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A nationwide survey of ixodid tick species recovered from domestic dogs and cats in Japan in 2011

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ABSTRACT

A nationwide survey of ixodid ticks was performed in 2011, during which a total of 4237 and 298 ticks were recovered from 1162 dogs and 136 cats, respectively. *Haemaphysalis longicornis* was the most frequently found tick species on canine hosts (739 dogs), followed by *H. flava* (166), *Ixodes ovatus* (139), and *Rhipicephalus sanguineus sensu lato* (70). *H. hystricis*, *H. japonica*, *H. megaspinosa*, *H. formosensis*, *H. campanulata*, *H. ias*, *I. nipponensis*, *I. persulcatus*, and *Amblyomma testudinarium* were also recovered. *H. longicornis* was also the most frequently found species on feline hosts (52 cats), followed by *I. ovatus* (34), *A. testudinarium* (19), and *H. flava* (12). *H. hystricis*, *H. japonica*, *H. megaspinosa*, *I. nipponensis*, *I. persulcatus*, *I. granulatus* and *R. sanguineus sensu lato* were also recovered from cats. The three major species of ticks found on dogs and cats, *H. longicornis*, *H. flava*, and *I. ovatus*, displayed a wide geographical distribution, with specimens found throughout northern and southern Japan. *R. sanguineus sensu lato* was primarily recovered in Okinawa, but was also found in Kanagawa, Wakayama, Hiroshima, and Yamaguchi Prefectures. *A. testudinarium* was mainly distributed throughout western Japan, but small numbers were also recovered from Gumma and Shizuoka Prefectures. *H. longicornis* was more frequently found on dogs in rural areas than those in urban or suburban areas. Exposure to woodland environments was significantly associated with *H. flava* and *I. ovatus* in dogs. Dogs in urban or suburban areas encountered *R. sanguineus sensu lato* more often than other tick species. Most of the cats surveyed in the present study were from rural areas. In the present study, *H. hystricis* and *R. sanguineus sensu lato* were found on cats for the first time in Japan.

Introduction

Recently, interest in ticks and tick-borne diseases of domestic animals has been increasing due to the emergence of tick-borne zoonoses such as severe fever with thrombocytopenia syndrome (SFTS) and spotted fever rickettsia in Japan (Imaoka et al., 2011; Takahashi et al., 2014). As domestic dogs and cats can transport ticks into human living environments, epidemiological information on the tick species found on these animals is important for a better understanding of the risk of tick-borne diseases (Shaw et al., 2001; Claerebout et al., 2013). Some previous reports have assessed the tick species found on various animals in Japan (Yamaguti et al., 1971), and nationwide studies of tick species carried by canine and feline hosts in 2001 supplied systematic information on the distribution and most frequently recovered tick species in Japan (Shimada et al., 2003 a and b). These studies also recorded some tropical tick species, such as *Rhipicephalus sanguineus sensu lato*, in mainland Japan. These instances are thought to be results of the movement of dogs from foreign countries or the tropical Okinawa Prefecture to the mainland (Shimada et al., 2003a). Global warming is another concern that may affect the geographic distribution and activities of these arthropod vectors (Kurane, 2010). In the present study, ticks from domestic dogs and cats were collected and identified throughout Japan in 2011. The distribution and infestation patterns of tick species found on companion animals were analyzed and compared to previous data.

Materials and methods

Tick collection and identification

Ticks were collected between May and December 2011, from 1162 dogs and 136 cats that were under examination or treatment

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Table 1
Distribution of each tick species recovered from 1162 domestic dogs and 136 domestic cats in Japan.

Tick species	Numbers of animal hosts			Distribution (Prefectures)
	Dogs	Cats	Total	
H. longicornis	739	52	791	Hokkaido, Aomori, Iwate, Akita, Miyagi, Yamagata, Fukushima, Tochigi, Gunma, Ibaraki, Saitama, Chiba, Tokyo, Kanagawa, Yamanashi, Nagano, Shizuoka, Niigata, Ishikawa, Fukui, Gifu, Aichi, Shiga, Mie, Kyoto, Osaka, Wakayama, Hyogo, Tottori, Okayama, Shimane, Hiroshima, Yamaguchi, Kagawa, Tokushima, Kochi, Ehime, Fukuoka, Saga, Nagasaki, Ohita, Kumamoto, Miyazaki, Kagoshima
H. flava	166	12	178	Aomori, Yamagata, Fukushima, Tochigi, Gunma, Ibaraki, Saitama, Chiba, Tokyo, Kanagawa, Yamanashi, Nagano, Shizuoka, Niigata, Ishikawa, Fukui, Gifu, Aichi, Shiga, Kyoto, Osaka, Wakayama, Hyogo, Tottori, Okayama, Shimane, Yamaguchi, Kagawa, Tokushima, Kochi, Ehime, Fukuoka, Saga, Nagasaki, Ohita, Kumamoto, Miyazaki, Kagoshima
H. hystricis	18	5	23	Wakayama, Okayama, Hiroshima, Yamaguchi, Kagawa, Tokushima, Ehime, Fukuoka, Nagasaki, Miyazaki, Kagoshima
H. megaspinosa	7	1	8	Kanagawa, Shizuoka, Wakayama, Hyogo, Shimane
H. campanulata	3	0	3	Ibaraki, Chiba
H. japonica	10	2	12	Hokkaido, Aomori, Akita, Miyagi, Yamagata, Tochigi
H. formosensis	6	0	6	Shizuoka, Kagawa, Kochi, Nagasaki, Kagoshima
H. ias	1	0	1	Niigata
I. ovatus	139	34	173	Hokkaido, Aomori, Iwate, Akita, Miyagi, Yamagata, Fukushima, Tochigi, Gunma, Ibaraki, Chiba, Tokyo, Kanagawa, Yamanashi, Nagano, Shizuoka, Niigata, Toyama, Ishikawa, Fukui, Gifu, Aichi, Shiga, Kyoto, Tottori, Okayama, Shimane, Yamaguchi, Kagawa, Tokushima, Kochi, Fukuoka, Oita, Kagoshima
I. persulcatus	22	6	28	Hokkaido, Aomori, Iwate, Akita
I. nipponensis	29	10	39	Yamagata, Saitama, Tokyo, Nagano, Shizuoka, Niigata, Toyama, Fukui, Shiga, Kyoto, Okayama, Shimane, Kagawa, Tokushima, Kochi, Ehime, Kumamoto, Kagoshima
I. granulatus	0	1	1	Okinawa
A. testudinarium	16	19	35	Gunma, Shizuoka, Fukui, Shiga, Kyoto, Wakayama, Okayama, Shimane, Yamaguchi, Kochi, Ehime, Fukuoka, Nagasaki, Miyazaki, Kagoshima, Okinawa
R. sanguineus	70	2	72	Kanagawa, Wakayama, Hiroshima, Yamaguchi, Okinawa

at selected veterinary clinics in Japan. A total of 108 veterinary clinics, from all 47 prefectures in Japan, were recruited to participate in this study. Each clinic was asked to collect as many ticks as possible from each animal patient during normal clinical examinations. Collected ticks were fixed and stored in a 70% ethanol solution for later identification at Obihiro University of Agriculture and Veterinary Medicine. The date of specimen collection, as well as sex, breed, hair length, and living environment (urban or rural) of host animals were recorded. Habitats to which host animals had been exposed in the two weeks prior to examination were also recorded by questionnaire, using the same methods as previous studies (Shimada et al., 2003 a and b). River, woodland, urban park, and home garden were taken into consideration as habitat options. All ticks were identified using standard keys for Japanese ticks (Kitaoka, 1985; Yamaguchi, 1981) and individual figures (Yamaguti et al., 1971), with examinations conducted using a stereomicroscope and an ultraviolet microscope.

Statistical analysis

The significance of individual factors as determinants for attachment of major tick species to both dogs and cats were analyzed via Pearson's chi-squared test. The critical probability was set at $p = 0.05$.

Results

Canine ticks

The number of each tick species found to be attached to domestic dogs and cats, and the distribution of each tick are summarized in Table 1. The number of ticks from each species found on dogs are also shown in Table 2. *Haemaphysalis longicornis* was the most frequently found tick species on canine hosts (739 of 1162 dogs (63.6%), 2633 ticks), followed by *H. flava* (166 of 1162 dogs (14.3%), 316 ticks), *Ixodes ovatus* (139 of 1162 dogs (12.0%)), and *R. sanguineus sensu lato* (70 of 1162 dogs (6.0%)). Small numbers of *H. hystricis*, *H. japonica*, *H. megaspinosa*, *H. formosensis*, *H. campanulata*, *H. ias*, *I. nipponensis*, *I. persulcatus*, and *Amblyomma testudinarium* were also recovered (Table 1). A total of 4237 ticks were removed from 1162 dogs, including 1788 larvae (42.2%), 1025 nymphs (24.2%), 1219 females (28.8%), and 204 males (4.8%) (Table 2). Small numbers of unidentified immature or broken individuals of *Haemaphysalis* spp. and *Ixodes* spp. were also recovered. The numbers of ticks found in each month of examination are shown in Table 2. A total of 1614 ticks (38.1%) were collected in September, followed by June (809 ticks, 19.1%), July (516 ticks, 12.2%), and August (437 ticks, 10.3%). The percentage of adult ticks in September was only 4.4%, with the other 95.6% being immature (larvae and nymphs). In comparison, the percentages of adult and immature ticks in June were 70.5% and 29.5%, respectively. *H. longicornis* was the most frequently collected species in September (1233 ticks; including one male, 24 females, 269 nymphs, and 939 larvae), June (544 ticks; including 14 males, 354 females, 168 nymphs, and eight larvae), and August (282 ticks; including three males, 14 females, 31 nymphs, and 234 larvae). *H. flava* was the most frequently collected species in October (115 ticks; including 21 males, 35 females, six nymphs, and 53 larvae), and less frequent in July (15 ticks) and August (seven ticks). *I. ovatus* specimens were only collected in June (105 ticks), May (66 ticks), July (10 ticks), and August (one tick). *R. sanguineus sensu lato* was most frequently recovered in September (316 ticks), followed by July (168 ticks) and August (133 ticks), but no ticks of this species were recovered in December.

Feline ticks

H. longicornis was also the most frequently found tick species in cats (52 of 136 cats (38.2%), 106 ticks), followed by *I. ovatus* (34 of 136 cats (25.0%), 55 ticks), *A. testudinarium* (19 of 136 cats (14.0%), 80 ticks), and *H. flava* (12 of 136 cats (8.8%), 18 ticks). Small numbers of *H. hystricis*, *H. japonica*, *H. megaspinosa*, *I. nipponensis*, *I. persulcatus*, *I. granulatus* and *R. sanguineus sensu lato* were also recovered (Table 1). The *H. hystricis* and *R. sanguineus sensu lato* specimens collected in the present study were the first recorded specimens found