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Data Paper

Data on the Seawater and Atmospheric Temperature Recorded by Data Logger in Katsuura, Pacific Coast of Japan

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Abstract Research on the fauna and flora based on the specimens collected in Katsuura, Pacific coast of Boso Peninsula, Japan, has been conducted to elucidate the diversity of marine organisms in the region at Coastal Branch of Natural History Museum and Institute, Chiba. As basic data to trace changes in the marine biota due to global warming, seawater and atmospheric temperature data are measured over time using temperature data loggers installed on rocky reefs and land around the Museum. The present data paper contains original temperature data recorded at 15–30-minute intervals and daily mean, maximum and minimum temperature data calculated from the original data from 2010 to 2020.

Key words: rocky reefs, intertidal zone, subtidal zone, intake facility, global warming, fauna and flora

Measurement (s): temperature of water and atmosphere
Technology Type (s): temperature data logger
Factor Type (s): temporal interval, geographic location, depth, elevation
Sample Characteristic – Environment: sea, temperate rocky reef, intertidal reef, subtidal reef, land
Sample Characteristic – Location: Pacific coast, Boso Peninsula, Japan, Katsuura, Chiba Prefecture
Location of Storage: DOI: 10.6084/m9.figshare.13452023

Coastal Branch of Natural History Museum and Institute, Chiba is situated at Katsuura, Pacific coast of Boso Peninsula, Japan. The coast around the museum is dominated by rocky reefs. There are wide and flat reefs in the intertidal zone, extending to more than 200 m offshore at low tide near the museum. Research and collection of marine organisms have been conducted, taking advantage of the location. A total of 72,153 specimens of marine organisms have been registered since the end of 2020 in the museum (Kawase *et al*., 2021). Recently, the effects of rising seawater temperature due to global warming on marine organisms have been discussed in different fields (e.g., Sunobe *et al*., 2014). Continuous temperature data with specimens collected in the region are essential for future studies of long-term changes in marine biota around the museum. Temperature data have been measured using temperature data loggers installed around the museum since 2010. In this data paper, data on the seawater temperature of the reefs and atmospheric temperature outside the museum up to 2020 is reported.

Methods

Temperature data loggers, HOBO Water Temp Pro v2, and HOBO Pendant Temperature Data Logger UA-001-64 (Onset Computer Corporation, Bourne, MA USA) were adopted to collect continuous data on seawater and atmospheric temperature around the museum. The logger was first mounted on the adapter, HOBO Optic USB Base Station BASE-U-4, to connect to a personal computer, Dell Precision Tower 7810, with OS Windows 10. The start date, time, and measurement intervals of the logger were operated by the software HOBOware version 3.7.12. The logger was again connected to the computer after measurement to read recorded data on dates and temperatures.

Temperature data loggers were installed at the following five locations (Table 1, Figs. 1 and 2).

The reef off Shimura Beach (Table 1A, Fig. 1 Site A, and Fig. 2A) has a steep shelf-like slope. The logger tied with a binding band to a 1-kg lead weight for diving was installed behind a shelf-shaped reef at a depth of 9 m (Fig. 2A, arrow).

Table 1. Data of locations where temperature data loggers were installed.

	Location	Environment	Depth or height	Latitude, Longitude
A	Shimura	subtidal rocky reef	9 m water depth	35.13255° N, 140.28210° E
B	Box for intake	subtidal rocky reef	2 m water depth	35.13385° N, 140.28399° E
C	Tide pool	intertidal rocky reef	0.85 m tidal height	35.13425° N, 140.28539° E
D	Museum	land	9 m elevation	35.13649° N, 140.28413° E
E	Museum laboratory	indoor	—	—

See text for details of each location.

Table 2. List of original temperature data files recorded by temperature data logger at each locations.

Location	File names	Start date of measurement	End date of measurement	Measurement intervals (min)
A	Shimura20120725r	10:30, 20 May, 2011	09:45, 25 July, 2012	15
	Shimura20130912r	10:00, 25 July, 2012	09:30, 12 September, 2013	15
	Shimura20141120r	10:00, 12 September, 2013	14:00, 20 November, 2014	30
	Shimura20160518r	14:30, 20 November, 2014	13:30, 18 May, 2016	30
	Shimura20170907r	14:00, 18 May, 2016	10:30, 7 September, 2017	30
	Shimura20181107r	11:00, 7 September, 2017	09:30, 7 November, 2018	30
	Shimura20191003r	10:00, 7 November, 2018	09:30, 3 October, 2019	30
	Shimura20201104r	10:00, 3 October, 2019	10:30, 4 November, 2020	30
B	Intake20120105r *[1]	14:30, 13 July, 2010	21:30, 5 January, 2012	15
	Intake20121220r	17:00, 15 February, 2012	13:30, 20 December, 2012	15
	Intake20140319r *[2]	15:00, 20 December, 2012	10:00, 19 March, 2014	15
	Intake20150212r	10:30, 19 March, 2014	10:30, 12 February, 2015	30
	Intake20160303r	11:00, 12 February, 2015	09:30, 3 March, 2016	30
	Intake20180314r	10:00, 3 March, 2016	15:00, 14 March, 2018	30
	Intake20190228r	15:30, 14 March, 2018	12:30, 28 February, 2019	30
	Intake20200220r	13:00, 28 February, 2019	10:00, 20 February, 2020	30
C	TP20100625r	15:00, 6 April, 2010	10:00, 25 June, 2010	15
	TP20110420r	11:15, 28 July, 2010	11:00, 20 April, 2011	15
	TP20120424r	11:15, 20 April, 2011	11:30, 24 April, 2012	15
	TP20120803r	11:45, 24 April, 2012	12:00, 3 August, 2012	15
D	Museum20110420r	00:00, 5 April, 2010	12:00, 20 April, 2011	15
	Museum20120424r	12:15, 20 April, 2011	23:45, 23 April, 2012	15
	Museum20130423r	00:00, 24 April, 2012	23:45, 23 April, 2013	15
	Museum20140422r	00:00, 23 April, 2013	23:45, 21 April, 2014	15
	Museum20150424r	00:00, 22 April, 2014	23:45, 23 April, 2015	15
	Museum20160422r	00:00, 24 April, 2015	23:45, 21 April, 2016	15
	Museum20170501r	00:00, 22 April, 2016	16:00, 1 May, 2017	15
	Museum20180512r	16:15, 1 May, 2017	23:45, 11 May, 2018	15
	Museum20190430r	00:00, 12May, 2018	11:30, 30 April, 2019	30
	Museum20200529r	12:00, 30 April, 2019	08:30, 29 May, 2020	15
E	Lab20110420r	00:00, 5 April, 2010	11:30, 20 April, 2011	15
	Lab20120424r	11:45, 20 April, 2011	23:45, 23 April, 2012	15
	Lab20130423r	00:00, 24 April, 2012	23:45, 22 April, 2013	15
	Lab20140422r	00:00, 23 April, 2013	23:45, 21 April, 2014	15
	Lab20150424r	00:00, 22 April, 2014	23:30, 23 April, 2015	30
	Lab20160422r	00:00, 24 April, 2015	23:45, 21 April, 2016	15
	Lab20170501r	00:00, 22 April, 2016	18:00, 1 May, 2017	15
	Lab20180512r	18:15, 1 May, 2017	23:45, 11 May, 2018	15
	Lab20200529r	00:00, 1 May, 2019	23:30, 2 March, 2020 *[3]	30

See Figs. 1, 2 and Table 1 for locations. All data files are in csv format. *[1]: Due to the dead battery, data is missing before the next measurement starts. *[2]: The data for two times before the data logger exchange is missing. *[3]: Abnormal values detected on #769–772, #1333–1343 and #2971–2973 were replaced by the mean values of the latest value before and after the abnormal values.

There are wide and flat intertidal rocky reefs in the immediate vicinity of the museum. There is a box for intake at the west of the reefs created by excavating reefs (Table 1B, Fig. 1 Site B, and Fig. 2B). The box's upper surface is dried at low tide, located at almost Nearly Lowest Low-water Level, i.e., at a depth of 0 m and a tide height of 0 m. Stainless steel grid plates are set on the top (Fig. 2A, arrow) and side of the box to allow seawater to flow into the box. A ladder for maintenance of the intake was set on the wall in the box, and a logger was fixed on the ladder with a cable tie at a depth of 2 m.

At the east of the reefs, the logger protected by a vinyl chloride pipe was attached to the tide pool with concrete nails at a tide height of 0.85 m (mean sea level of Katsuura: 0.90 m) (Table 1C, Fig. 1 Site C, and Fig. 2C).

Outside the staff entrance at the north of the museum building, which is not exposed to direct sunlight, the logger was installed at a height of 1.5 m from the ground (elevation 9 m) (Table 1D, Fig. 1 Site D, and Fig. 2D) to measure the land's atmospheric temperature.

Seawater pumped from an intake box on the reef (Fig. 1 Site B) is sent to the first water tank (capacity: 30 tons) on the

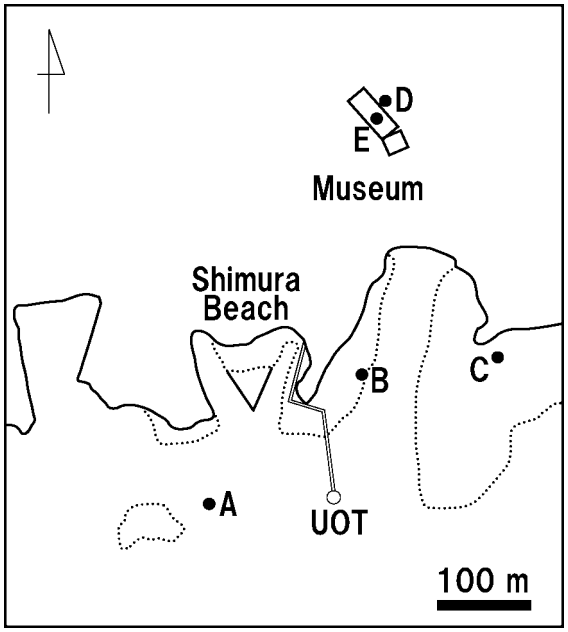

Fig. 1. Map showing locations where temperature data loggers were installed. A: Shimura (9 m water depth); B: Box for intake (2 m water depth); C: Tide pool (0.85 m tidal height); D: Museum (9 m elevation); and E: Museum laboratory. See Table 1 and text for details of each location. The solid line denotes coastline, dotted line intertidal rocky reefs. UOT: Underwater Observation Tower of Katsuura Undersea Park; Museum: Coastal Branch of Natural History Museum and Institute, Chiba.

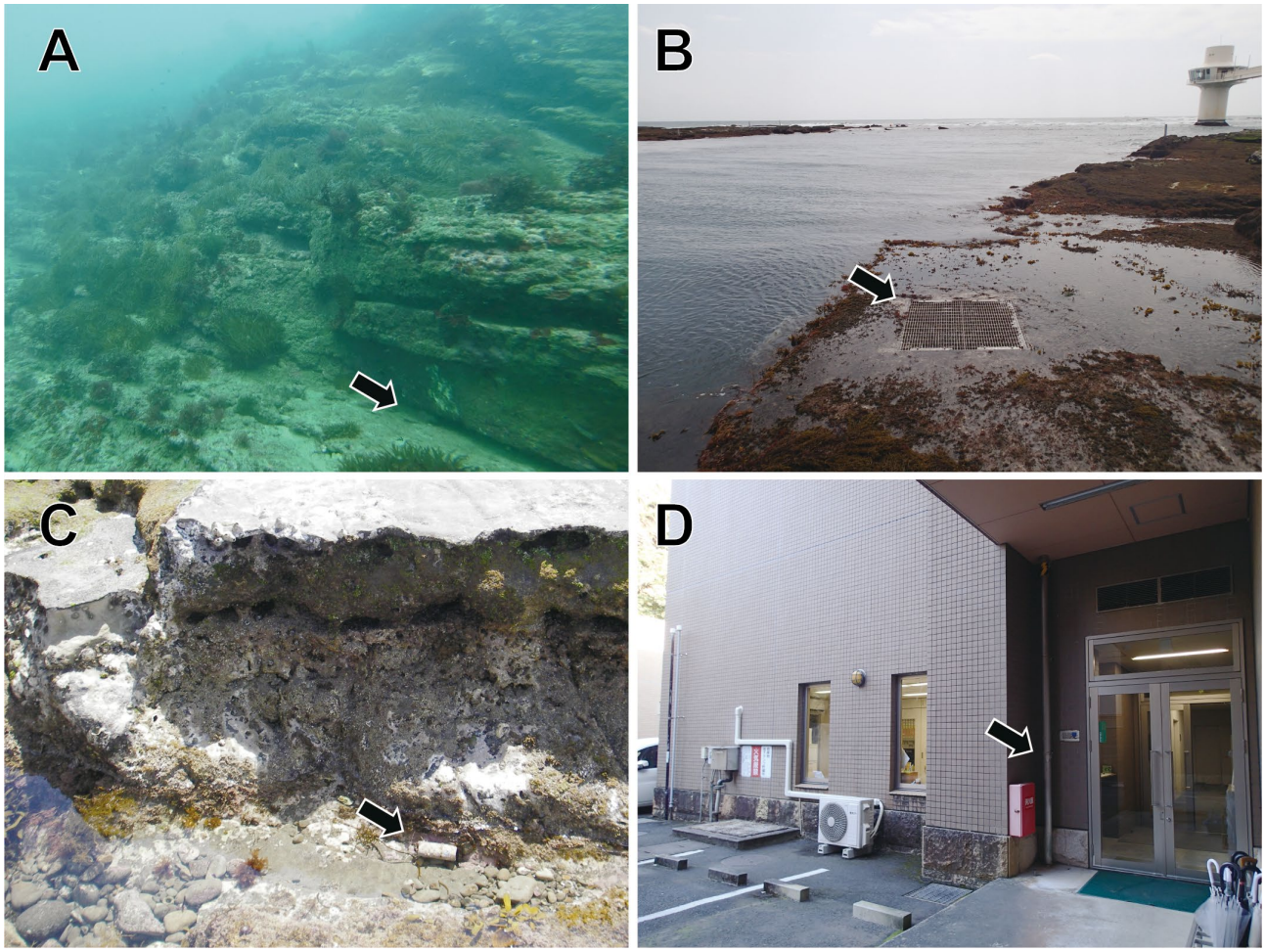

Fig. 2. Photos showing locations where temperature data loggers were installed. A: Shimura (9 m water depth); B: Box for intake (2 m water depth); C: Tide pool (0.85 m tidal height); and D: Museum (9 m elevation). See Table 1 and text for details of each location.

Table 3. List of daily temperature data files calculated from the original data of each locations.

Location	File name	Start date of measurement	End date of measurement
A	Shimura_daily	21 May, 2011	3 November, 2020
B	Intake_daily *[1]	14 July, 2010	19 February, 2020
C	TP_daily *[2]	6 April, 2010	2 August, 2012
D	Museum_daily	5 April, 2010	28 May, 2020
E	Lab_daily *[3]	5 April, 2010	2 March, 2020

See Figs. 1, 2 and Table 1 for locations. All data files are in csv format. *[1]: Due to the dead battery, data from 5 January to 15 February 2012 is missing. *[2]: Data from 25 June to 28 July 2010 is missing. *[3]: Due to the malfunction of data logger, data from 11 May 2018 to 30 April 2019 is missing.

premises of the museum through the underground pipes of about 300 m. The seawater is filtered and sent to the second water tank (capacity: 4 tons) on the museum rooftop. The seawater is supplied to each laboratory in the museum. In the breeding laboratory, the logger was installed in a running water tank (capacity: 200 litters, running water volume: 3 litters/minute) (Table 1E).

The temperature data loggers installed at each site were replaced with new loggers almost every year to measure the temperatures continuously. However, the measurement in the tide pool (Table 1C) was terminated in August 2012.

Data Records

The data was converted to a highly versatile csv format file since it was recorded in the hobo format in the temperature data logger. In the converted file, unnecessary data was recorded between the time when the logger was started and installed at the destination and the time when the logger was collected after measurement and stopped. Therefore, the original temperature data file was created by removing such unnecessary data (Table 2). The first line of the original data file contains the unique number of data (#), measurement date and time (Time, GMT + 9: 00), and water temperature in degree Celsius (Temp) up to the third decimal place. Each data recorded at 15–30-minute intervals is lined up below the first line.

The daily mean, maximum, and minimum temperature were calculated using the original temperature data. The file containing these temperature data was defined as the daily temperature data file (Table 3). In the first line of the daily data file, the month (Month), date (Date), daily maximum temperature (20xx max), daily minimum temperature (20xx min), and daily mean temperature (20xx ave) are listed, where "xx" refers to the last two digits of the year of data acquisition. In the month and day columns, 366 rows of numbers corresponding to January 1st to December 31st are lined up, and temperature data for each year (20xx) are next to them.

Kawase (2021) used the daily data measured on the reef off Shimura Beach and on the reef in the vicinity of the museum (Table 3A and B) to report changes in monthly and annual mean water temperature from 2010 to 2020.

Technical Validation

The data logger used in this study is inexpensive, compact, and highly accurate and has been used for temperature measurement in many studies (e.g., Lents *et al*., 2013). In the measurement of the atmospheric temperature outside the museum (Tables 1D and 2D) and the water temperature in the running water tank in the laboratory (Tables 1E and 2E), a new logger was installed before replacing the used data logger; thus the temperature was measured simultaneously with two loggers for about one day. The difference in the temperatures recorded at the same time on the two data loggers was confirmed to be within 0.2˚C.

Bahr *et al*. (2016) suggested that when the seawater temperature of the coral reefs was measured in direct sunlight on the temperature data logger, the value was higher than when measured in the shade. The loggers in the present study were installed to prevent their exposure to direct sunlight at any of the sites.

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温度ロガーで計測された千葉県勝浦市沿岸の海水温と気温データ

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要　旨　千葉県勝浦市にある千葉県立中央博物館分館海の博物館では，博物館の周辺で採集された海洋生物の標本に基づいて，この地域の海洋生物相を解明する研究が行われている．地球温暖化に伴う海洋生物相の変化を解明する基礎データとして，博物館周辺の岩礁や陸上に温度ロガーを設置して，海水温と気温を継続的に計測している．このデータペーパーでは，2010～2020 年に温度ロガーにより計測された海水温と気温のオリジナルデータ（温度ロガーに 15～30 分間隔で記録された温度）と，オリジナルデータから計算された日データ（日平均温度，日最高温度，日最低温度）を報告する．