Chironomidae collected at the seashore in Kume Island, Japan

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Abstract

Local residents and tourists of Kume Island suffer from the biting of *Leptoconops taiwanensis* (Lien, Lin & Weng 1998) (Ceratopogonidae), a species known as asa-mushi (sea lettuce bug). Because *L. taiwanensis* bites tend to occur while harvesting sea lettuce, some locals mistakenly believe that *L. taiwanensis* inhabits the sea lettuce. The objectives of the current study are to (i) identify the chironomid species inhabiting the sea lettuce, (ii) determine the distribution of the larvae, and (iii) perform a faunistic investigation of Chironomidae at Shinri Beach. Only one male chironomid species, *Ainuyusurika tuberculatum* (Tokunaga, 1940), emerged from the samples taken from the beach. The density of chironomid larvae was the highest in the presence of sea lettuce. A total of 53 males were collected using light traps, of which we identified males of seven genera and seven species belonging to three subfamilies. No *L. taiwanensis* were collected in this study.

Introduction

Females of the genus *Leptoconops* (Ceratopogonidae) are particularly vicious biting midges that attack humans in many parts of the world (Kettle 1962). Local residents and tourists of Kume Island suffer from the biting of *Leptoconops* (*Leptoconops*) *taiwanensis* (Lien, Lin & Weng 1998), a species that is known as asa-mushi (sea lettuce bug) in Japanese, because it appears during the sea lettuce (*Monostroma nitidum* Wittrock, 1866) gathering season (Okinawa Prefecture 2022) from January to the end of March. Specimens of *Leptoconops*, are commonly found in arid habitats where the larvae burrow in sandy soil or clay (Mullen and Hribar 1988). Because bites of *L. taiwanensis* tend to occur while harvesting sea lettuce, some locals mistakenly believe that this species inhabits the sea lettuce.

Motivated by this, and our observation that larvae of Chironomidae were present in the sea lettuce at Shinri Beach, we wanted to survey the chironomid species in sea lettuce. There is almost no information on midges on Kume Island other than the report by Kawai et al. (2011). The objectives of the current study are thus to (i) identify the chironomid species inhabiting the sea lettuce, (ii) determine the distribution of the larvae, and (iii) perform a faunistic investigation of Chironomidae at Shinri Beach.

Materials and Methods

Study site

Shinri Beach is located in front of the Cypress Resort hotel on the western coast of Kume Island. This 3 km white sand beach is popular for its shoals and great view of the sunset. Adults of *L. taiwanensis* have a biased distribution around Shinri Beach (Okano et al. 2012). The sampling site (26°21'N, 126°42'E) was located near the airport at the edge of the beach (Fig. 1).

Chironomid sampling

Samples of chironomid larvae were collected on 8 March 2019. Larvae were taken from the seabed by pushing petri dishes (9 cm in diameter, 1 cm in depth) into the substratum, digging into the sand with a plasterer's trowel, and inverting the dishes upon removal (Hirabayashi et al. 2004). Each dish was covered with a cover slip, and the whole was sealed with insulating tape. There were four kinds of sampling habitats: always underwater, exposed (to the air) at low tide, high water mark, and terrestrial (always above sea water). On each sampling occasion, three samples were taken from a sand area apparently free of sea lettuce (underwater, sand exposed at low tide, and high-water mark), three samples where sea lettuce was present (un-

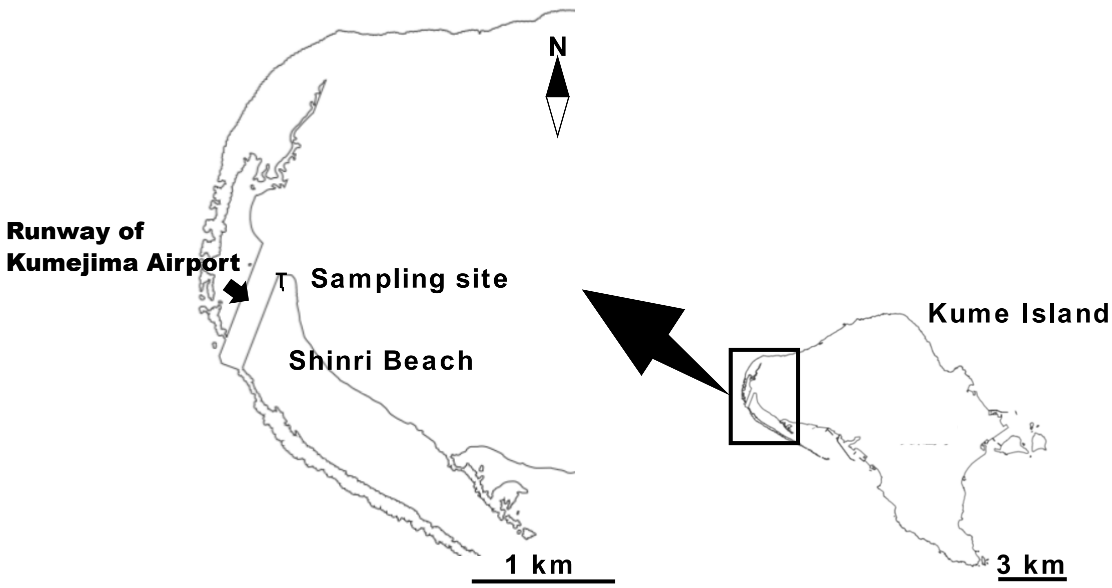

Figure 1. Map of Shinri Beach with the locations of the sampling site (●). This map is based on public survey maps published by the Geospatial Information Authority of Japan.

derwater and sand exposed at low tide), and three samples where terrestrial vegetation was present.

Estimates of chironomid larval density and larval rearing

The samples were transported to our laboratory under cool conditions the following day. In the laboratory, the dishes were unsealed, the chironomid larvae were picked out, then counted under a binocular microscope.

For larval rearing, seabed substrates were collected with petri dishes in without sea lettuce area and sea lettuce areas on 8 March 2019. The two substrate samples were mixed in a plastic bag and transported to our laboratory under cool conditions on the same day. The samples were submerged in water and kept at room temperature with aeration treatment using an air pump. Temperature of the rearing water was monitored every hour during rearing with a thermistor thermos recorder and averaged 22.0 ± 2.0 °C. No additional food was supplied during rearing because the substrate samples considered to contain enough detritus as food for the chironomid larvae. Emerging adults were checked and collected every day for 23 days until 31 May 2019.

Light trap

The abundance of adult chironomid midges from Shinri Beach was investigated with UV light and white LEDs using pan traps. The traps were set up at Shinri Beach in front of the Resort Hotel and were located about 10 m apart from each other. The pan traps were in place from the 6th to the 8th of March 2019. The pans were replaced with new ones every morning (at about 09:00) and replaced the position of the UV light and white LEDs was switched each period. Light intensities measured using HSR-OE1000 (Opto Research Corp.) for each LED were 2.0×10^{11} photons . m^{-2} . s^{-1} for both UV and white light.

Identification of species and data analyses

Male adults were mounted on slides with gum chloral and their species were identified following the taxonomical keys of Wiederholm (1989), Sasa and Kikuchi (1995), Saether et al. (2000), and Langton and Pinder (2007). Females were excluded from the analysis as they could not be identified to species level. Larval density was analyzed using a multiple comparison test (Tukey's honestly significance difference (HSD) test). All data were analyzed using a computer program package (SPSS Ver. 11.5.1J, SPSS Japan Inc., Tokyo, Japan).

Results and Discussion

The density (mean ± S.D.) of chironomid larvae ranged from 0 to 69,251.1 ± 10,491.6 individuals/m^2. A significant difference was found in the density of chironomids, based on the substrate type. The density of chironomid larvae was the highest in the sea lettuce exposed at low tide ($p < 0.001$, Tukey's HSD test). Sea lettuce did not affect the larval density in sea sediment that was not exposed at low tide ($p > 0.05$, Tukey's HSD test). On the other hand, this species was not distributed on terrestrial substrate. These results suggest the length of exposure of the sediment to sea water has an effect on the distribution of chironomid larvae. We would like to know the undiscovered habitats of the *L. taiwanensis*, but we have not been able to find them from the sea sediment with or without sea lettuce.

A total of six males emerged from the substrate samples. The only species found was *Ainuyusurika tuberculatum* (Tokunaga 1940).

A total of 53 males were collected using light traps. We identified seven genera and seven species belonging to three subfamilies of meles. Chironominae was the most abundant subfamily, accounting for 92.5 % of the males, followed by Telmatogetoninae (5.7 %) and Orthocladiinae (1.9

Table 1. Chironomid species collected at the sampling site using light traps.

Taxon	3/6–3/7		3/7–3/8		Total	Percent male (%)
	UV	White	UV	White		
Chironominae						
Chironomini						
Ainuyusurika tuberculata	3		19	9	31	58.5
Chironomus okinawanus				2	2	3.8
Dicrotendipes enteromorphae				1	1	1.9
Tanytarsini						
Yaetanytarsus iriomotensis	11		2		13	24.5
Tanytarsus sp. nr. *boodleae*	2				2	3.8
Orthocladiinae						
Smittia littoralis			1		1	1.9
Telmatogetoninae						
Thalassomya japonica		1	1	1	3	5.7
Male	16	1	23	13	53	100
UV			39			
White			14			

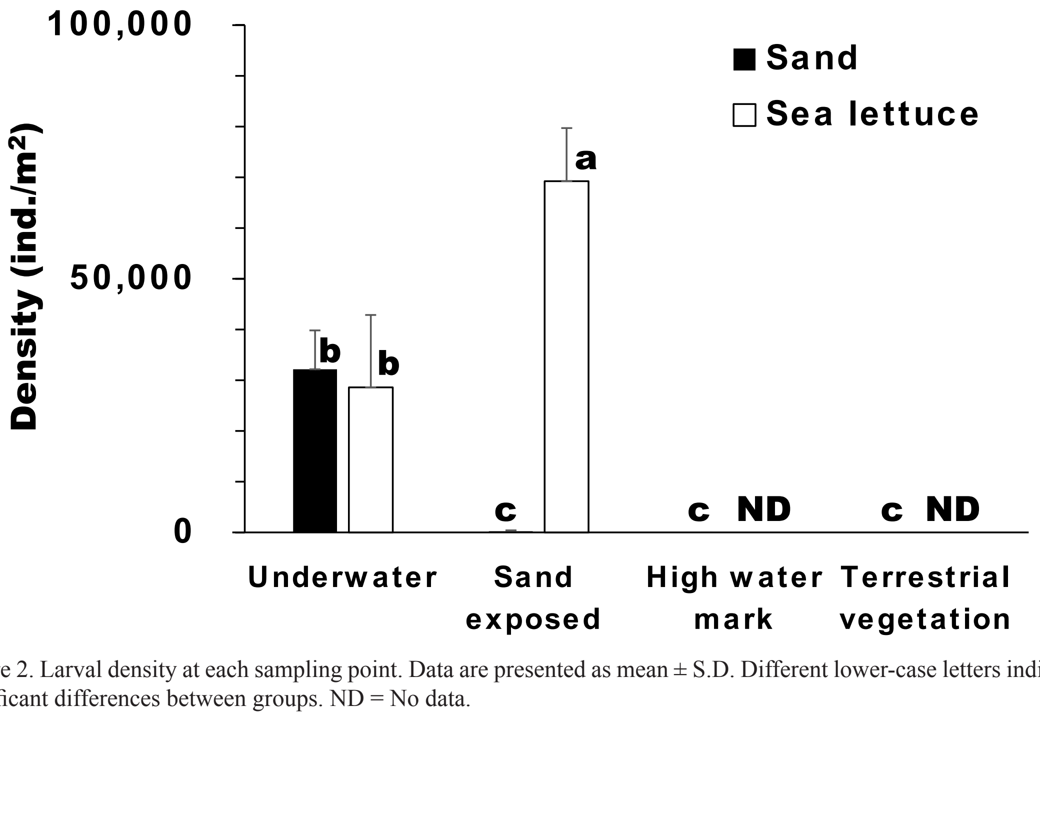

Figure 2. Larval density at each sampling point. Data are presented as mean ± S.D. Different lower-case letters indicate significant differences between groups. ND = No data.

%). The most abundant species, *A. tuberculatum* (58.5 %), *Yaetanytarsus iriomotensis* (24.5 %) and *Thalassomya japonica* (5.7 %), composed 88.7 % of the total males. No *L. taiwanensis* adults were collected in the present study.

Ainuyusurika tuberculatum and *Y. iriomotensis* were the most widely collected species from the Honshu to Yaeyama Islands obtained from sea substrate samples (Kawai et al. 2011). In the present study, *A. tuberculatum* and *Y. iriomotensis* were dominant species, and they were attracted UV lights. Residents may be exposed not only to *L. taiwanensis* adults but also to a seasonal abundance of chironomid midges, especially *A. tuberculatum* and *Y. iriomotensis*. In the present study, adults of *Y. iriomotensis* were collected at several sampling sites using light traps and sweeping nets, but their emerging adults were collected from only one sampling site of the sea substrate samples. These results suggest that it was more difficult for larvae of *Y. iriomotensis* than for larvae of *A. tuberculatum* to develop into adults under the same rearing conditions. The abundance of emerged adults from larval rearing seems to be an underestimation of the habitat range as well as the density for some species (Inoue et al. 2008).

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