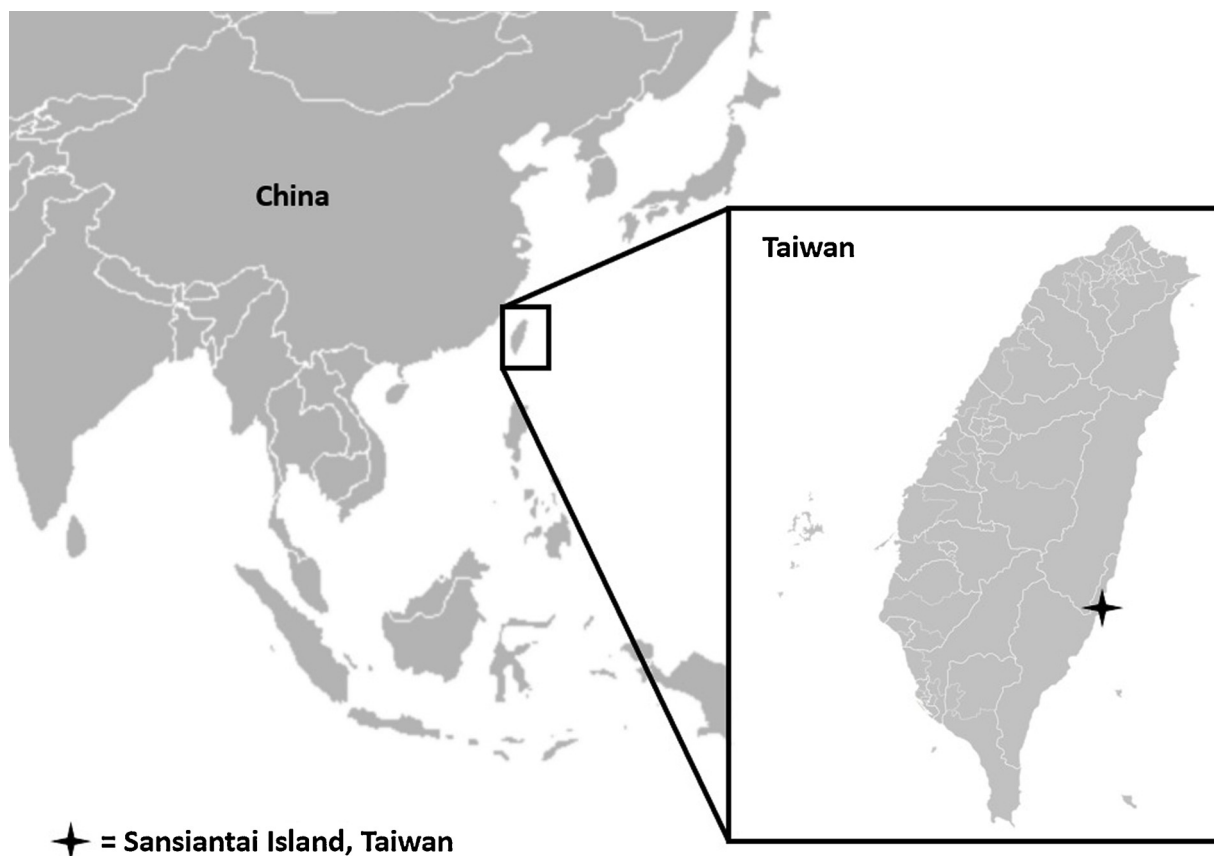


Fig. 1. location of Sansiantai Island, Taitung county, Taiwan.

While a number of specimens of ticks from the genus *Amblyomma* were present in the museum's tick collection, none of these were *A. nitidum*. However, two adult male ticks were collected from a wild *L. colubrina* surveyed on Sansiantai Island (Figs. 2 and 3).

Based on the presence of the scutum the two male specimens were identified as belonging to the family Ixodidae. The presence of eyes, festoons, and elongated palps, indicated the specimens belong to the genus *Amblyomma* (though one eyeless species of *Amblyomma* does occur in Taiwan). The combination of 4/4 dentition, small paired spurs on coxa I, extremely small pointed spurs on coxae II and III, a small spur on coxa IV of similar size to those on coxa I, and lack of metallic ornamentation indicated that the specimens represented *A. nitidum*. Comparison with specimens of *A. nitidum* in the personal collection of one of the authors (MLK) further supported this identification.

This represents the first record of this species within Taiwan and increases the number of native *Amblyomma* species known from Taiwan to six.

4. Discussion

Sea kraits (*Laticauda* spp.) primarily occur in tropical and subtropical coastal areas and reefs through much of the Asia-Pacific. Unsurprisingly the sea snake tick *A. nitidum* co-occurs with *Laticauda* spp. throughout much of their range, and has previously been recorded from six countries. These are the Solomon Islands (Hirst and Hirst, 1910), New Caledonia (France) (Rageau, 1967), Japan (Yamaguti et al., 1971; Hayashi and Masunaga, 2001), Singapore (Warburton, 1933), Papua New Guinea (Wilson, 1970), and India (Sharif, 1928). However, the host genus occurs along the coastlines of many more countries than the aforementioned six (Lillywhite and Martins, 2019). Therefore, it is likely that *A. nitidum* occurs in many more countries and that further sampling is required to determine how extensive the range of this

species actually is.

Interestingly, Kwak (2018b) noted that fragmentation and degradation of suitable habitat may cause local declines or extinctions in *A. nitidum*. As many nations in Asia develop, this pattern may occur widely and causing local or even countrywide extinction of *A. nitidum*. For example, in Singapore, though the species was collected during the early 20th century, no specimens of *A. nitidum* have been found there for over 70 years despite numerous recent collections of *L. colubrina* from Singaporean waters (author's (MLK) personal observation). Therefore, this species may already be extinct in Singapore due to the fragmentation and degradation of suitable habitat caused by urbanisation and land reclamation. It is unclear whether the lack of observation of *A. nitidum* in Taiwan up until now reflects the tick's relative rarity within Taiwan, or simply sampling bias.

While there are no truly aquatic ticks, a small number of species have evolved to exploit semi-marine niches. These include the marine iguana tick (*Amblyomma darwini*), little penguin tick (*Ixodes eudyptidis*), spotted shag tick (*Ixodes jacksoni*), and the sea snake tick (*A. nitidum*). Interestingly, some terrestrial ticks also appear to be capable of survive on marine hosts despite not having evolved on them. For example, the Asian heart tick (*Amblyomma cordiferum*), which normally occurs in forests, was recently recorded feeding and surviving on a saltwater crocodile (*Crocodylus porosus*) in a coastal habitat (Kwak et al., 2019). Audy et al. (1960) noted two key factors that have likely allowed *A. nitidum* to synchronise its ecology and life history with its hosts in the genus *Laticauda*. Firstly, the *Laticauda* sea snakes appears to have invaded marine habitats more recently than other sea snake clades, such as the hydrophiids, and must frequently come ashore to rest, unlike many other sea snakes (Heatwole, 1999). Because *Laticauda* sea snakes must return to land to rest, the tick is able to moult or oviposit on the land, where it can also find other hosts. The second factor that Audy et al. (1960) noted as being important for the ecology of *A. nitidum*, is



Fig. 2. A male sea snake tick (*Amblyomma nitidum*) collected from Sansiantai Island, Taiwan.



Fig. 3. the sea snake tick (*Amblyomma nitidum*) infesting a wild yellow-lipped sea krait (*Laticauda colubrina*) on Sansiantai Island, Taiwan. Photo credit: Kuo-Cheng Yeh (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

the propensity of *Laticauda* sea snakes to engage in diurnal congregation behaviour when resting on shore. This allows *A. nitidum* numbers to build up in locations regularly used by large numbers of *Laticauda* sea snakes and maintain sufficient transmission rates to maintain viable populations. Despite what has already been elucidated regarding the ecology of *A. nitidum*, there is still much which remains to be learned and future studies will hopefully begin to address this knowledge gap in not only *A. nitidum* but the other Taiwanese *Amblyomma* as well.

Although research focused on ticks and tick-borne disease in Taiwan is increasing, foundational knowledge concerning the diversity and distribution of ticks in Taiwan requires greater attention, as this discovery has highlighted.

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CRediT authorship contribution statement

Mackenzie L. Kwak: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing - original draft, Writing - review & editing. **Chi-Chien Kuo:** Conceptualization, Data curation, Investigation, Resources, Software, Validation, Visualization, Writing - review & editing. **Ho-Tsung Chu:** Investigation, Writing - review & editing.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.ttbdis.2020.101383>.

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