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SHORT NOTE

New Distribution Record of *Reticulitermes speratus* Kolbe (Isoptera: Rhinotermitidae) in the Coldest Highland in Central Japan

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Abstract
The distribution of *Reticulitermes speratus* Kolbe was investigated in the Sugadaira highland, the coldest area in central Japan. We found *R. speratus* in an empty lot in June 2013. The following spring, we found the overwintered termites in the log, which had been naturally covered in snow. Conversely, the population size in the empty lot had decreased from April through June 2014. Moreover, *R. speratus* were not found in the forest. These suggest that the individuals found in the empty lot had been artificially introduced and the establishment might be difficult in the coldest areas in Japan.

The Japanese subterranean termite *Reticulitermes speratus* Kolbe (Isoptera: Rhinotermitidae) is a very important ecological component in the cycling of organic matter via decomposition of litter and dead wood (Donovan et al., 2001). In addition, it is a very important destructive pest, causing extensive damage to wooden structures (Su, 2002). The termite is distributed in the Korean peninsula, Kyushu island, Shikoku island, Honshu island, and southwestern Hokkaido island (Austin et al., 2002; Park et al., 2006; Kim et al., 2012). Although the northern limit of *R. speratus* distribution has been investigated (Aoyama & Murakami, 2003), little is known about an altitudinal limit. *Reticulitermes speratus* has expanded its geographic range from southwestern into central Hokkaido island (Aoyama & Murakami, 2003); however the termites found in central Hokkaido nested and overwintered near places artificially kept warm in winter. In addition, the new distribution records of the termites in Hokkaido were discontinuous, suggesting an anthropogenic origin of termite populations in central Hokkaido were artificially introduced.

Sugadaira highland, Ueda City, Nagano Prefecture, central Japan lies at an altitude of approximately 1300 m and is one of the coldest areas in central Japan. *Reticulitermes speratus* has not been found in the Sugadaira highland or in the northernmost part of Hokkaido. Monthly temperatures in the Sugadaira highland are lower than those in northernmost Hokkaido and are slightly higher than those in central Hokkaido (Japan Meteorological Agency, 2014). We accordingly hypothesized that *R. speratus* could invade artificially, but the termites could not overwinter or be established in the coldest areas in central Japan. We investigated the presence of *R. speratus* in the Sugadaira highland. Our objectives of this study were as follows: 1) to determine the presence of *R. speratus* in summer, and 2) to determine whether *R. speratus* overwinters and is established in the Sugadaira highland.

Two study areas were selected in the Sugadaira highland (36°31′N, 138°20′E). The first was an empty lot where four logs of Japanese red pine, *Pinus densiflora* Siebold & Zucc., three logs of Nikko fir, *Abies homolepis* Siebold & Zucc., and > 10 logs of Japanese alder, *Alnus japonica* (Thunb.) Steud. were piled and left away (> 20 m) from houses. To assess the presence of *R. speratus* in spring, we identified log species using bark characteristics. Subsequently, on June 19, 2013, we dissected one, one, and three logs of Japanese red pine, Nikko fir, and Japanese alder, respectively, and recorded the presence of *R. speratus*.

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When the termites were found in the logs, the logs in the empty lot were experimentally left and the termites in the logs were allowed to overwinter and be covered in snow. To determine whether *R. speratus* had overwintered in the Sugadaira highland, all Japanese red pine and Nikko fir logs, and 10 Japanese alder logs were dissected, and the presence of *R. speratus* was recorded on April 22, 2014, immediately after the logs emerged from under snow. Moreover, the logs were dissected, and the presence of *R. speratus* was recorded on June 18, 2014.

The second study area was in the Sugadaira Montane Research Center, University of Tsukuba, 1.2 km away from the empty lot. To assess the presence of *R. speratus* in early summer in the forest, we conducted a census in the site's center. On July 24, 2014, all Japanese red pine logs found along the observation route in the Japanese red pine forest and in the Japanese red pine and broad-leaved mixed forest were dissected, and the presence of *R. speratus* was recorded.

To record under-snow temperatures, two temperature loggers (iButton®, Maxim Integrated Products, Inc., California, USA) were placed in the center of the logs from December 22, 2013, through April 1, 2014.

We found *R. speratus* nesting in a Japanese red pine log in spring 2013. To the best of our knowledge, this is a new distribution record of *R. speratus* in the coldest area of central Japan. No termites were found in Nikko fir or Japanese alder logs.

Reticulitermes speratus is not found in the northernmost part of Hokkaido because of low winter temperatures (Aoyama & Murakami, 2003), but temperatures in the Sugadaira highland are lower than those in the northernmost part of Hokkaido (The Japan Meteorological Agency, 2014). Thus, our results suggest that *R. speratus* can damage wooden structures in early summer not only in the coldest areas in central Japan, but also in northernmost Hokkaido.

We found *R. speratus* nesting in a Japanese red pine log in spring 2014; however, only a few individuals were found in the logs in the following early summer. Again, no termites were found in Nikko fir or Japanese alder logs. The results indicate that the overwintering of *R. speratus* might be difficult, although under-snow temperatures in the Sugadaira highland ranged from −0.5°C to 0.5°C.

In addition, termites or their tunnels were not found in 45 Japanese red pine logs along the observation route in the forest, at the site's center. This suggests that the individuals found in the empty lot had been artificially introduced. Although *R. speratus* was not established in the study area, artificial introductions may temporarily affect the cycling of organic matter via decomposition of litter and dead wood in the Sugadaira highland, as well as in northernmost and central Hokkaido.

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