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DISTRIBUTION OF *AEDES ALBOPICTUS* MOSQUITOES IN AN INLAND CLIMATE MOUNTAIN AREA, NAGANO PREFECTURE, JAPAN

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Abstract Nagano Prefecture, an inland climate mountain area of Japan, extends widely north and south, and the altitude varies greatly with the location. Mosquitoes transmitting infectious disease have a diversity of habitats in Nagano, and many species can be expected. There have been few reports about mosquito fauna, and there is little information on mosquitoes such as *Aedes albopictus*. In this study, we clarify the distribution patterns by investigating the fauna of mosquitoes, focusing on *A. albopictus*, in 8 areas (including Nagano, Ueda, Karuizawa, Matsumoto, Suwa and Okaya, Ina and Minamiminowa, Komagane and Miyata, and Iida) from July to September in 2012 and 2013. We set up CDC traps in each area and also collected mosquito larvae in temple and shrine precincts in each area. Although *A. albopictus* was not collected in the Karuizawa Area (altitude 950 m, annual mean air temperature 8.5° C), it was captured in the other 7 areas (annual mean air temperature 11.2 to 13.1° C). Kobayashi et al. (2002) reported that *A. albopictus* can inhabit areas with an annual mean air temperature above 11.0° C, and our results agreed with theirs.

Key words Altitude, annual mean air temperature, CDC trap, habitat, larval survey.

INTRODUCTION

Aedes albopictus (Skuse) ranks second only to *Aedes aegypti* (Linn.) in importance to human as a disease vector of dengue and dengue hemorrhagic fever (Knudsen, 1995; Knudsen et al., 1996). They affect at least 2.5 billion people living in urban and suburban environments in more than 100 countries in tropical and subtropical regions around the world (European Centre for Disease Prevention and Control, 2009; Guzman et al., 2010). According to Hotta (1953), Japan experienced endemic dengue outbreaks in several coastal cities in 1942-1945. Although dengue hemorrhagic fever has not been prevalent in Japan for 50 years, the possibility of dengue hemorrhagic fever outbreak exists because of the common distribution of the vector *A. albopictus* (Hotta, 1998). Vector control is an essential measure for controlling the outbreak of viral disease. Thus, collecting information about distribution and ecology of vectors might be the most important and essential/effective method of vector control.

Nagano Prefecture, an inland climate mountain area, extends widely north and south, and the altitude varies with the location in Japan. Therefore, mosquitoes transmitting an infectious disease have a diversity of habitats in Nagano, and many species can be expected (Kamimura, 1968; Uchikawa, 1977). However, there have been few reports about mosquito fauna, in particular; little information on mosquitoes such as *Aedes albopictus* has been distributed (Kurihara et al., 2000; Shirai et al., 2002).

Kamimura (1968) reported 19 mosquito species including *A. albopictus* in Nagano Prefecture in July-August 1964 and in August, September-October 1965 (qualitative data). However, he did not describe the collecting sites and densities, so we do not know which area *A. albopictus* inhabited and how many individual *A. albopictus* were collected. From 1972 to 1974, Uchikawa (1977) investigated the mosquito fauna in Matsumoto and its environs by light trap and the collected larval survey from June to September. He reported that 11 species were caught by light traps and 9 species of mosquito larvae were collected by a dipping method. *A. albopictus* was not collected during the investigation periods. Kurihara et al. (2000), reported many individual *A. albopictus* adults were collected from Nagano, Matsumoto and Ueda Cities. Shirai et al. (2002) reported *A. albopictus* larvae were not collected from Matsumoto and its environs in August of 2000 and July of 2001.

In this study we attempted to clarify the distribution patterns by investigating the fauna of mosquitoes, especially focusing on *A. albopictus*, in 8 areas from the end of July to early September in 2012 and 2013. CDC traps were set in each area and mosquito larvae were collected in several temple and shrine precincts in each area.

MATERIALS AND METHODS

Mosquito surveys were carried out from the end of July to early September 2012 and 2013 in 8 areas (Nagano, Ueda, Karuizawa, Matsumoto, Suwa and Okaya, Ina and Minamiminowa, Komagane and Miyata, and Iida; including 8 cities, 1 town and 2 villages) in Nagano Prefecture (Figure 1). Adults and larvae were collected at 57 sampling sites. Table 1 lists the study area, sampling site, locations (longitude; 137°48’46.32”E - 138°38’10.77”), and environmental conditions (annual mean air temperature in each area from 2003 to 2012; 10 years) of collecting sites and investigation periods/days. Figure 2 shows the relationship between the altitude latitude of sampling sites in this study. The latitude range was from 35°30’21.24”N to 36°39’42.95”N, and altitude was 353 - 996 m, respectively.

For adult collections, CDC traps without a bulb, baited with 1 kg dry ice were used and operated continuously from 15:00 to 10:00. Mosquitoes in the traps were collected every morning and taken to the laboratory for identification. Species was identified following the morphological keys of Tanaka et al. (1979). *A. albopictus* samples were picked up and counted. CDC traps were set up at 37 sites (a total of 47 nights) at 1-2, 7-8, 30-31 Aug. 2012 and 3-4 Sep. 2012 at 2 sites in the Karuizawa Area, 3-4 Sep. 2012 at 1 site in the Ueda Area, 29-30 Jul. 2013 at 7 sites in the Matsumoto Area, 12-13 Jul. and 6-7 Aug. 2013 at 12 sites in the Suwa and Okaya Areas, 4-5 Sep. 2013 at 8 sites in the Ina and Minamiminowa Areas, and Komagane and Miyata Areas, and 3-4 Sep. 2013 at 7 sites in the Iida Area. Collection sites of larvae were selected from each sampling area. The larvae were collected at a total of 31 sites (76 points), using a glass pipette, from artificial containers, such as flower vases in graveyards of Buddhist temples, wash basins in shrines, used tires stacked in the backyard or along roadsides, used cans or plastic containers, and bamboo stumps. We collected larval samples at 5 Sep. 2012 at 7 sites (25 points) in the Ueda Area, 6 Sep. 2012 at 6 sites (15 points) in the Nagano Area, 30 and 31 Aug. 2012 at 1 site (4 points) in the Karuizawa Area, 29 and 30 Jul. 8 Aug. 2013 at 7 sites (22 points) in the Matsumoto Area, 7 Aug. 1 site (1 point) in the Suwa and Okaya Areas, 4 Sep. 2013 at 6 sites (6 points) in the Ina and Minamiminowa Areas, and Komagane and Miyata Areas, 3 Sep. 2013 at 3 sites (3 points) in the Iida Area. The larvae were collected and placed in small polypropylene containers (ca. 100 ml volume), which were kept at room temperature in our insectary. Identification was based on emerged adults.

RESULTS AND DISCUSSION

A total of 255 individual *A. albopictus* (93 adult mosquitoes by CDC traps and 162 individuals from larvae) were collected during the investigation periods (Table 1).

Although *A. albopictus* was not collected in the Karuizawa Area, it was captured in the other 7 areas in Nagano Prefecture. For adult collections, a large number of *A. albopictus* were collected from the Iida Area, the total of 49 individuals; average 7.0 individual numbers / night / CDC trap, followed by the Ueda Area, 14 individuals; average 14 individual numbers / night / CDC trap. On the other hand, for larval collections, a large number of *A. albopictus* were collected from the Matsumoto Area, the total of 84 individuals; average 3.8 individual numbers / sampling point, followed by the Ueda Area, 57 individuals; average 2.3 individual numbers / sampling point.

According to Kurihara et al. (2000), *A. albopictus* adults were collected from Nagano, Matsumoto and Ueda Cities. They also reported that the density of *A. albopictus* might be increased from ca. 1992/1993. In our study, *A. albopictus* was newly confirmed in 17 sites (adult collecting at 16 sites, larval collecting at 2 sites, and both collecting at 1 site) at 4 study areas (southern part of Nagano Prefecture; i.e., Suwa and Okaya, Ina and Minamiminowa, Komagane and Miyata, and Iida Areas).

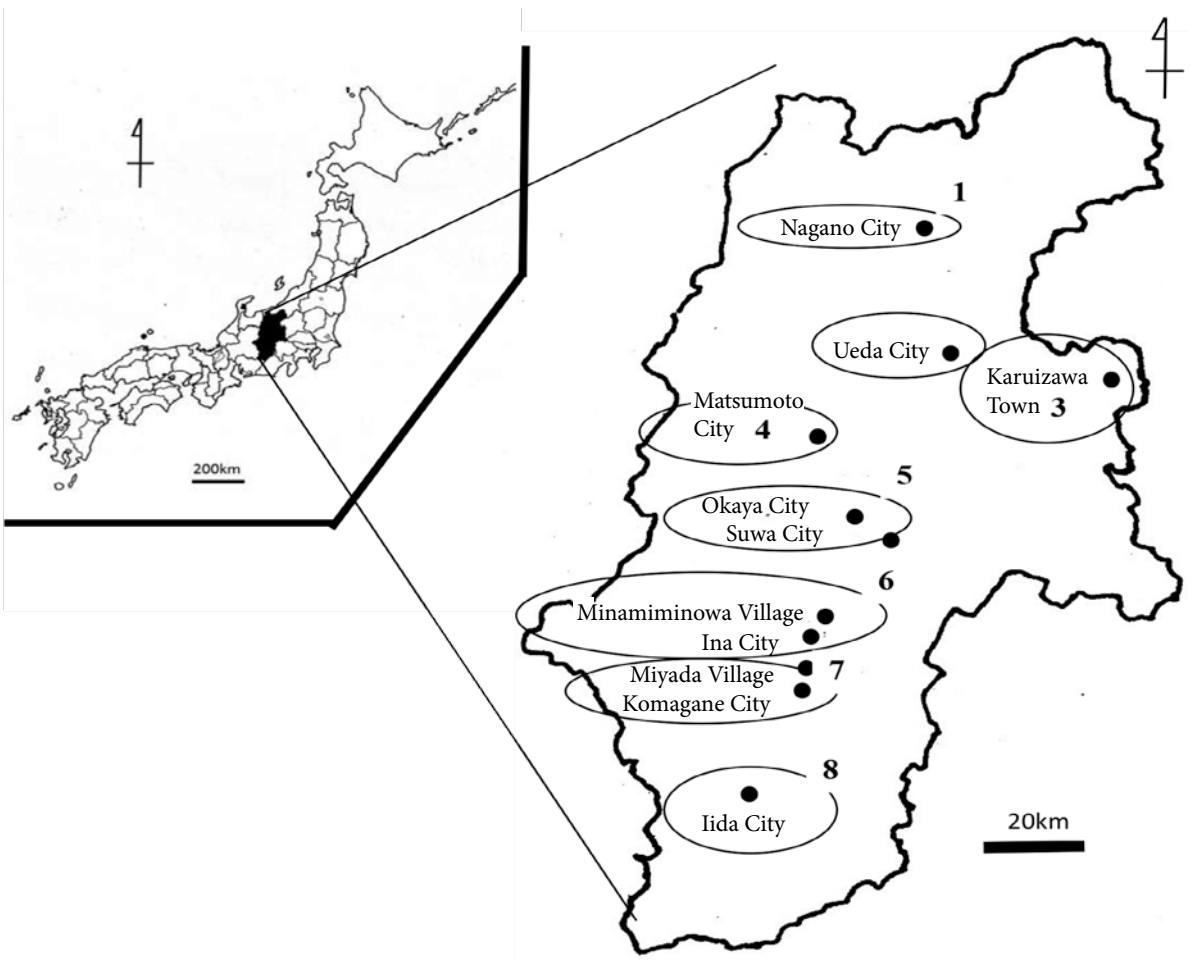

Figure 1. Distribution of studied 8 areas in Nagano Prefecture: 1. Nagano Area, 2. Ueda Area, 3. Karuisawa Area, 4. Matsumoto Area, 5. Suwa and Okaya Areas, 6. Ina and Minamiminowa Areas, 7. Komagane and Miyada Areas, and 8. Iida Area.

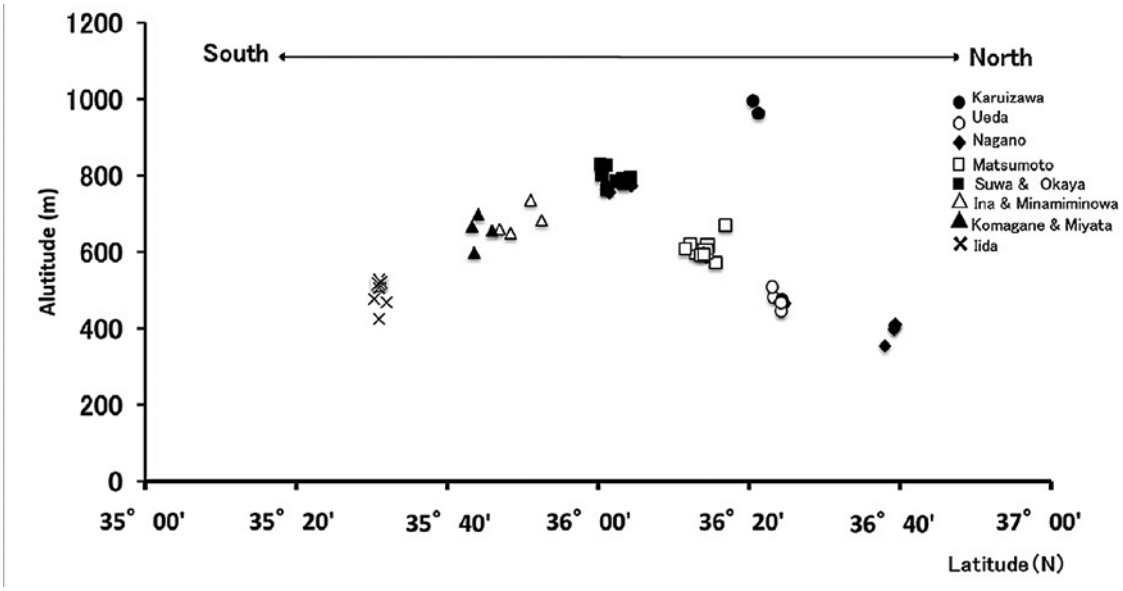

Figure 2. Relationship between altitude and latitude of sampling sites.

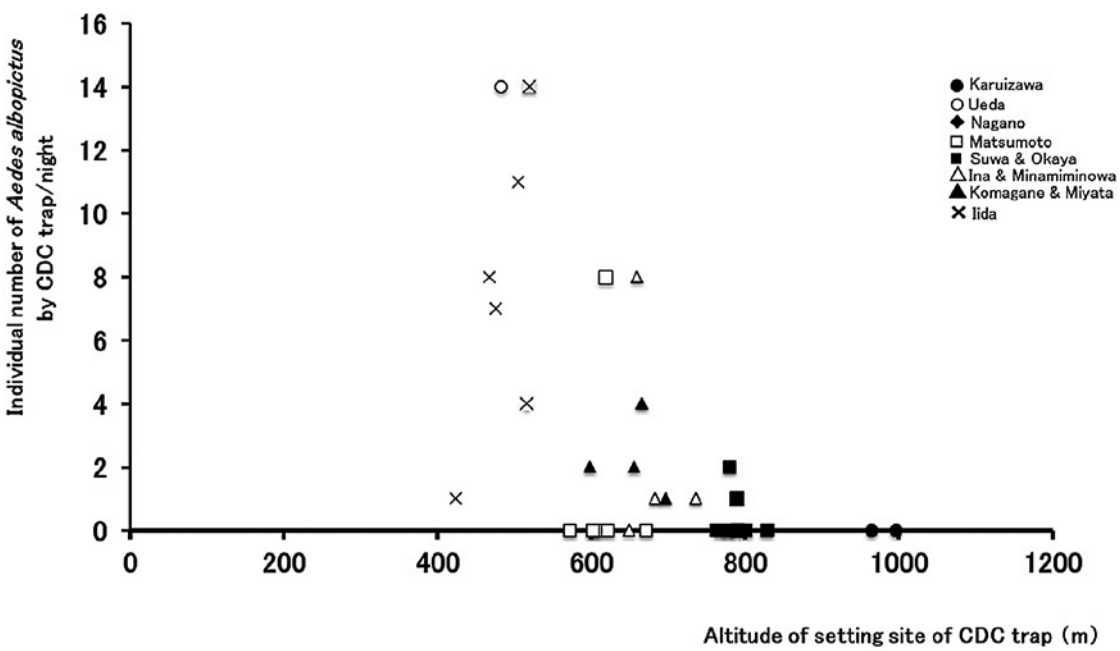

Figure 3. Relationship between individual number of *Aedes albopictus* by CDC trap/night and altitude of CDC trap site.

Figure 3 shows the relationship between the individual number of *A. albopictus* by CDC trap / night and the altitude of the CDC trap site. The individual number of *A. albopictus* decreased with increasing altitude. A strong negative correlation was found between the altitude of the meteorological station in this study area and the annual mean air temperature at each area during the 10 years ($r^2 = 0.72$). According to Kobayashi et al. (2002), there was a strong correlation between the *A. albopictus* mosquito-infested areas and annual mean air temperature above 11 degrees Celsius. In our study, *A. albopictus* was not collected in Karuizawa, located in a mountainous area, with an altitude of 964-996 m, and an annual

mean air temperature of 8.6±9.0 degrees Celsius. In the other 7 areas, (annual mean air temperature; ranging from 11.2 to 13.1 degrees Celsius), *A. albopictus* was captured. Thus, our results agreed with those of Kobayashi et al. (2002).

This is, to our knowledge, the first report on the quantitative data of *A. albopictus* by CDC traps in Nagano Prefecture. Further follow-up field investigations are necessary to collect more adults by several combined sampling methods may well further improve our understanding of the mosquito fauna in Nagano Prefecture.

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