.

5.26 Distribution and ecology of oceanic *Halobates* and their responce to environmental factors

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

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(2) Introduction and Objectives

Many great voyages were launched to explore the oceans and what lies beyond, because they have always held a great fascination to us. A great variety of marine organisms were collected and describe during these voyages, but insects appear to have received little attention (Andersen & Chen, 2004). Although they are the most abundant animals on land, insects are relatively rare in marine environments (Cheng, 1985). However, a few thousand insect species belonging to more than 20 orders are considered to be marine (Cheng & Frank, 1993; Cheng, 2003). The majority of marine insects belong to the Coleoptera, Hemiptera, and Diptera, and they can be found in various marine habitats. However, the only insects to live in the open ocean are members of the genus *Halobates*, commonly known as sea-skaters. They belong to the family Gerridae (Heteroptera), which comprises the common pond-skaters or water-striders. Unlike most of its freshwater relatives, the genus *Halobates* is almost exclusively marine. Adults are small, measuring only about 0.5 cm in body length, but they have rather long legs and may have a leg span of 1.5 cm or more except for a new species, *Halobates megamoomario*. This new species which has very long boy length of 0.9 cm and large mid-leg span of 3.2 cm has been newly and recently collected in the tropical Pacific Ocean during the cruise, MR-06-05-Leg 3, and described (Harada et al., submitted). They are totally wingless at all stages of their life cycle and are confined to the air-sea interface, being an integral member of the pleuston community (Cheng, 1985). One may wonder how much tiny insects have managed to live in the open sea, battling waves and storms. In life, sea-skaters appear silvery. On calm days ocean-going scientists have probably seen them as shiny spiders skating over the sea surface. It is not known whether ancient mariners ever saw them, and no mention of their presence has been found in the logs of Christopher Columbus'S (1451-1506) ships or other ships that sailed to and from the New World (Andersen & Cheng, 2004).

Forty-seven species of *Halobates* are now known (Andersen & Cheng, 2004; Harada *et al.*, submitted). Six are oceanic and are widely distributed in the Pacific, Atlantic and the Indian Oceans. The remaining species occur in near-shore areas of the tropical seas associated with mangrove or other marine plants. Many are endemic to islands or island groups (Cheng, 1989).

The only insects that inhabit the open sea area are seven species of sea skaters: *Halobates micans, H. sericeus, H. germanus, H. splendens, H. sobrinus* (Cheng, 1985) and new oceanic species of *H. princeps* and *H. moomario* (proposed new species: Harada & Sekimoto, prepared) under description (Harada *et al.*, submitted). Three species, *Halobates sericeus*, *H. micans* and *H. germanus* inhabit tropical and temperate areas of the Pacific Ocean in the northern hemisphere, including The Kuroshio Current and the East China Sea (Andersen & Polhemus, 1976, Cheng, 1985). *Halobates sericeus, H. micans and H germanus* are reported from latitudes of 13ºN-40ºN, 0ºN-35ºNand 0ºN-37ºN, respectively, in the Pacific Ocean (Miyamoto & Senta,,1960; Andersen & Polhemus, 1976; Ikawa *et al.*, 2002). However, this information was collected on different cruises and in different times of the years. There have been several ecological studies based on samples collected in a specific area in a particular season during the six cruises of R/V HAKUHO-MARU: KH-02-01, KH-06-02, TANSEI-MARU: KT-07-19, KT-08-23 and R/V MIRAI: MR-06-05-Leg 3, MR-08-02.

During one cruise, KH-02-01, one sea skater species, *Halobates sericeus,* was collected at 18 locations in

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the East China Sea area (27°10' N- 33°24' N, 124º57' E - 129º30' E) (Harada, 2005), and *H. micans* and/or *H. germanus* at only 8 locations in the area south of 29° 47'N, where water temperatures were more than 25℃. At three locations, where the water temperature was less than 23℃, neither *H. micans* nor *H. germanus* were caught.

During another cruise, KH-06-02, in the latitude area of 12° N to 14° 30' N, *Halobates micans* were caught at 6 of 7 locations, while *H.germanus* and *H. sericeus* were caught at only 3 and 1 location(s), respectively (Harada *et al,* 2006). However, at 15° 00' N or northern area, *H. germanus* were caught at 14 of 19 locations, whereas *H. micans* and *H. cericeus* were caught at only 8 and 6 locations, respectively (Harada *et al*, 2006).

In the cruise, MR-06-05-Leg 3, larvae of both *H. micans* and *H. germanus* were very abundant at 6º N, whereas adults of *H. germanus* alone were completely dominant at 2º N on the longitudinal line of 130ºE. On the longitudinal line of 138ºE, larvae and adults of *H. micans* alone were dominant at points of 5 º and 8ºN, while adults of *H. germanus* were abundant between 0º and 2ºN. At the two stations of St. 37 (6º N, 130º E) and St. 52 (5º N, 138º E), relatively great number of larvae of *H. sericeus* were collected. This species has been known to be distributed in the northern area of the Pacific Ocean. At St. 52 (6º N, 138º E), it was heavily raining around the ship while trailed.

In the cruise, KT-07-19 on the northern edge of Kuroshio Current, *H. sericeus* was mainly collected in the northern-eastern area of 135º-140ºE, 34º-35ºN whereas *H. germanus and H. micans* were mainly collected in the relatively southern-western area of 131º-133ºE., 31º-33ºN. Only *H. sericeus* can be transferred by the Kuroshio Current onto the relatively northern-eastern area and to do reproduce at least in the summer season. In the cruise of KT-08-23, Most of "domestic" specimen collected in the area northern to Kuroshio current and near to Kyushu and Shikoku islands in September were *H. germanus* (Harada *et al*., submitted).

All samplings of *Halobates* have been performed at different geographical positions in any cruise in the Pacific Ocean so far. However, there has been no information on the dynamics in species and individual compositions in relatively eastern area of 145-160ºE, 0-10ºN of tropical Pacific Ocean. This study aims, first, to perform samplings in this area of the Western Pacific Ocean and examine dynamics of the species composition and reproductive and growth activity and compare these data to the data in the past which were got in more western area of 130-137ºE, 0-10ºN in the cruise, MR-06-05- Leg 3 (Harada *et al.,* 2007; Harada *et al*., 2011a).

During the cruise, MR-08-02, on the longitudinal line of 130ºE, larvae of both *H. micans* and *H. germanus* were very abundant at 5-12º N, whereas adults of *H. sericeus* alone were dominant at 17º N. In the lower latitude area of 5-8 º N, all the three described species, *H. micans, H. germanus* and *H. sericeus* and un-described species, *Halobates moomario* (Harada & Sekimoto, prepared) were collected. At a fixed point located at 12ºN, 135ºE, *H. micans* was dominant through the sampling period of 20 days, whereas *H. sericeus* was collected mainly in the latter half of the period. Higher number of *Halobates* (593) was collected in the first half of the sampling period (8^{th} – 17^{th} June, 2008) when the weather was very fine than that (427) in the second half (18^{th} – 27^{th} June, 2008) when the typhoon No 6 was born and developed near the fixed sampling point.

In this cruise of MR-09-04, on the longitudinal line of 155-156ºE *H. germanus* was very dominant, whereas three adults of *H. micans*, *H. germanus* and *H. sericeus* were dominant at 5º N on the longitudinal line of 147 ºE during this cruise held in Nov 4-Dec 12, 2009 (Harada *et al*., 2009; Harada *et al.,* 2010a). Among several latitudes of 0-10 º N, peak of number of individuals collected was located at 8 º N, 5 º N and 0-2 º N for *H.m., H.g.* and *H.s.,* respectively, on the longitudinal line of 155-156 º E. From latitudinal point of view, *H. micans* and *H.germanus*. were abundant in 5-8 º N, whereas *H. sericeus* and *H. moomario* were in 0-5 º N. Except for St. 6 at 3 º N, 147 º E, more than half of specimen collected were larvae at the remaining St. 1-5 and St.7,8.. Un-described new species, *Halobates moomario* was mostly on the longitudinal line of 147ºE. On the

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longitudinal line of 147 º E, more newly hatched larvae were collected than those on the line of 155-156E. *Halobates micans* was dominantly inhabiting at a fixed point of 3N, 139E in the tropical Pacific Ocean during a science cruise of MR-10-03 administered in May and June of 2010.

In the cruise, KH-10-04-Leg. 1 (Harada *et al.*, 2010b), the samplings of *Halobates* inhabiting temperate and subtropical Pacific Ocean along the cruise track from Tokyo to Honolulu for the 2 weeks showed that four species of *Halobates micans, H.germanus, H. sericeus, H. moomario* inhabited in the relatively northern and western area of 30ºN-34ºN and 140ºE-144ºE, although *H. sericeus* was dominant species. In the relatively southern and eastern area of 19 ºN-29ºN and 147ºE-163ºW, only *H. sericeus* was exclusively inhabiting. Many larvae of this species were collected through all the stations and the reproductive activity of *H. sericeus* seems to be active in this area. Significantly more female-adults were collected rather than male-adults in total (χ^2-test, P<0.01). The extent of positive phototaxis by females may be higher than that of males, or avoiding behavior from the opening of the Neuston Net might be more active by males than females.

In the cruise, KH-10-04-Leg 2(Harada *et al.*, 2010c), the samplings of *Halobates* in Central or Eastern Tropical Pacific Ocean showed that *Halobates sericeus* was dominant at 13º59'N, 162º06'W, while *Halobates megamoomario* and *Halobates moomario* were dominant in the areas of 2º35'N-2º45'N, 164ºW-166ºW and 14ºN-17ºN, 172ºW-176ºW, respectively. In the sampling area of the Central or Eastern Tropical Pacific ocean, the population density of *Halobates* is relatively low of 3626.4/km^2.

In the cruise, KH-10-05-Leg 1 (Harada et al., 2010d), the samplings of *Halobates* in Tropical Indian Ocean showed that *Halobates micans* was dominant with estimated population density of about 58000 individuals/km^2 along the cruise track from 04'09S, 094'26E to 08˚40'S, 084˚04'E, while *H. micans* was also dominant but estimated population density was relatively low of 0 -21523 /km^2 on the line of cruise track from 10˚12'S, 080˚24'E to 15˚23'S, 067˚48'E. Positive and negative correlations were shown between chlorophyll conc. and the number of *Halobates* (mostly *H. micans*) individuals collected and between oxygen and the number of sea skaters inhabiting in Tropical Indian Ocean, respectively.

This study aims, first, to examine the relationship between the individual number and species components of the oceanic sea skaters of *Halobates* micans (Heteroptera: Gerridae) and *H. germanus* and oceanic dynamism on several factors like as precipitation, waves, air temperature, chlorophyll conc. and dissolved oxygen conc. in surface water during 2 months of sampling- and examination-period at the fixed point of 8ºN,80ºE in Tropical Indian Ocean during the science cruise, MR-11-07 which is participation of CYNDY2011 (Cooperative Indian Ocean experiment on intra-seasonal variability in the Year 2011) an international project on the other hand.

Fresh water species in Gerridae seem to have temperature tolerance from -3℃ to 42℃ (Harada, 2003), because water temperature in fresh water in ponds and river highly changes daily and seasonally. However, water temperatures in the ocean are relatively stable and only range from 24℃ to 30 ℃ in the center of Kuroshio current in southern front of western Japan (Harada, 2005). Adults of *Halobates germanus* showed semi-heat-paralysis (SHP: static posture with no or low frequency to skate on water surface), when they were exposed to temp. higher than 32℃ (Harada unpublished, data in the TANSEIMARU cruise: KT-05-27).

In contrast to the temperate ocean, water temperature in the tropical ocean area, is more stable around 30℃. Therefore, the tropical species of *H. micans* is hypothesized to have lower tolerances to temperature changes than the tropical-temperate species, *H. sericeus*. This hypothesis was true in the laboratory experiment during the cruise of KH-06-02-Leg 5 (Harada *et al.*, submitted). When the water temperature increased stepwise 1℃ every 1 hour, heat-paralysis (ventral surface of thorax attaché to water surface and unable to skate) occurred at 29℃ to >35 ℃ (increase by 1 to >7 ℃). Three of four specimens in *Halobates sericeus* were not paralyzed even at 35 ℃ and highly resistant to temperature change, while only one of nine in *H. micans.* and only four of twelve in *H. germanus* were not paralyzed at 35 ℃. On average, *H. sericeus, H germanus and H. micans* were paralyzed at >35.6 ℃ (SD: 0.89), >32.9 ℃(SD: 2.17) and >31.6 ℃ (SD: 2.60) on average,

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respectively (Harada *et al.*, submitted).

As an index of cold hardiness, super cooling points (SCPs) have been used in many insects (Bale, 1987, 1993; Worland, 2005). The absence of ice-nucleating agents and/or the lack of an accumulation of cryo-protective elements can often promote higher super cooling points (Milonas & Savopoulou-Soultani, 1999). SCPs, however, might be estimated as only the lower limits of super cooling capacity and only a theoretical lower threshold for the survival of insects as freeze-non-tolerant organisms. Many insects show considerable non-freezing mortality at temperatures well above the SCPs, a "chill-injury" species (Carrillo *et al.*, 2005; Liu *et al.*, 2007). Liu *et al* (2009) recently showed that SCPs change in accordance with the process of winter diapauses, decreasing in Dec-Feb and increasing rapidly in Feb-Apr (diapauses completing season) due to making glycogen from trehalose as a "blood suger" leading to lower osmotic pressure in haemolymph due to low "trehalose" level. This relation supports the possibility of SCPs available as an indirect indicator of cold hardiness of insects.

The 0-10ºN latitude-area in the Pacific Ocean has very complicated dynamic systems of ocean and atmosphere. Because of such complicated system, water/air temperatures and water conductivity (salinity) can be in dynamic change temporally and spatially. Sea skaters inhabiting this area of the Pacific Ocean show relatively high tolerance to temperature changes (heat tolerance) (Harada *et al.,* 2011a), and *H. sericeus* which is inhabiting wide latitude area of 40ºN-40ºS in the Pacific Ocean is more hardy to temperature increase than other two oceanic sea skaters, *H. germanus* and *H. micans* inhabiting narrower latitude range of 25ºS-25ºN and 20ºS-20ºN in the Indian and Pacific Ocean (Harada *et al.*, 2011a). Adult specimens of *Halobates micans* living at 6ºS, 89ºE where currents from south and north directions hit and get together than those living at other places of 8ºN, 89ºE in the tropical Indian Ocean (Harada *et al*., 2011b). Due to 3 or 4ºC of temperature decrease when rain falls, tolerance to high temperature by *H. micans* becomes weaker in the tropical Pacific Ocean (Harada *et al*., 2011b). Recently, a cross-tolerance to high and low severe temperature has been reported by fresh water species of semi-aquatic bug, *Aquarius paludum* (Harada *et al.*, 2010e). Also oceanic sea skaters (all four species of *H. micans, H. germanus, H. sericeus* and *H.sp.*) inhabiting tropical ocean showed a negative correlation between heat coma temperature and SCP (Harada *et al.*, 2009: the cruise report of MR-09-04). Similar correlation was also observed only for males of *H. sericeus* collected on the cruise track between Tokyo and Honolulu, Hawaii (Harada *et al.*, 2010b: the cruise report of KH-10-04-Leg 1).

This study aims, second, to examine whether sea skaters, living at the fixed point of 8S, 80S of the tropical Indian Ocean show a high cross tolerance of higher heat tolerance and lower super cooling points (SCP) and also to examine some relationship between SCP as a index of cold hardiness of sea skaters and oceanic dynamism on several factors like as precipitation, waves, air temperature, chlorophyll conc. and dissolved oxygen conc. in surface water.

Insects which have chance to be exposed to sea water or brackish water are known to adopt one of two strategies to survive an stress as higher osmotic pressure, "osmoregulating" and "osmoconforming" (Bradley, 1987). In the former strategy, insect maintains the osmotic pressure in haemolymph relatively lower level against high salinity environment. For example, dipteran larvae including saline-water mosquitoss of the genus *Aedes* and chironomids (Neumann, 1976; Kokkin, 1986) constantly lose water in saline water. To prevent water loss, larvae drink the external medium and at the same time excrete a concentrated "urine" to keep lower osmotic pressure in the haemolymph. In the latter strategy, osmoconforming, insects of other genera of mosquitoes (Bradley, 1987, 1994) and euryhaline species of other order genera (for example a dragon fly nymph, *Enallagma clausam*: Stobbart & Shaw, 1974) equilibrate the osmotic pressure of the haemolymph with that of the saline environment.

A semi-aquatic bug, *Aquarius paludum,* a fresh water and semi-cosmopolitan species in Palearctic area response to the exposure to the brackish water: the limit for nymph growth was 0.9% of NaCl, and even in 0.45% of salinity can depress the reproductive activity (down up to 2/3 of fecundity) in the population

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inhabiting fresh water habitat (Kishi *et al.*, 2006, 2007, 2009). How do oceanic sea skaters adapt to the brackish and fresh water environment? In the open ocean, some heavy rain can make the sea water file leading to rapid decreasing of osmotic pressure.

In the cruise of KH-09-05-Leg.7 (Harada & Sekimoto, 2010: the cruise report), Salinity experiment was performed at the first time on sea skaters of *Halobates* sp (under the description as *Halobates moomario*) inhabiting Tomini Bay in Indonesia. The movements of mid- and/or hind legs of all the specimen on the fresh water were paralyzed with unusual back position and quick fluctuating and all ones were dead within 2 hours after the occurrence of such so called “paralysis due to fresh-water shock” The paralysis and death after that occurred only on the fresh water 19-31hrs and 21-33 hrs, respectively. In total data from Experiments 1-3, females showed significantly longer hours of 27 hrs in survival on average than males only on the fresh. Individuals on 2/3 sea water tended to be in survival longer than those on 100% sea water in Experiments 1-3 (Wilcoxon test on average value: z= -1.604, p=0.109).

In the cruise of KH-10-04-Leg 2 (Harada *et al.*, 2010c: the cruise report), on the fresh water, the movements of mid- and/or hind legs of all the specimen on the fresh water were paralyzed with unusual back position and quick fluctuating just after transferring to the fresh water and all ones were dead within 2-3 hours after the transferring to the fresh water in all three species of *Halobates sericeus*, *H. moomario* and *H. megamoomario* inhabiting open Pacific Ocean. In the case of *H. moomario* inhabiting in Tomini bay, such fresh water paralysis occurred 15-20hours after the transferring to the fresh water. Sea skaters inhabiting the open Ocean may be less resistant to fresh water than those living on Tomini Bay, because there are no effects of fresh water flowing from the rivers of lands. Even on the salinity of 11‰, all the three species of sea skaters survived for similar hours to those on the higher salinity of 22-36‰. They can survive when they are exposed to the heavy rain and following very low salinity level of the surface layer of the sea.

In the cruise of KH-10-05 (Harada *et al*., 2010c: the cruise report), the fresh water shock occurred very quickly within 2-9hrs for in all adult specimens of *H. micans* from the Oceans and dead within 2hrs thereafter. Significantly longer hours in survival were shown by the both species on 1/3 or 2/3 sea water than those on sea water. The longer hours in survival by oceanic sea skaters to “brackish waters” could be speculated to be adaptation to the occasional rain fall on the sea water film.

As a third aim of this study, another experiment is performed on oceanic sea skaters, *Halobates micans and H. germanus* inhabiting the Indian Ocean to know an exact threshold of higher limit to trig the leg paralysis due to lower salinity which can be named “low salinity shock” . This experiment tries to clarify whether some relationship is between oceanic dynamics (for example, weather, precipitation, waves, salinity, air temperatures) in the day before the collection and survival days under several salinity levels and also the threshold to trig the “low salinity shock”.

(3) Materials and Methods

Samplings

Samplings were performed in 27th September– 22nd October, 2011 with a Neuston NET (6 m long and with diameter of 1.3 m.)(Photo 1). The Neuston NET was trailed for 15 mm x 3 times on the sea surface at 17 stations in which 16 stations are around a point of 08º00’S, 080º30’E in tropical Indian Ocean on the starboard side of R/V MIRAI (8687t) which is owned by JAMSTEC (Japan Agency for Marine-earth Science and TECHnology). The trailing was performed for 15min exclusively at night with the ship speed of 2.0 knot to the sea water (Photo 1). It was repeated 2 times in each station. Surface area which was swept by Neuston NET was evaluated as a expression of [flow-meter value x 1.3m of width of the Neuston NET (Photo 1). All contents including sea skaters trapped in the pants (grey and plastic bottle (Photo 2) were transferred to a round-shaped transparent plastic aquarium (Photo 3). All sea skaters were picked up from the contents of the

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aquarium.

Laboratory experiment

The sea skaters trapped in the pants were paralyzed with the physical shock due to the trailing of the NET. Such paralyzed sea skaters were transferred on the surface of paper towel (Photo 4) to respire. Some individuals could recover completely from the paralysis. Then, the paralysis of some ones was discontinued within 20min. When sea skaters were trapped in the jelly of jelly fishes, the jelly was removed from the body of sea skaters very carefully and quickly by hand for the recovering out of the paralysis.

Adults and 3rd to 5th instars which recovered out of the paralysis were moved on the sea water in the aquarium set in the laboratory (Photo 5) for the Heat-Paralysis Experiments and measuring Super Cooling Points (Photo 6). Many white cube aquaria with 30cm X 30cm X 40cm) were used in the laboratory of the ship for rearing of the adults and larvae which were recovered out of the paralysis due to the trailing. Each aquarium contained ten to twenty adults and/or larvae of *Halobates*. Both the room temperature and sea water temperature in the aquaria were kept at 29±2℃. For about 9 hours after the collection, sea skaters were kept in the aquaria before the heat-paralysis experiment. All the individuals of *Halobates* which have been kept in the aquaria more than 12 hours after the collection were fed on adult flies, *Lucillia illustris.* When SCP was measured without being applied to heat coma experiment, specimen were kept starved more than 24 hours before the measurement. The transparent aquarium as the experimental arena has sea water with the same temperature (mostly 28 or 29℃) as that of the aquarium to keep sea skaters. 4 to 11 individuals at adult or larval stage were moved to the transparent aquarium. Temperature was stepwise increased by 1℃ every 1 hour till the high temperature paralysis occurring in all the experimental specimens. Four or five layers of cardboard were rapped around the round-shaped experimental aquarium and functioned as an insulator.

Temperature was very precisely controlled by handy on-off-switching to keep in ±0.3 ℃ of the current water temperature. Handy-stirring with 10cm air tube with 5mm diameter and ball stone with 3cm diameter was effective to keep the precise controlling of the current temperature. Sea skaters on the water surface of the aquarium were recorded with Digital Handy Video Camera (GZ-MG840-S: VICTOR) from above position for the last 10 min of each 1hour under the current temperature. Temperature at which Semi Heat Coma (Heat Semi-Coma Temperature [HSCT]: little or no movement on the water surface more than 3 seconds) occurs and another temperature at which Heat Coma (Heat Coma Temperature [HCT]: ventral surface of the body was caught by sea water film and no ability to skate any more) occurs were recorded.

Determination of super cooling point (SCP)

Measurements of super cooling points and increasing temperature value at the moment of an exothermic event occurred in the body of the specimen (ITSCP: increased temperature at SCP) were performed for the specimen (mainly adults) paralyzed by high temperature of the two species of oceanic *Halobates* (*H. micans, H. germanus*) just after the heat paralysis experiment during this cruise. Some actively skating specimens were directly applied to the measurements of SCP and ITSCP without heat paralysis experiment to detect the effect of heating during the experiment on SCP and ITSCP.

Surface of each adult was dried with filter paper, and thermocouples which consist of nickel and bronze were attached to the abdominal surface of the thorax and connected to automatic temperature digital recorders (Digital Thermometer, Yokogawa Co, LTD, Model 10, Made in Japan). The thermocouple was completely fixed to be attached to the ventral surface of abdomen by a kind of Scotch tape. The specimen attached to thermocouples was placed into a compressed-Styrofoam box ($5\times5\times3$ cm^3) which was again set inside another insulating larger compressed Styrofoam to ensure that the cooling rate was about 1ºC/min for recording the SCP in the freezer in which temperature was -35ºC. The lowest temperature which reached before an exothermic event occurred due to release of latent heat was regarded as the SCP (Zhao & Kang, 2000). All

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tested specimen were killed by the body-freezing when SCP was determined.

Salinity experiment

The fifth instars and adults of *H. micans* collected during this cruise, MR-11-07-Leg 2 were used for the salinity experiment. All specimen (mostly adults) for Experiment 1-3 were moved on the sea water in the aquaria set in the wet laboratory in R/V Mirai (temperature was kept within 30.0±2C). White cube aquaria with 30cm X 30cm X 40cm) (Photo 2) were used for the experiments. Experimental specimens were moved to one of the 6 salinity conditions, brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, A': 9‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰).

All specimens were adults or 5th instars of *Halobates micans.* Experimental specimens were kept more than 24 hours within 1 week after the collection and fed on the flies, *Lucilia illustris* (rate of one fly per 10 sea skaters per one day). After the transfer to one of 6 salinity conditions, whether the specimen were living and also whether they were in the legs-paralysis due to low salinity were checked every 1 hours without no food during being kept.

(4) Results and Discusssion

Population density and other Meteorological factors

The samplings of *Halobates* (Table 1) inhabiting two locations at 01º55'S, 083º24'E (Station 1) and 08º00'S, 080º30'E (Stations 2-17) in subtropical Indian Ocean showed that two species of *Halobates micans* and *H.germanus* inhabited in the tropical Indian Ocean,, although *H. micans* was dominant species. This result coincides with results of the past study (Andersen & Cheng, 2004; Harada et al., 2011b). Table 2 shows a comparison of population density of *Halobates* species among three tropical sampling ranges in Indian and Pacific Oceans. At the fixed location of 08º00'S, 080º30'E, one third of the density of *H. micans* can be estimated , compared with the density in relatively wide area of 8N-6S, 76-86E in the Indian Ocean. Probably the low activity of photosynthesis and relatively high oxygen consumption which can be suggested by low amount of chlorophyll in surface sea water in this fixed location may be related to relatively low density of *Halobates*, because low photosynthesis activity and high dissolved oxygen show extremely low amount of animals like as zooplankton and nekton which mean low amount of foods for sea skaters (Fig. 1).

Samplings at the fixed location at 08º00'S, 080º30'E showed that higher population density (20491.4 individuals/km^2) of *Halobates micans* was estimated at the stations where air temperature was 27.5ºC than that (12070.9 individuals/km^2) in the stations at which air temp. was less than 27.5 ºC (Mann-Whitney U-test: z=-2.614, p=0.009)(Fig. 2). Similar result in the population density of larvae (481 larvae of *H. micans* and 70 ones of *H. germanus* were collected in total at Stations 1-17: Table 3) implies higher reproductive activity when the air temperature become higher than 27.5 ºC (z=-2.935, p=0.003)(Fig. 3).

Laboratory experiment

Heat semi-coma temperature (HSCT), heat coma temperature (HCT), gap temperature for heat coma (GTHC) super cooling point (SCP) and Increased temperature at super cooling point (ITSCP) were ranged 29 ºC to 41 ºC, 30 ºC to 41ºC, 1ºC to 13ºC, -21.4ºC to -9.1ºC and 0.5ºC to 11.7Cº, respectively (Table 4).

No significant correlation between HCT (or GTHC) and SCP was shown at all in *H. micans* and also *H. germanus* (Pearson's correlation test: r=-0.031, p=0.901, n=19) (Fig. 4), whereas Harada et al (2010) showed that clear negative correlation was shown not by female-adults but by male-adults of *H. sericeus* in the area of 34˚43'N, 140˚14'E to 19˚33'N, 164˚44'W in the temperate and subtropical Pacific Ocean. On the other hand, in the area of 00˚04'N-09˚59'N, 146˚59'E-156˚20'E of the central tropical Pacific Ocean, adults of *H. sericeus* showed very clear and significant negative correlation (Pearson's correlation test: r=-0.463, p=0.011, n=26) (Harada *et al.*, 2009). Such negative correlation between heat resistance and SCP might imply a

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physiological cross tolerance between heat and cold hardiness, because SCP could be one index of cold hardiness. In the open ocean, only *H. sericeus* showed relatively clear correlation. This phenomenon may link to that only this species is “rider” on the several currents, especially “*Kuroshio*” current (Harada, submitted). Parallel physiological development of both cold and heat hardiness could be hypothesized to be evolved only this “rider sea skaters”. However, many actual data to support this hypothesis are remained to be got currently.

Exceptionally high heat tolerance was shown in this area of 08º00’S, 80º30’S in the tropical Indian Ocean. Average of THP was abound 40Cº and 39Cº for *H. germanus* and *H. micans* (Tables 5-A,B,C). This high value by both species is much higher than that in any other subtropical and tropical open ocean area in Indian and Pacific Ocean (Harada *et al.*, 2008; Harada *et al.*, 2011b) by 3-5ºC. Such high heat resistance coincides with high heat coma temperature of 39Cº as average value at 06º25’S, 089º00’E in the tropical Indian Ocean (Harada *et al.*, 2011b). Harada *et al.* (2011b) discuss on such extreme high heat resistance that currents get together from North and South in this area and some special temperature dynamics appearing here can be related to the extreme high temperature hardiness. The chief scientist of this cruise and a Meteorologist, Dr Kunio Yoneyama kindly gave us a very important comment that this fixed position of 08º00’S, 080º00’E is included in the special area of 5-10ºS, 75º-95ºE where intra-seasonal temperature variation is highest in the world open oceans. This high resistance to high temperature shown by *H. micans* might be naturally selected within one generation which is proposed within 2-3 months or also over generations by such dynamic air and water temperatures around sea surface. However, the relationship between heat tolerance of sea skaters and meteorological data are currently remained to be analyzed for the near future.

After the application to the Heat Coma Experiment (HC exp.), super-cooling points shown by adults became significantly higher by 2ºC than those by specimen without the application (Table 6). Heat stimulation during the HC exp. might increase the osmotic pressure of heamolymph up to the level of -16ºC of SCP as one speculation.

The relationship between heat hardiness and SCP, and several physical parameters (current speed, air temp., dissolved oxygen and chlorophyll from CTD data) in each day when sampling was performed should be also analyzed.

Salinity experiment

Most of the specimen at 10‰ and 9‰ and all specimen at 8-0‰ were under the paralysis of all six legs due to lower salinity concentration. However, the longer the time needed for the paralysis to be dead , the higher the salinity concentration. Due to similar experiments performed during the cruises of KH-09-07 and KH-10-05, similar survival duration among 36-12‰ were shown in *Halobates sp.* and *Halobates micans.* Therefore, no sharp-critical response but instead gradual responses to salinity were shown between 10-0‰ for the survival days under starvation. Another threshold salinity concentration for triggering the paralysis due to lower salinity so called “low salinity shock” seems to be located between 12‰ and 10‰.

(5) Additional Analyses

The data on field samplings in this study and environmental data on the oceanography during the cruise should be compared to the sampling data and related oceanography data in the area of 34˚43’N - 19˚39’N, 140˚14’E - 163˚48’ W, in the Pacific Ocean at the cruise, KH-10-04-Leg 1, as well as those in the area of 4S to 13S and 8 º N to 6 º S in the Indian Ocean at two cruises, KH-10-05-Leg 1(Harada et al., 2010) and KH-07-04-Leg1 (Harada *et al*., 2008), respectively and those in the area of 30-35 º N along the Kuroshio Current at the cruises, KT-07-19, KT-08-23, KT-09-20 and the other R/V TANSEIMARU cruises held in the past.

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Cross tolerance between heat and cold hardiness was shown by *Halobates* inhabiting western tropical Pacific Ocean with 0-8N, 147-156E during the MR-09-04 and also shown by male *Halobates sericeus* in the cruise of KH-10-04-Leg 1. SCP measurement and heat paralysis experiment were done in the same manner during the cruise KT-09-20 in September, 2009. The relationship of the extent of the heat tolerance and SCP value should be analyzed to the ocean dynamics like as surface air and water temperature, dissolved oxygen and chlorophyll contents in the Pacific and Indian Ocean in the near future.

The video camera data will be also analyzed after the cruise to examine the frequency and speed of skating and their responses to the temperature differences. Dissection data (for example reproductive maturation), chemical contents data (example lipids) and gene data of MtDNA from *Halobates* samples should be analyzed in the future.

For the salinity experiments, raw data were shown in this report and all the statistical analyses should be done as soon as possible after the cruise.

(6) Data Archive

All data during this cruise will be submitted to the JAMSTEC Data Integration and Analysis Group (DIAG).

(7) Acknowledgements

We would like to thank Dr. KunioYONEYAMA (Head Scientist of the cruise: MR-11-07-Leg 1) and Dr. Masaki KATSUMATA (Head Scientist of the cruise: MR-11-07-Leg 2) for the permission of doing this study during the cruise on the R/V MIRAI, and also for their warm suggestion on ocean and atmosphere dynamics, and encouragement and help throughout this cruise. The samplings and the experimental study were also possible due to supports from all of the crew (Captain: Mr. Yasushi ISHIOKA) and all the scientists and the engineers and scientists from GODI (Global Ocean Development) and MWJ (Marine Work Japan) in this cruise. We would like to give special thanks to them.

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Table 1-A. Number of *Halobates* collected at locations in the tropical Indian Ocean in Sep. 27, 2011 (N:Total number of individuals collected; *H.m.: Halobates micans; H.g.: Halobates germanus; H.s.: Halobates sericeus*; Stat: Station number; WT: Water temperature (℃); AT: Air temp.; L: N of larvae; A: N of adults, E: N of exuviae; Date: sampling date; Sampling was performed for 45min. EG: eggs on some substrates like as polystyrene form thousands of eggs laid on the substrate. S: Surface area which was swept by Neuston NET was expressed as value of flow-meter x 1.3m of width of Neuston NET; WS: wind speed (m/s); W: weather; TD: Time of day; WS: Wind speed, CS: Current speed(m/s)CD: Current direction; F: female; M: male; DO: dissolved oxygen (μmol/kg); Chl: Chlorophyll-A conc.(relative fluorescent value); SL: salinity(‰)

Latitude	Longitude	N	L	A		*H.m.*	*H.g.*	*H.s.*	EG	E	Stat	WT	AT	WS	W	CS	CD	TD	Date	S(x1.3 m^2)	DO	Chl	SL
				F	M																		
01º55’S	083º24E	7	0	1	6	4	3	0	0	0	St.1-1	29.0	27.9	5.2	Fine	0.9	130º	18:24~39	Sep 27	804.0	189.34	0.955	32
01º56’S	083º24’E	14	3	6	5	9	5	0	0	0	St.1-2	29.0	27.9	4.3	Fine	0.9	97º	18:43-58	Sep 27	767.0	189.34	0.955	32
01º55’S	083º24’E	9	3	2	4	5	4	0	0	0	St.1-3	29.0	27.9	4.8	Fine	1.0	119º	19:03-18	Sep 27	801.0	189.34	0.955	32
08º00’S	080º30’E	4	2	1	1	2	2	0	0	0	St.2-1	28.4	26.7	5.0	Cloud	0.4	311º	20:34~49	Sep 30	615.0	189.04	1.190	32
08º00’S	080º30’E	0	0	0	0	0	0	0	0	2	St.2-2	28.4	26.7	4.4	Cloud	0.3	266º	20:53~21:08	Sep 30	503.0	189.04	1.190	32
08º00’S	080º30’E	3	3	0	0	1	2	0	0	0	St.2-3	28.4	26.7	4.4	Cloud	0.3	273º	21:13~28	Sep 30	570.0	189.04	1.190	32
08º00’S	080º29’E	9	3	3	3	3	6	0	0	0	St.3-1	28.2	25.2	9.3	Rainy	0.4	265º	20:58~21:13	Oct 1	760.0	189.8	1.240	32
08º00’S	080º29’E	10	5	4	1	9	1	0	0	0	St.3-2	28.2	25.2	11.2	Rainy	0.3	269º	21:20~35	Oct 1	656.0	189.8	1.240	32
08º00’S	080º29’E	19	7	8	4	18	1	0	0	0	St.3-3	28.2	25.2	13.5	Rainy	0.4	279º	21:39~54	Oct 1	604.0	189.8	1.240	32
08º00’S	080º30’E	11	9	1	1	7	4	0	0	0	St.4-1	28.5	27.8	8.6	F/C	0.7	141º	20:56~21:11	Oct 3	656.0	189.62	0.63	31
08º00’S	080º30’E	20	15	2	3	15	5	0	0	0	St.4-2	28.5	27.8	7.8	F/C	0.7	155º	21:16~31	Oct 3	663.0	189.62	0.63	31
08º01’S	080º30’E	65	10	9	46	62	3	0	0	0	St.4-3	28.5	27.8	8.0	F/C	0.8	158º	21:35~50	Oct 3	667.0	189.62	0.63	31
08º00’S	080º29’E	21	11	7	3	19	2	0	0	0	St.5-1	28.5	25.4	4.7	Rainy	0.2	209º	20:50~21:05	Oct 4	569.0	189.45	0.84	32
08º00’S	080º30’E	22	11	8	3	20	2	0	0	1	St.5-2	28.5	25.4	8.6	Rainy	0.1	152º	21:10~25	Oct 4	504.0	189.45	0.84	32
08º00’S	080º30’E	84	68	10	6	64	20	0	0	3	St.5-3	28.5	25.4	9.5	Rainy	0.5	176º	21:29~44	Oct 4	601.0	189.45	0.84	32
07˚59’S	080˚29’ E	6	4	1	1	3	3	0	0	0	St.6-1	28.4	26.7	10.4	C/R	0.9	185 º	20:54-21:09	Oct 6	662.0	189.85	0.67	32
08˚00’S	080˚29’ E	11	9	1	1	7	4	0	0	0	St.6-2	28.4	26.7	9.2	C/R	0.7	189º	21:13- 28	Oct 6	690.0	189.85	0.67	32

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08˚01'S	080˚30' E	7	6	1	0	7	0	0	0	0	St.6-3	28.4	26.7	7.5	C/R	0.7	206º	21:33- 48	Oct 6	552.0	189.85	0.67	32
07˚59'S	080˚29'E	10	7	0	3	3	7	0	0	0	St.7-1	28.5	27.4	4.2	Fine	0.2	154 º	20: 49-21:04	Oct 7	787.0	189.46	0.56	32
08˚00'S	080˚30'E	9	6	1	2	4	5	0	0	0	St.7-2	28.5	27.4	4.1	Fine	0.3	121 º	21: 09-24	Oct 7	594.0	189.46	0.56	32
08˚00'S	080˚30'E	6	4	1	1	3	3	0	0	0	St.7-3	28.5	27.4	4.4	Fine	0.4	129º	21:29-44	Oct 7	621.0	189.46	0.56	32
07˚59'S	080˚29'E	15	12	1	2	12	3	0	0	0	St.8-1	28.5	26.8	6.5	Fine	0.4	230º	20:49~21:04	Oct 9	766.0	189.92	1.23	32
08˚00'S	080˚29'E	11	8	0	3	9	2	0	0	1	St.8-2	28.5	26.8	6.2	Fine	0.5	221º	21:09~24	Oct 9	684.0	189.92	1.23	32
08˚00'S	080˚29'E	9	7	1	1	6	3	0	0	2	St.8-3	28.5	26.8	8.2	Fine	0.5	208º	21:29~44	Oct 9	582.0	189.92	1.23	32
07˚59'S	080˚29'E	3	2	0	1	3	0	0	0	0	St.9-1	28.3	27.3	12.7	Cloudy	1.0	179º	20:51~21:06	Oct10	708.0	192.10	2.08	32
08˚00'S	080˚29'E	14	8	2	4	14	0	0	0	1	St.9-2	28.3	27.3	12.0	Cloudy	0.5	206º	21:11~26	Oct 10	698.0	192.10	2.08	32
08˚01'S	080˚29'E	7	5	1	1	6	1	0	0	0	St.9-3	28.3	27.3	12.5	Cloudy	0.5	196 º	21:30~45	Oct 10	595.0	192.10	2.08	32

Table 1-B. Number of *Halobates* collected at locations in the tropical Indian Ocean in Sep. 27, 2011 (N:Total number of individuals collected; *H.m.: Halobates micans; H.g.: Halobates germanus; H.s.: Halobates sericeus*; Stat: Station number; WT: Water temperature (℃); AT: Air temp.; L: N of larvae; A: N of adults, E: N of exuviae; Date: sampling date; Sampling was performed for 45min. EG: eggs on some substrates like as polystyrene form thousands of eggs laid on the substrate. S: Surface area which was swept by Neuston NET was expressed as value of flow-meter x 1.3m of width of Neuston NET; WS: wind speed (m/s); W: weather; TD: Time of day; WS: Wind speed, CS: Current speed(m/s)CD: Current direction; F: female; M: male; DO: dissolved oxygen (μmol/kg); Chl: Chlorophyll-A conc.(relative fluorescent value); SL: salinity (‰)

Latitude	Longitude	N	L	A		*H.m.*	*H.g.*	*H.s.*	EG	E	Stat	WT	AT	WS	W	CS	CD	TD	Date	S(x1.3 m^2)	DO	Chl	SL
				F	M																		
07˚59'S	080˚29'E	23	17	5	1	23	0	0	0	2	St.10-1	28.2	27.7	11.6	Fine	0.8	231º	20:55~21:10	Oct 12	688.0	189.12	1.08	32
08˚00'S	080˚29'E	16	12	3	1	12	4	0	0	3	St.10-2	28.2	27.7	10.8	Fine	0.4	193º	21:15~30	Oct 12	622.0	189.12	1.08	32
08˚00'S	080˚29'E	32	20	6	6	32	0	0	0	0	St.10-3	28.2	27.7	11.4	Fine	0.4	191º	21:35~50	Oct 12	602.0	189.12	1.08	32
08˚00'S	080˚29'E	15	9	5	1	13	2	0	0	0	St.11-1	28.2	27.5	9.6	Fine	0.4	197º	20:53~21:08	Oct 13	612.0	189.03	0.695	32
08˚00'S	080˚29'E	10	7	1	2	10	0	0	0	0	St.11-2	28.2	27.5	9.5	Fine	0.5	219º	21:14-29	Oct 13	592.0	189.03	0.695	32
08˚00'S	080˚30'E	13	13	0	0	12	1	0	0	2	St.11-3	28.2	27.5	10.9	Fine	0.3	204º	21:34-49	Oct 13	554.0	189.03	0.695	32
07˚59'S	080˚29'E	19	15	1	3	19	0	0	0	0	St.12-1	28.4	27.9	9.1	Fine	0.8	184º	20:51~21:0 6	Oct 15	593.0	188.75	0.405	32

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08˚00'S	080˚29'E	13	10	1	2	13	0	0	0	0	St. 12-2	28.4	27.9	8.6	Fine	0.8	185º	21:10~25	Oct 15	658.0	188.75	0.405	32
08˚01'S	080˚30'E	14	12	2	0	14	0	0	0	2	St. 12-3	28.4	27.9	10.0	Fine	0.8	183º	21:30~45	Oct 15	698.0	188.75	0.405	32
07˚59'S	080˚29'E	12	10	1	1	12	0	0	0	0	St.13-1	28.4	27.9	13.0	Fine	0.3	214º	20:55~21:10	Oct 16	623.0	188.58	0.475	32
08˚00'S	080˚29'E	20	16	1	3	19	1	0	0	1	St.13-2	28.4	27.9	11.8	Fine	0.2	190º	21:15~30	Oct 16	625.0	188.58	0.475	32
08˚00'S	080˚30'E	23	19	1	3	21	2	0	0	0	St.13-3	28.4	27.9	11.5	Fine	0.4	193º	21:35~50	Oct 16	654.0	188.58	0.475	32
07º59'S	080º29'E	5	4	0	1	5	0	0	0	0	St.14-1	28.4	27.6	9.8	Fine	0.5	244º	20:54~21:09	Oct 18	641.0	187.86	0.575	32
07º59'S	080º29'E	22	16	4	2	22	0	0	0	1	St.14-2	28.4	27.6	9.6	Fine	0.5	224º	21:14~29	Oct 18	688.0	187.86	0.575	32
08º00'S	080º30'E	8	7	1	0	8	0	0	0	0	St.14-3	28.4	27.6	11.2	Fine	0.5	246º	21:33~48	Oct 18	645.0	187.86	0.575	32
07º59'S	080º30'E	11	10	1	0	11	0	0	0	0	St.15-1	28.3	27.7	5.9	Fine	0.2	213º	20:55~21:10	Oct 19	663.0	187.91	0.43	32
07º59'S	080º30'E	18	16	1	1	17	1	0	0	0	St.15-2	28.3	27.7	7.7	Fine	0.4	254º	21:15~30	Oct 19	678.0	187.91	0.43	32
08º00'S	080º30'E	22	18	3	1	22	0	0	0	0	St.15-3	28.3	27.7	5.8	Fine	0.3	249º	21:35~50	Oct 19	632.0	187.91	0.43	32
07˚59'S	080˚30' E	18	16	2	0	18	0	0	0	2	St.16-1	28.6	27.9	4.9	Fine	0.7	259 º	21:00-15	Oct 21	790.0	188.72	0.28	32
07˚59'S	080˚29' E	17	16	1	0	17	0	0	0	1	St.16-2	28.6	27.9	5.8	Fine	0.5	274º	21:20- 35	Oct 21	823.0	188.72	0.28	32
08˚00'S	080˚29' E	38	34	3	1	34	4	0	0	3	St.16-3	28.6	27.9	4.4	Fine	0.8	250º	21:40- 55	Oct 21	850.0	188.72	0.28	32
07˚59'S	080˚29'E	7	5	0	2	6	1	0	0	0	St.17-1	28.8	27.7	5.5	Fine	0.4	230º	20:53~21:08	Oct 22	834.0	186.22	0.22	32
08˚00'S	080˚29'E	13	11	2	0	12	1	0	0	1	St.17-2	28.8	27.7	3.9	Fine	0.6	233º	21:13~28	Oct 22	664.0	186.22	0.22	32
08˚00'S	080˚30'E	11	10	0	1	10	1	0	0	2	St.17-3	28.8	27.7	5.1	Fine	0.3	249º	21:33~48	Oct 22	631.0	186.22	0.22	32

Table 1-C. Number of *Halobates* collected at locations in the tropical Indian Ocean in Sep. 27, 2011 (N:Total number of individuals collected; *H.m.: Halobates micans; H.g.: Halobates germanus; H.s.: Halobates sericeus*; Stat: Station number; WT: Water temperature (℃); AT: Air temp.; L: N of larvae; A: N of adults, E: N of exuviae; Date: sampling date; Sampling was performed for 45min. EG: eggs on some substrates like as polystyrene form thousands of eggs laid on the substrate. S: Surface area which was swept by Neuston NET was expressed as value of flow-meter x 1.3m of width of Neuston NET; WS: wind speed (m/s); W: weather; TD: Time of day; WS: Wind speed, CS: Current speed(m/s)CD: Current direction; F: female; M: male; DO: dissolved oxygen (μmol/kg); Chl: Chlorophyll-A conc.(relative fluorescent value); SL: salinity (‰)

Latitude	Longitude	N	L	A		*H.m.*	*H.g.*	*H.s.*	EG	E	Stat	WT	AT	WS	W	CS	CD	TD	Date	S(x1.3 m^2)	DO	Chl	SL
				F	M																		

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08˚00'S 080˚29'E	5	4	1	0	5	0	0	0	1	St.18-1	28.4	27.9	5.6	Fine	0.6	109º	20:55~21:10	Oct 31	831.0	186.78	0.43	32
08˚00'S 080˚30'E	1	1	0	0	1	0	0	0	1	St.18-2	28.4	27.9	6.4	Fine	0.8	108º	21:15~30	Oct 31	762.0	186.78	0.43	32
08˚00'S 080˚31'E	3	1	1	1	3	0	0	0	0	St.18-3	28.4	27.9	5.4	Fine	0.6	109º	21:35~50	Oct 31	809.0	186.78	0.43	32
08˚01'S 080˚30'E	7	7	0	0	6	1	0	0	0	St.19-1	28.4	27.9	6.2	Fine	0.3	141º	20:52~21:07	Nov 1	766.0	186.98	0.45	32
08˚00'S 080˚30'E	9	7	2	0	9	0	0	0	1	St.19-2	28.4	27.9	8.1	Fine	0.5	145º	21:15-30	Nov 1	792.0	186.98	0.45	32
08˚01'S 080˚30'E	13	7	3	3	11	2	0	0	1	St.19-3	28.4	27.9	7.3	Fine	1.2	144º	21:35-50	Nov 1	802.0	186.98	0.45	32
08˚00'S 080˚30'E	19	15	1	3	19	0	0	0	2	St.20-1	28.5	27.5	7.7	F/R	0.3	101º	20:58~21:13	Nov 2	796.0	187.30	0.46	32
08˚00'S 080˚30'E	10	3	4	3	10	0	0	0	1	St. 20-2	28.5	27.5	8.0	F/R	0.4	114º	21:18~33	Nov 2	767.0	187.30	0.46	32
08˚00'S 080˚31'E	13	10	2	1	12	1	0	0	0	St. 20-3	28.5	27.5	11.0	F/R	0.9	120º	21:38~53	Nov 2	754.0	187.30	0.46	32
08˚00'S 080˚30'E	3	2	0	1	3	0	0	0	1	St.21-1	28.4	27.8	6.6	Fine	0.1	191º	20:57~21:12	Nov 3	758.0	187.83	0.41	31
08˚00'S 080˚30'E	6	2	3	1	6	0	0	0	0	St.21-2	28.4	27.8	6.4	Fine	0.4	202º	21:16~31	Nov 3	650.0	187.83	0.41	31
08˚00'S 080˚31'E	7	5	2	0	7	0	0	0	0	St.21-3	28.4	27.8	6.6	Fine	0.9	194º	21:36~51	Nov 3	585.0	187.83	0.41	31
08º00'S 080º30'E	5	5	0	0	5	0	0	0	2	St.22-1	28.4	27.7	4.2	Fine	0.3	179º	20:56~21:11	Nov 4	745.0	188.00	0.44	32
08º00'S 080º30'E	3	1	0	2	3	0	0	0	0	St.22-2	28.4	27.7	7.3	Fine	0.4	167º	21:16~31	Nov 4	788.0	188.00	0.44	32
08º00'S 080º31'E	4	4	0	0	3	1	0	0	0	St.22-3	28.4	27.7	9.2	Fine	0.3	161º	21:35~50	Nov 4	604.0	188.00	0.44	32
08º00'S 080º30'E	12	8	2	2	12	0	0	0	1	St.23-1	28.4	27.6	8.2	F/R	0.1	230º	20:53~21:08	Nov 5	741.0	188.10	0.38	32
07º59'S 080º30'E	6	3	1	2	6	0	0	0	0	St.23-2	28.4	27.6	7.4	F/R	0.3	197º	21:15~30	Nov 5	655.0	188.10	0.38	32
08º00'S 080º30'E	11	9	1	1	10	1	0	0	1	St.23-3	28.4	27.6	9.5	F/R	0.2	137º	21:35~50	Nov 5	754.0	188.10	0.38	32
08˚00'S 080˚29' E	9	8	0	1	9	0	0	0	0	St.24-1	28.4	27.6	5.7	Fine	0.7	259 º	20:54-21:09	Nov 6	779.0	188.00	0.33	32
08˚00'S 080˚30' E	8	7	1	0	8	0	0	0	0	St.24-2	28.4	27.6	7.5	Fine	0.5	274º	21:14- 29	Nov 6	774.0	188.00	0.33	32
08˚00'S 080˚31' E	6	3	2	1	6	0	0	0	0	St.24-3	28.4	27.6	7.9	Fine	0.8	250º	21:34- 49	Nov 6	784.0	188.00	0.33	32
08˚00'S 080˚30'E	7	4	1	2	7	0	0	0	0	St.25-1	28.4	27.9	9.6	Fine	0.4	265º	20:52~21:07	Nov 8	704.0	187.82	0.33	31
08˚00'S 080˚29'E	12	10	1	1	12	0	0	0	0	St.25-2	28.4	27.9	8.3	Fine	0.2	217º	21:11~26	Nov 8	904.0	187.82	0.33	31
08˚00'S 080˚30'E	6	2	3	1	6	0	0	0	0	St.25-3	28.4	27.9	9.8	Fine	0.4	211º	21:31~46	Nov 8	801.0	187.82	0.33	31

Table 1-D. Number of *Halobates* collected at locations in the tropical Indian Ocean in Sep. 27, 2011 (N:Total number of individuals collected; *H.m.: Halobates*

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micans; H.g.: Halobates germanus; H.s.: Halobates sericeus; Stat: Station number; WT: Water temperature (℃); AT: Air temp.; L: N of larvae; A: N of adults, E: N of exuviae; Date: sampling date; Sampling was performed for 45min. EG: eggs on some substrates like as polystyrene form thousands of eggs laid on the substrate. S: Surface area which was swept by Neuston NET was expressed as value of flow-meter x 1.3m of width of Neuston NET; WS: wind speed (m/s); W: weather; TD: Time of day; WS: Wind speed, CS: Current speed(m/s)CD: Current direction; F: female; M: male; DO: dissolved oxygen (μmol/kg); Chl: Chlorophyll-A conc.(relative fluorescent value); SL: salinity (‰)

Latitude	Longitude	N	L	A		*H.m.*	*H.g.*	*H.s.*	EG	E	Stat	WT	AT	WS	W	CS	CD	TD	Date	S(x1.3 m^2)	DO	Chl	SL
				F	M																		
08˚00'S	**080˚30'E**	**26**	**18**	**4**	**4**	**26**	**0**	**0**	**0**	**0**	**St.26-1**	**28.4**	**27.4**	**4.2**	**Fine**	**0.6**	**262º**	**20:53~21:08**	**Nov 9**	**864.0**	**188.2**	**0.27**	**32**
08˚00'S	**080˚30'E**	**29**	**24**	**2**	**3**	**29**	**0**	**0**	**0**	**1**	**St.26-2**	**28.4**	**27.4**	**4.7**	**Fine**	**0.6**	**288º**	**21:13~28**	**Nov 9**	**723.0**	**188.2**	**0.27**	**32**
08˚01'S	**080˚30'E**	**32**	**32**	**0**	**0**	**32**	**0**	**0**	**0**	**1**	**St.26-3**	**28.4**	**27.4**	**5.2**	**Fine**	**0.5**	**284º**	**21:32~47**	**Nov 9**	**663.0**	**188.2**	**0.42**	**32**
08˚00'S	**080˚30'E**	**9**	**7**	**2**	**0**	**8**	**1**	**0**	**0**	**1**	**St.27-1**	**28.2**	**27.7**	**6.8**	**Fine**	**0.3**	**269º**	**20:56~21:11**	**Nov 11**	**748.0**	**188.74**	**0.35**	**32**
08˚00'S	**080˚30'E**	**28**	**28**	**0**	**0**	**27**	**1**	**0**	**0**	**0**	**St.27-2**	**28.2**	**27.7**	**5.3**	**Fine**	**0.5**	**286º**	**21:15-30**	**Nov 11**	**782.0**	**188.74**	**0.35**	**32**
08˚00'S	**080˚31'E**	**43**	**38**	**4**	**1**	**40**	**3**	**0**	**0**	**1**	**St.27-3**	**28.2**	**27.7**	**5.9**	**Fine**	**1.2**	**295º**	**21:35-50**	**Nov 11**	**794.0**	**188.74**	**0.35**	**32**
08˚00'S	**080˚30'E**	**19**	**15**	**1**	**3**	**19**	**0**	**0**	**0**	**2**	**St.28-1**	**28.5**	**27.5**	**2.7**	**Fine**	**0.4**	**296º**	**20:53~21:08**	**Nov 12**	**804.0**	**189.28**	**0.28**	**32**
08˚00'S	**080˚29'E**	**10**	**3**	**4**	**3**	**10**	**0**	**0**	**0**	**1**	**St. 28-2**	**28.5**	**27.5**	**1.2**	**Fine**	**0.4**	**296º**	**21:13~28**	**Nov 12**	**664.0**	**189.28**	**0.28**	**32**
08˚01'S	**080˚29'E**	**13**	**10**	**2**	**1**	**12**	**1**	**0**	**0**	**0**	**St. 28-3**	**28.5**	**27.5**	**1.3**	**Fine**	**0.4**	**298º**	**21:33~48**	**Nov 12**	**591.0**	**189.28**	**0.28**	**32**
08˚00'S	**080˚30'E**	**6**	**4**	**2**	**0**	**6**	**0**	**0**	**0**	**1**	**St.29-1**	**28.1**	**27.5**	**7.5**	**Fine**	**0.7**	**266º**	**20:52~21:07**	**Nov 14**	**693.0**	**189.17**	**0.37**	**31**
08˚00'S	**080˚30'E**	**10**	**7**	**1**	**2**	**10**	**0**	**0**	**0**	**1**	**St.29-2**	**28.1**	**27.5**	**8.0**	**Fine**	**0.8**	**276º**	**21:12~27**	**Nov 14**	**615.0**	**189.17**	**0.37**	**31**
08˚00'S	**080˚30'E**	**12**	**9**	**2**	**1**	**11**	**1**	**0**	**0**	**2**	**St.29-3**	**28.1**	**27.5**	**7.9**	**Fine**	**0.7**	**264º**	**21:31~46**	**Nov 14**	**641.0**	**189.17**	**0.37**	**31**
08º00'S	**080º30'E**	**13**	**7**	**3**	**3**	**13**	**0**	**0**	**0**	**1**	**St.30-1**	**28.2**	**27.6**	**8.8**	**F/R**	**0.7**	**274º**	**20:53~21:08**	**Nov 15**	**921.0**	**189.24**	**0.29**	**31**
08º00'S	**080º30'E**	**19**	**12**	**4**	**3**	**19**	**0**	**0**	**0**	**0**	**St.30-2**	**28.2**	**27.6**	**9.4**	**F/R**	**0.5**	**267º**	**21:13~28**	**Nov 15**	**868.0**	**189.24**	**0.29**	**31**
08º00'S	**080º31'E**	**28**	**21**	**4**	**3**	**28**	**0**	**0**	**0**	**0**	**St.30-3**	**28.2**	**27.6**	**8.9**	**Fine**	**0.6**	**242º**	**21:32~47**	**Nov 15**	**905.0**	**189.24**	**0.29**	**31**
08º00'S	**080º30'E**	**10**	**7**	**0**	**3**	**10**	**0**	**0**	**0**	**0**	**St.31-1**	**28.3**	**27.5**	**6.5**	**Fine**	**0.6**	**262º**	**20:50~21:05**	**Nov 17**	**746.0**	**188.85**	**0.36**	**31**
08º00'S	**080º30'E**	**10**	**7**	**1**	**2**	**10**	**0**	**0**	**0**	**1**	**St.31-2**	**28.3**	**27.5**	**7.5**	**Fine**	**0.3**	**290º**	**21:10~25**	**Nov 17**	**582.0**	**188.85**	**0.36**	**31**
08º00'S	**080º31'E**	**10**	**4**	**2**	**4**	**10**	**0**	**0**	**0**	**0**	**St.31-3**	**28.4**	**27.5**	**7.9**	**Fine**	**0.5**	**299º**	**21:29~44**	**Nov 17**	**755.0**	**188.85**	**0.36**	**31**
08˚00'S	**080˚29' E**	**9**	**8**	**0**	**1**	**9**	**0**	**0**	**0**	**1**	**St.32-1**	**28.4**	**28.0**	**9.3**	**F/R**	**0.8**	**268 º**	**20:54-21:09**	**Nov 18**	**985.0**	**188.67**	**0.30**	**32**

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08˚00'S	080˚29' E	17	10	3	4	16	1	0	0	0	St.32-2	28.4	28.0	10.2	F/R	0.9	262º	21:14- 29	Nov 18	1030.0	188.67	0.30 32
08˚01'S	080˚29' E	9	3	3	3	9	0	0	0	0	St.32-3	28.4	28.0	9.3	F/R	0.9	269º	21:45-22:00	Nov 18	665.0	188.67	0.30 32
08˚00'S	080˚30'E	15	9	3	3	15	0	0	0	1	St.33-1	28.4	27.7	7.1	Fine	0.4	265º	20:54~21:09	Nov 20	720.0	188.71	0.27 32
08˚00'S	080˚30'E	24	12	5	7	23	1	0	0	0	St.33-2	28.4	27.7	6.9	Fine	0.5	262º	21:14~29	Nov 20	788.0	188.71	0.27 32
08˚01'S	080˚31'E	23	11	5	7	23	0	0	0	1	St.33-3	28.4	27.7	7.5	Fine	0.4	271º	21:33~48	Nov 20	833.0	188.71	0.27 32

Table 1-E. Number of *Halobates* collected at locations in the tropical Indian Ocean in Sep. 27, 2011 (N:Total number of individuals collected; *H.m.: Halobates micans; H.g.: Halobates germanus; H.s.: Halobates sericeus*; Stat: Station number; WT: Water temperature (℃); AT: Air temp.; L: N of larvae; A: N of adults, E: N of exuviae; Date: sampling date; Sampling was performed for 45min. EG: eggs on some substrates like as polystyrene form thousands of eggs laid on the substrate. S: Surface area which was swept by Neuston NET was expressed as value of flow-meter x 1.3m of width of Neuston NET; WS: wind speed (m/s); W: weather; TD: Time of day; WS: Wind speed, CS: Current speed(m/s)CD: Current direction; F: female; M: male; DO: dissolved oxygen (μmol/kg); Chl: Chlorophyll-A conc.(relative fluorescent value); SL: salinity (‰)

Latitude	Longitude	N	L	A		*H.m.*	*H.g.*	*H.s.*	EG	E	Stat	WT	AT	WS	W	CS	CD	TD	Date	S(x1.3 m^2)	DO	Chl	SL
				F	M																		
08˚00'S	080˚29'E	6	5	1	0	6	0	0	0	0	St.34-1	28.2	27.5	4.5	Fine	0.8	292º	20:52~21:07	Nov 21	864.0	189.4	0.33	31
08˚00'S	080˚30'E	3	3	0	0	3	0	0	0	0	St.34-2	28.2	27.5	5.4	Fine	0.7	301º	21:12~27	Nov 21	723.0	189.4	0.33	31
08˚00'S	080˚30'E	5	4	1	0	4	1	0	0	1	St.34-3	28.2	27.5	5.3	Fine	0.7	268º	21:31~46	Nov 21	584.0	189.4	0.33	31
08˚00'S	080˚30'E	10	7	2	1	0	0	0	0	0	St.35-1	28.4	27.5	5.8	Fine	0.6	254º	20:51~21:07	Nov 23	848.0	189.42	0.40	32
08˚00'S	080˚30'E	8	6	2	0	0	0	0	0	1	St.35-2	28.4	27.5	5.5	Fine	0.5	263º	21:10-25	Nov 23	688.0	189.42	0.40	32
08˚01'S	080˚30'E	5	4	1	0	5	0	0	0	0	St.35-3	28.4	27.5	6.0	Fine	0.6	256º	21:29-44	Nov 23	708.0	189.42	0.40	32
08˚00'S	080˚30'E	16	9	5	2	16	0	0	0	1	St.36-1	28.2	27.9	6.2	Fine	0.7	296º	20:52~21:07	Nov 24	763.0	189.28	0.48	32
08˚00'S	080˚29'E	13	5	3	5	13	0	0	0	0	St. 36-2	28.2	27.9	7.0	Fine	0.9	296º	21:11~26	Nov 24	583.0	189.28	0.48	32
08˚01'S	080˚29'E	14	4	6	4	14	0	0	0	0	St. 36-3	28.2	27.9	7.7	Fine	0.6	298º	21:31~46	Nov 24	562.0	189.28	0.48	32

Table 2: A comparison of population density of oceanic sea skaters, Halobates among three area of open Indian

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and Pacific Oceans. Samplings were performed the three cruises including this cruise. *H.m: Halobates micans; H.g.: H. germanus; H.s.: H. sericeus; H.p.: H. princeps;* sp.: *H.* sp.: Density: individual number/km^2

1. MR-10-03: Western Tropical Pacific Ocean, 5ºN, 139º30'E (Harada et al., 2010)

	Total		*H.m*	*H.g*	*H. s .*	*H. p or* sp	AS#
	Nymphs	Adults					
Number	3772	383	4059	66	1	28	0.105310
Density	35834.0	3638.5	38560.5	627.0	9.5	266.0	-

2.KH-07-04-Leg 1: Eastern Tropical Indian Ocean, 8ºN-6º35'S, 86ºE- 76º36'E) (Harada et al., 2010)

	Total		*H.m*	*H.g*	*H. s .*	*H. p or* sp	AS#
	Nymphs	Adults					
Number	1291	706	1886	111	0	0	0.044292
Density	29147.5	15939.7	42581.1	2506.1	0	0	-

3. MR-11-07-Leg 1 (this cruise, Stations 1-17): Eastern Tropical Indian Ocean, 01º55'S, 083º24E 8ºS, 80º30'E)

	Total		*H.m*	*H.g*	*H. s .*	*H. p or* sp	AS#
	Nymphs	Adults					
Number	551	255	697	109	0	0	0.0438607
Density	12562.5	5813.9	15891.2	2485.1	0	0	-

Table 3-A. Components of instars of larvae and adults of oceanic sea skaters, *Halobates micans* and *H. germanus* sampled at 01º55'S, 083º24E (St 1) and around 80º00'S, 080º30'E(St 2 to St 10) in the tropical Indian Ocean.

	Halobates micans							*H. germanus*						
						Adults							Adults	
	1st	2nd	3rd	4th	5th	F	M	1st	2nd	3rd	4th	5th	F	M
St1-1	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**3**
St1-2	**0**	**0**	**0**	**0**	**1**	**4**	**4**	**0**	**0**	**1**	**0**	**1**	**2**	**1**
St1-3	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**0**	**0**	**1**	**2**	**0**	**1**	**0**
St2-1	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**0**
St2-2	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St2-3	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**
St3-1	**0**	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**3**
St3-2	**0**	**1**	**2**	**1**	**1**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
St3-3	**0**	**0**	**2**	**2**	**3**	**8**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
St4-1	**0**	**2**	**4**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**1**
St4-2	**0**	**4**	**2**	**4**	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**4**	**0**	**1**
St4-3	**0**	**0**	**1**	**2**	**4**	**9**	**46**	**0**	**0**	**0**	**1**	**2**	**0**	**0**
St5-1	**2**	**1**	**1**	**1**	**5**	**6**	**3**	**1**	**0**	**0**	**0**	**0**	**1**	**0**
St5-2	**0**	**1**	**2**	**0**	**6**	**8**	**3**	**1**	**0**	**0**	**1**	**0**	**0**	**0**
St5-3	**7**	**11**	**20**	**6**	**6**	**10**	**4**	**2**	**5**	**3**	**4**	**4**	**0**	**2**
St6-1	**0**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**
St6-2	**1**	**1**	**1**	**2**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**2**	**1**	**0**
St6-3	**1**	**1**	**1**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St7-1	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**1**	**2**	**0**	**3**
St7-2	**0**	**0**	**1**	**0**	**2**	**0**	**1**	**2**	**0**	**0**	**0**	**1**	**1**	**1**
St7-3	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**1**	**0**
St8-1	**0**	**2**	**3**	**4**	**0**	**1**	**2**	**0**	**1**	**0**	**0**	**2**	**0**	**0**
St8-2	**2**	**1**	**1**	**2**	**0**	**0**	**3**	**0**	**1**	**0**	**0**	**1**	**0**	**0**

.

St8-3	**1**	**1**	**1**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**
St9-1	**0**	**0**	**0**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St9-2	**1**	**2**	**1**	**1**	**3**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St9-3	**0**	**0**	**0**	**0**	**4**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
St10-1	**2**	**3**	**6**	**2**	**4**	**5**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St10-2	**0**	**2**	**2**	**1**	**4**	**2**	**1**	**0**	**0**	**1**	**0**	**2**	**1**	**0**
St10-3	**2**	**3**	**0**	**9**	**6**	**6**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 3-B. Components of instars of larvae and adults of oceanic sea skaters, *Halobates micans* and *H. germanus* sampled at around 08º00'S,080º30'E in the tropical Indian Ocean.

	Halobates micans							*H. germanus*						
						Adults							Adults	
	1st	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**	**1st**	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**
St.11-1	**2**	**2**	**3**	**1**	**1**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**0**
St.11-2	**0**	**1**	**3**	**3**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.11-3	**1**	**4**	**3**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
St.12-1	**2**	**1**	**2**	**8**	**2**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.12-2	**0**	**1**	**3**	**3**	**3**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.12-3	**2**	**2**	**3**	**1**	**4**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.13-1	**0**	**1**	**0**	**2**	**7**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.13-2	**0**	**2**	**1**	**4**	**8**	**1**	**3**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
St.13-3	**0**	**3**	**3**	**5**	**6**	**1**	**3**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
St.14-1	**0**	**1**	**1**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.14-2	**0**	**4**	**4**	**6**	**2**	**4**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.14-3	**1**	**2**	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.15-1	**2**	**2**	**3**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

.

St.15-2	**2**	**9**	**4**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
St.15-3	**0**	**3**	**9**	**3**	**3**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.16-1	**0**	**5**	**3**	**4**	**4**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.16-2	**1**	**2**	**4**	**5**	**4**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.16-3	**4**	**10**	**10**	**6**	**2**	**2**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**1**
St.17-1	**0**	**1**	**0**	**1**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
St.17-2	**0**	**2**	**4**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
St.17-3	**1**	**2**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
St.18-1	**1**	**1**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.18-2	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.18-3	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.19-1	**0**	**1**	**1**	**3**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
St.19-2	**1**	**2**	**2**	**1**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.19-3	**0**	**1**	**3**	**1**	**0**	**3**	**3**	**0**	**1**	**1**	**0**	**0**	**0**	**0**
St.20-1	**0**	**0**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.20-2	**0**	**1**	**1**	**1**	**0**	**4**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.20-3	**1**	**3**	**4**	**1**	**0**	**2**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**

Table 3-C. Components of instars of larvae and adults of oceanic sea skaters, *Halobates micans* and *H. germanus* sampled at around 08º00'S,080º30'E in the tropical Indian Ocean.

	Halobates micans							*H. germanus*						
						Adults							Adults	
	1st	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**	**1st**	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**
St.21-1	**0**	**2**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.21-2	**1**	**0**	**0**	**1**	**0**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.21-3	**0**	**1**	**3**	**1**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

.

St.22-1	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.22-2	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.22-3	**0**	**1**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**
St.23-1	**0**	**5**	**2**	**1**	**0**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.23-2	**0**	**1**	**0**	**2**	**2**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.23-3	**1**	**2**	**3**	**0**	**2**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
St.24-1	**1**	**3**	**2**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.24-2	**1**	**0**	**3**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.24-3	**1**	**0**	**1**	**0**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.25-1	**0**	**0**	**0**	**4**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.25-2	**2**	**1**	**2**	**2**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.25-3	**0**	**0**	**1**	**1**	**0**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.26-1	**2**	**3**	**8**	**4**	**1**	**4**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.26-2	**1**	**4**	**9**	**7**	**3**	**2**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.26-3	**2**	**6**	**16**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.27-1	**0**	**2**	**5**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**
St.27-2	**0**	**1**	**15**	**10**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
St.27-3	**3**	**10**	**11**	**4**	**7**	**4**	**1**	**0**	**1**	**2**	**0**	**0**	**0**	**0**
St.28-1	**0**	**3**	**3**	**1**	**3**	**10**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.28-2	**0**	**2**	**8**	**7**	**5**	**5**	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
St.28-3	**0**	**3**	**3**	**2**	**1**	**3**	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
St.29-1	**1**	**3**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.29-2	**0**	**2**	**4**	**1**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.29-3	**0**	**2**	**3**	**2**	**1**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
St.30-1	**2**	**2**	**0**	**2**	**1**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.30-2	**0**	**1**	**4**	**6**	**1**	**4**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

.

St.30-3	2	2	6	7	4	4	3	0	0	0	0	0	0	0

Table 3-D. Components of instars of larvae and adults of oceanic sea skaters, *Halobates micans* and *H. germanus* sampled at around 08º00'S,080º30'E in the tropical Indian Ocean.

	Halobates micans							*H. germanus*						
						Adults							Adults	
	1st	2nd	3rd	4th	5th	F	M	1st	2nd	3rd	4th	5th	F	M
St.31-1	0	0	2	1	4	0	3	0	0	0	0	0	0	0
St.31-2	0	1	2	2	2	1	2	0	0	0	0	0	0	0
St.31-3	0	1	1	2	2	2	4	0	0	0	0	0	0	0
St.32-1	1	1	2	3	1	0	1	0	0	0	0	0	0	0
St.32-2	0	1	3	2	3	3	4	0	1	0	0	0	0	0
St.32-3	0	0	0	1	2	3	3	0	0	0	0	0	0	0
St.33-1	1	1	3	3	1	3	3	0	0	0	0	0	0	0
St.33-2	1	3	4	0	3	5	7	1	0	0	0	0	0	0
St.33-3	0	1	5	3	2	5	7	0	0	0	0	0	0	0
St.34-1	0	1	0	2	2	1	0	0	0	0	0	0	0	0
St.34-2	1	0	1	1	0	0	0	0	1	0	0	0	0	0
St.24-3	1	2	0	0	0	1	0	0	1	0	0	0	0	0
St.35-1	0	1	2	2	2	2	1	0	0	0	0	0	0	0
St.35-2	0	2	2	1	1	2	0	0	0	0	0	0	0	0
St.35-3	0	1	1	2	0	1	0	0	0	0	0	0	0	0
St.36-1	4	0	1	2	4	5	2	0	0	0	0	0	0	0
St.36-2	1	1	1	0	2	3	5	0	0	0	0	0	0	0
St.36-3	0	0	1	0	3	6	4	0	0	0	0	0	0	0

.

Table 4-Sheet 1. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis_(from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St. 1	01°56'S	083°24'E	1	28	-	30	2	-17.4	4.9	H.m.	Adult (male)	Sep 28	07:00~
St. 1	01°56'S	083°24'E	1	28	-	30	2	-15.0	4.0	H.m.	Adult(female)	Sep 28	07:00~
St. 1	01°56'S	083°24'E	1	28	-	30	2	-17.6	2.6	H.m.	Adult(female)	Sep 28	07:00~
St. 1	01°56'S	083°24'E	1	28	-	35	7	-16.4	8.2	H.m.	Adult (male)	Sep 28	07:00~
St. 1	01°56'S	083°24'E	1	28	-	36	8	-13.5	6.6	H.m.	Adult (male)	Sep 28	07:00~
St. 1	01°56'S	083°24'E	1	28	-	37	9	-9.4	4.6	H.m.	Adult (female)	Sep 28	07:00~
St. 1	01°56'S	083°24'E	1	28	-	38	10	-14.5	7.8	H.m.	5th instar	Sep 28	07:00~
St. 1	01°56'S	083°24'E	1	28	-	40	12	-11.7	7.2	H.m.	Adult (female)	Sep 28	07:00~
St. 1	01°56'S	083°24'E	1	28	-	40	12	-10.7	7.8	H.g.	Adult (female)	Sep 28	07:00~
St. 1	01°56'S	083°24'E	1	28	-	41	13	-15.1	5.6	H.g.	Adult (female)	Sep 28	07:00~
St.2	08°00'S	080°30'E	2	28	35	37	9	-9.7	4.4	H.m.	3rd instar	Oct 1	07:00~
St.2	08°00'S	080°30'E	2	28	36	38	10	-11.6	7.0	H.g.	Adult(female)	Oct 1	07:00~
St.2	08°00'S	080°30'E	2	28	35	39	11	-12.1	5.0	H.m.	4th instar	Oct 1	07:00~
St.2	08°00'S	080°30'E	2	28	35	41	13	-16.8	8.9	H.g.	5th instar	Oct 1	07:00~
St.3	08°00'S	080°29'E	3	28	29	31	3	-16.4	8.5	H.m.	5th instar	Oct 2	06:45~
St.3	08°00'S	080°29'E	3	28	34	36	8	-14.6	5.2	H.m.	Adult (male)	Oct 2	06:45~
St.3	08°00'S	080°29'E	3	28	32	37	9	-18.4	10.6	H.m.	Adult (female)	Oct 2	06:45~
St.3	08°00'S	080°29'E	3	28	36	37	9	-15.5	5.4	H.m.	Adult (male)	Oct 2	06:45~
St.3	08°00'S	080°29'E	3	28	33	37	9	-15.9	9.2	H.m.	Adult (female)	Oct 2	06:45~
St.3	08°00'S	080°29'E	3	28	36	38	10	-14.8	8.5	H.m.	Adult (female)	Oct 2	06:45~
St.3	08°00'S	080°29'E	3	28	36	39	11	-16.2	8.4	H.m.	Adult(male)	Oct 2	06:45~

.

St.3	**08º00’S**	**080º29’E**	**3**	**28**	**38**	**39**	**11**	**-15.4**	**7.2**	**H.m.**	**Adult(female)**	**Oct 2**	**06:45~**
St.3	**08º00’S**	**080º29’E**	**3**	**28**	**39**	**39**	**11**	**-15.1**	**8.7**	**H.m.**	**Adult(female)**	**Oct 2**	**06:45~**
St.3	**08º00’S**	**080º29’E**	**3**	**28**	**39**	**40**	**12**	**-15.5**	**9.0**	**H.m.**	**5th instar**	**Oct 2**	**06:45~**
St.3	**08º00’S**	**080º29’E**	**3**	**28**	**40**	**40**	**12**	**-11.5**	**4.5**	**H.m.**	**Adult(female)**	**Oct 2**	**06:45~**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**31**	**31**	**2**	**-19.6**	**4.8**	**H.m.**	**Adult(female)**	**Oct 4**	**07:00~**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**32**	**34**	**5**	**-16.7**	**8.0**	**H.m.**	**Adult(female)**	**Oct 4**	**07:00~**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**34**	**36**	**7**	**-13.2**	**4.4**	**H.m.**	**Adult(male)**	**Oct 4**	**07:00~**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**36**	**36**	**7**	**-15.6**	**4.7**	**H.m.**	**Adult(male)**	**Oct 4**	**07:00~**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**37**	**38**	**9**	**-13.5**	**5.8**	**H.m.**	**Adult(male)**	**Oct 4**	**07:00~**

Table 4-Sheet 2. Results of “heat-paralysis” experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis_(from base temp.); “Date and Time of day” when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	**Latitude**	**Longitude**	**Exp.No.**	**TA**	**TSHP**	**THP**	**GTHP**	**SCP**	**ITSCP**	**Species**	**Stage (sex)**	**Date**	**TD**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**37**	**38**	**9**	**-19.3**	**8.3**	**H.m.**	**Adult (male)**	**Oct 4**	**07:00~**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**38**	**38**	**9**	**-15.2**	**6.1**	**H.m.**	**Adult(male)**	**Oct 4**	**07:00~**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**38**	**38**	**9**	**-14.1**	**6.1**	**H.m.**	**Adult(male)**	**Oct 4**	**07:00~**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**38**	**38**	**9**	**-14.1**	**5.5**	**H.m.**	**Adult (female)**	**Oct 4**	**07:00~**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**38**	**39**	**10**	**-13.8**	**9.0**	**H.m.**	**Adult (female)**	**Oct 4**	**07:00~**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**-**	**-**	**-**	**-17.0**	**1.5**	**H.m.**	**Adult(male)**	**Oct 4**	**1000-1400**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**-**	**-**	**-**	**-15.0**	**6.3**	**H.m.**	**Adult (female)**	**Oct 4**	**1000-1400**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**-**	**-**	**-**	**-14.7**	**3.4**	**H.m.**	**Adult (male)**	**Oct 4**	**1000-1400**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**-**	**-**	**-**	**-14.9**	**6.4**	**H.m.**	**Adult(female)**	**Oct 4**	**1000-1400**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**-**	**-**	**-**	**-18.3**	**10.1**	**H.m.**	**Adult (male)**	**Oct 4**	**1000-1400**
St.4	**08º01’S**	**080º30’E**	**4**	**29**	**-**	**-**	**-**	**-20.2**	**9.2**	**H.m.**	**Adult (male)**	**Oct 4**	**1000-1400**

.

St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-19.1**	**7.6**	**H.m.**	**Adult (male)**	**Oct 4**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**- 20.8**	**6.8**	**H.m.**	**Adult(male)**	**Oct 4**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-18.8**	**3.9**	**H.m.**	**Adult (male)**	**Oct 4**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-16.5**	**6.0**	**H.m.**	**Adult (male)**	**Oct 4**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.5**	**6.6**	**H.m.**	**Adult(male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-19.9**	**8.9**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-16.6**	**7.5**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-20.8**	**10.7**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**- 20.1**	**5.9**	**H.m.**	**Adult(male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.6**	**5.2**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.3**	**7.0**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-15.9**	**8.3**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.6**	**8.9**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-18.9**	**9.6**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**- 15.4**	**7.8**	**H.m.**	**Adult(male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-18.1**	**6.5**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-18.0**	**9.2**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.7**	**7.9**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-21.0**	**8.1**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**

Table 4-Sheet 3. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	**Latitude**	**Longitude**	**Exp.No.**	**TA**	**TSHP**	**THP**	**GTHP**	**SCP**	**ITSCP**	**Species**	**Stage (sex)**	**Date**	**TD**

.

St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-22.2**	**7.7**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.7**	**7.2**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-18.6**	**7.5**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-21.8**	**7.9**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-16.2**	**7.6**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-21.2**	**9.1**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-19.5**	**3.5**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.6**	**8.3**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-20.8**	**5.3**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**32**	**33**	**5**	**-14.4**	**5.8**	**H.m.**	**5th instar**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**37**	**38**	**10**	**-18.6**	**8.3**	**H.m.**	**Adult (male)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**37**	**38**	**10**	**-16.5**	**6.6**	**H.m.**	**Adult (male)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**38**	**38**	**10**	**-15.6**	**7.6**	**H.m.**	**Adult (male)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**38**	**38**	**10**	**-18.8**	**8.1**	**H.m.**	**Adult (female)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**39**	**39**	**11**	**-16.5**	**9.2**	**H.m.**	**Adult (male)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**39**	**39**	**11**	**-9.6**	**4.2**	**H.m.**	**Adult(male)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**39**	**39**	**11**	**-12.0**	**9.1**	**H.m.**	**Adult(female)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**39**	**39**	**11**	**-13.7**	**7.0**	**H.m.**	**Adult (female)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-21.8**	**9.3**	**H.m.**	**Adult (male)**	**Oct 8**	**08:00-12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-15.6**	**4.3**	**H.m.**	**Adult (male)**	**Oct 8**	**08:00-12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-19.6**	**7.2**	**H.m.**	**Adult (female)**	**Oct 8**	**08:00~12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-21.0**	**10.6**	**H.m.**	**Adult (male)**	**Oct 8**	**08:00~12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-21.3**	**6.9**	**H.m.**	**Adult (female)**	**Oct 8**	**08:00~12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-19.6**	**4.3**	**H.m.**	**Adult (male)**	**Oct 8**	**08:00~12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-19.4**	**8.6**	**H.m.**	**Adult(female)**	**Oct 8**	**08:00~12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-16.5**	**6.4**	**H.m.**	**Adult(female)**	**Oct 8**	**08:00~12:00**

.

St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-17.0**	**7.0**	**H.m.**	**Adult (female)**	**Oct 8**	**08:00~12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-18.5**	**6.4**	**H.m.**	**Adult (female)**	**Oct 8**	**08:00~12:00**
St.6	**08˚00'N**	**080˚29' E**	**6**	**29**	**37**	**37**	**8**	**-16.1**	**9.9**	**H.m.**	**5th instar**	**Oct 7**	**06:45~**
St.6	**08º00'S**	**080º29'E**	**6**	**29**	**32**	**38**	**9**	**-15.6**	**9.6**	**H.m.**	**Adult (female)**	**Oct 7**	**06:45~**

Table 4-Sheet 4. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St.6	**08º00'S**	**080º29'E**	**6**	**29**	**33**	**38**	**9**	**-15.4**	**9.2**	**H.m.**	**Adult (male)**	**Oct 7**	**06:45~**
St.6	**08º00'S**	**080º29'E**	**6**	**29**	**32**	**38**	**9**	**-17.8**	**4.0**	**H.m.**	**4th instar**	**Oct 7**	**06:45~**
St.6	**08º00'S**	**080º29'E**	**6**	**29**	**33**	**39**	**10**	**-16.4**	**5.1**	**H.m.**	**4th instar**	**Oct 7**	**06:45~**
St.6	**08º00'S**	**080º29'E**	**6**	**29**	**32**	**39**	**10**	**-15.2**	**6.3**	**H.g.**	**Adult (female)**	**Oct 7**	**06:45~**
St.6	**08º00'S**	**080º29'E**	**6**	**29**	**33**	**39**	**10**	**-19.3**	**4.8**	**H.g.**	**Adult(male)**	**Oct 7**	**06:45~**
St.6	**08º00'S**	**080º29'E**	**6**	**29**	**40**	**41**	**12**	**-15.5**	**6.4**	**H.g.**	**Adult(female)**	**Oct 7**	**06:45~**
St.6	**08º00'S**	**080º29'E**	**6**	**29**	**32**	**>=38**	**>=9**	**-**	**-**	**H.g.**	**4th instar**	**Oct 7**	**06:45~**
St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**30**	**37**	**8**	**-16.0**	**9.5**	**H.m.**	**5th instar**	**Oct 8**	**06:45~**
St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**32**	**37**	**8**	**-15.9**	**6.4**	**H.m.**	**5th instar**	**Oct 8**	**06:45~**
St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**31**	**38**	**9**	**-15.8**	**9.5**	**H.g.**	**Adult (male)**	**Oct 8**	**06:45~**
St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**32**	**38**	**9**	**-16.3**	**6.3**	**H.m.**	**Adult (male)**	**Oct 8**	**06:45~**
St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**38**	**38**	**9**	**-14.4**	**11.7**	**H.m.**	**Adult (male)**	**Oct 8**	**06:45~**
St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**31**	**39**	**10**	**-18.5**	**7.3**	**H.g.**	**Adult (male)**	**Oct 8**	**06:45~**
St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**38**	**39**	**10**	**-19.4**	**6.9**	**H.g.**	**Adult(female)**	**Oct 8**	**06:45~**
St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**39**	**39**	**10**	**-18.5**	**5.0**	**H.g.**	**Adult(male)**	**Oct 8**	**06:45~**

.

St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**40**	**40**	**11**	**-11.8**	**5.0**	**H.g.**	**Adult(female)**	**Oct 8**	**06:45~**
St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**40**	**40**	**11**	**-12.5**	**0.5**	**H.g.**	**Adult (male)**	**Oct 8**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**32**	**36**	**7**	**-15.6**	**5.3**	**H.m.**	**Adult(male)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**32**	**36**	**7**	**-15.0**	**6.7**	**H.m.**	**Adult(male)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**37**	**37**	**8**	**-17.2**	**5.0**	**H.m.**	**Adult(male)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**37**	**37**	**8**	**-16.2**	**4.6**	**H.m.**	**Adult(male)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**38**	**38**	**9**	**-16.6**	**7.7**	**H.m.**	**Adult(male)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**38**	**38**	**9**	**-15.3**	**5.4**	**H.m.**	**5th instar**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**38**	**40**	**11**	**-15.0**	**5.3**	**H.m.**	**5th instar**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**38**	**40**	**11**	**-15.4**	**9.6**	**H.m.**	**5th instar**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**31**	**40**	**11**	**-17.0**	**3.1**	**H.g.**	**Adult(female)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**-**	**=>35**	**=>6**	**-**	**-**	**H.m.**	**4th instar**	**Oct 10**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**30**	**30**	**1**	**-16.1**	**8.4**	**H.m.**	**5th instar**	**Oct 11**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**32**	**36**	**7**	**-16.3**	**2.1**	**H.m.**	**Adult(male)**	**Oct 11**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**32**	**38**	**9**	**-16.3**	**6.2**	**H.m.**	**5th instar**	**Oct 11**	**06:45~**

Table 4-Sheet 5. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**37**	**39**	**10**	**-17.9**	**6.7**	**H.m.**	**Adult(male)**	**Oct 11**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**35**	**39**	**10**	**-16.3**	**7.6**	**H.m.**	**4th instar**	**Oct 11**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**37**	**39**	**10**	**-18.2**	**4.7**	**H.m.**	**Adult(male)**	**Oct 11**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**38**	**40**	**11**	**-18.8**	**1.8**	**H.m.**	**Adult(male**	**Oct 11**	**06:45~**

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St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**37**	**40**	**11**	**-15.2**	**8.3**	**H.m.**	**Adult(female)**	**Oct 11**	**06:45~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-19.1**	**9.0**	**H.m.**	**Adult(female)**	**Oct 13**	**06:50~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-17.6**	**10.2**	**H.m.**	**Adult(female)**	**Oct 13**	**07:15~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-16.8**	**8.8**	**H.m.**	**Adult(male)**	**Oct 13**	**07:45~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-15.3**	**7.5**	**H.m.**	**Adult(female)**	**Oct 13**	**08:05~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-17.0**	**8.4**	**H.m.**	**5th instar**	**Oct 13**	**08:25~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-14.8**	**7.2**	**H.m.**	**5th instar**	**Oct 13**	**08:40~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-17.1**	**7.0**	**H.m.**	**5th instar**	**Oct 13**	**08:55~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-15.3**	**4.9**	**H.m.**	**5th instar**	**Oct 13**	**09:10~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**33**	**38**	**9**	**-11.0**	**4.3**	**H.m.**	**Adult(male)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**37**	**39**	**10**	**-21.0**	**8.6**	**H.m.**	**Adult(female)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**38**	**39**	**10**	**-16.3**	**7.1**	**H.m.**	**Adult(female)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**38**	**39**	**10**	**-20.9**	**9.2**	**H.m.**	**Adult(male)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**38**	**39**	**10**	**-18.6**	**6.2**	**H.m.**	**Adult(male)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**38**	**39**	**10**	**-17.8**	**4.2**	**H.m.**	**Adult(male)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**39**	**40**	**11**	**-12.9**	**1.5**	**H.m.**	**Adult(male)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**39**	**40**	**11**	**-16.9**	**6.9**	**H.m.**	**Adult(female)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**40**	**40**	**11**	**-16.4**	**7.1**	**H.m.**	**Adult(female)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**40**	**40**	**11**	**-15.2**	**4.8**	**H.m.**	**Adult(female)**	**Oct 13**	**06:30~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**33**	**36**	**7**	**-19.0**	**10.7**	**H.m.**	**5th instar**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**32**	**37**	**8**	**-14.8**	**6.1**	**H.m.**	**Adult(female)**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**37**	**38**	**9**	**-21.1**	**10.4**	**H.m.**	**Adult(female)**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**40**	**40**	**11**	**-20.2**	**8.4**	**H.m.**	**5th instar**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**38**	**40**	**11**	**-17.9**	**7.8**	**H.m.**	**Adult(male)**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**38**	**40**	**11**	**-12.3**	**5.2**	**H.m.**	**Adult(male)**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**38**	**40**	**11**	**-16.6**	**9.2**	**H.m.**	**Adult(female)**	**Oct 14**	**06:35~**

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Table 4-Sheet 6. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St.11	08˚00'N	080˚29'E	11	29	39	40	11	-17.1	10.5	H.m.	Adult(female)	Oct 14	06:35~
St.11	08˚00'N	080˚29'E	11	29	33	41	12	-20.0	6.8	H.g.	5th instar	Oct 14	06:35~
St.11	08˚00'N	080˚29'E	11	29	30	41	12	-21.2	10.4	H.g.	Adult(female)	Oct 14	06:35~
St.13	08˚00'S	080˚29'E	13	29	-	-	-	-16.1	7.0	H.m.	5th instar	Oct 17	06:55~
St.13	08˚00'S	080˚29'E	13	29	-	-	-	-13.5	5.3	H.m.	5th instar	Oct 17	07:15~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-13.2	5.4	H.m.	5th instar	Oct 17	07:30~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-18.1	6.0	H.m.	5th instar	Oct 17	08:00~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-18.6	9.4	H.m.	5th instar	Oct 17	08:25~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-17.3	7.5	H.m.	5th instar	Oct 17	11:40~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-17.0	8.5	H.m.	5th instar	Oct 17	11:55~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-19.6	11.6	H.m.	5th instar	Oct 17	12:10~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-15.4	6.3	H.m.	5th instar	Oct 17	13:00~
St. 12	08˚00'S	080˚29'E	12	29	35	35	6	-15.4	6.6	H.m.	Adult (female)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	31	37	8	-14.5	8.4	H.m.	Adult(male)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	36	39	10	-16.5	7.3	H.m.	Adult(female)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	38	39	10	-18.7	6.0	H.m.	Adult (male)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	38	40	11	-15.6	7.4	H.m.	Adult (male)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	39	40	11	-21.4	9.1	H.m.	Adult (female)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	40	40	11	-16.5	7.0	H.m.	Adult (male)	Oct 16	06:45~

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St. 12	08˚00'S	080˚29'E	12	29	40	40	11	-15.9	6.1	H.m.	Adult (male)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	40	40	11	-17.8	8.3	H.m.	Adult (male)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	39	41	12	-17.9	5.7	H.m.	Adult (female)	Oct 16	06:45~
St. 13	08˚00'S	080˚29'E	13	29	37	39	10	-16.3	8.7	H.m.	Adult(male)	Oct 17	06:45~
St. 13	08˚00'S	080˚29'E	13	29	36	39	10	-15.7	6.8	H.m.	Adult (female)	Oct 17	06:45~
St. 13	08˚00'S	080˚29'E	13	29	38	39	10	-17.5	9.4	H.m.	Adult (male)	Oct 17	06:45~
St. 13	08˚00'S	080˚29'E	13	29	39	40	11	-16.6	7.5	H.m.	Adult (male)	Oct 17	06:45~
St. 13	08˚00'S	080˚29'E	13	29	38	40	11	-9.1	3.6	H.m.	Adult (female)	Oct 17	06:45~
St. 13	08˚00'S	080˚29'E	13	29	39	40	11	-15.8	5.9	H.m.	Adult (female)	Oct 17	06:45~
St. 13	08˚00'S	080˚29'E	13	29	39	40	11	-16.3	4.8	H.m.	Adult (female)	Oct 17	06:45~
St. 13	08˚00'S	080˚29'E	13	29	39	41	12	-15.4	4.9	H.m.	Adult (male)	Oct 17	06:45~

Table 4-Sheet 7. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St. 13	08˚00'S	080˚29'E	13	29	40	41	12	-17.3	7.9	H.m.	Adult (female)	Oct 17	06:45~
St. 13	08˚00'S	080˚29'E	13	29	39	41	12	-16.0	4.8	H.m.	Adult(male)	Oct 17	06:45~
St. 14	07º59'S	080º29'E	14	29	39	39	10	-20.4	8.6	H.m.	Adult (male)	Oct 19	06:30~
St. 14	07º59'S	080º29'E	14	29	38	39	10	-18.4	6.5	H.m.	Adult(female)	Oct 19	06:30~
St. 14	07º59'S	080º29'E	14	29	39	39	10	-18.8	6.1	H.m.	Adult(male)	Oct 19	06:30~
St. 14	07º59'S	080º29'E	14	29	39	40	11	-20.3	10.3	H.m.	Adult (female)	Oct 19	06:30~
St. 14	07º59'S	080º29'E	14	29	39	40	11	-20.8	10.3	H.m.	Adult (male)	Oct 19	06:30~
St. 14	07º59'S	080º29'E	14	29	41	41	12	-18.1	9.0	H.m.	Adult (female)	Oct 19	06:30~

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St. 14	**07°59'S 080°29'E**	**14**	**29**	**41**	**41**	**12**	**-18.6**	**8.8**	**H.m.**	**Adult (female)**	**Oct 19**	**06:30~**
St. 15	**07°59'S 080°30'E**	**15**	**29**	**31**	**40**	**11**	**-18.1**	**9.9**	**H.m.**	**5th instar**	**Oct 20**	**06:45~**
St. 15	**07°59'S 080°30'E**	**15**	**29**	**37**	**40**	**11**	**-19.4**	**5.1**	**H.m.**	**5th instar**	**Oct 20**	**06:45~**
St. 15	**07°59'S 080°30'E**	**15**	**29**	**35**	**40**	**11**	**-**	**-**	**H.m.**	**Adult (male)**	**Oct 20**	**06:45~**
St. 15	**07°59'S 080°30'E**	**15**	**29**	**40**	**40**	**11**	**-15.8**	**2.2**	**H.m.**	**5th instar**	**Oct 20**	**06:45~**
St. 15	**07°59'S 080°30'E**	**15**	**29**	**35**	**40**	**11**	**-12.3**	**7.6**	**H.m.**	**Adult(female)**	**Oct 20**	**06:45~**
St. 15	**07°59'S 080°30'E**	**15**	**29**	**37**	**40**	**11**	**-17.6**	**0.8**	**H.m.**	**Adult(female)**	**Oct 20**	**06:45~**
St. 15	**07°59'S 080°30'E**	**15**	**29**	**39**	**40**	**11**	**-12.6**	**5.2**	**H.m.**	**Adult (female)**	**Oct 20**	**06:45~**
St. 15	**07°59'S 080°30'E**	**15**	**29**	**39**	**41**	**12**	**-15.6**	**4.3**	**H.m.**	**Adult(female)**	**Oct 20**	**06:45~**
St. 15	**07°59'S 080°30'E**	**15**	**29**	**36**	**41**	**12**	**-16.1**	**4.0**	**H.g.**	**Adult(male)**	**Oct 20**	**06:45~**
St. 16	**07˚59'S 080˚29' E**	**16**	**29**	**32**	**38**	**9**	**-14.2**	**7.8**	**H.m.**	**Adult(female)**	**Oct 22**	**06:45~**
St. 16	**07˚59'S 080˚29' E**	**16**	**29**	**36**	**39**	**10**	**-18.1**	**9.0**	**H.m.**	**5th instar**	**Oct 22**	**06:45~**
St. 16	**07˚59'S 080˚29' E**	**16**	**29**	**37**	**39**	**10**	**-13.8**	**6.6**	**H.m.**	**5th instar**	**Oct 22**	**06:45~**
St. 16	**07˚59'S 080˚29' E**	**16**	**29**	**39**	**40**	**11**	**-19.2**	**9.1**	**H.m.**	**5th instar**	**Oct 22**	**06:45~**
St. 16	**07˚59'S 080˚29' E**	**16**	**29**	**37**	**40**	**11**	**-20.0**	**10.7**	**H.m.**	**Adult(female)**	**Oct 22**	**06:45~**
St. 16	**07˚59'S 080˚29' E**	**16**	**29**	**39**	**40**	**11**	**-**	**-**	**H.m.**	**5th instar**	**Oct 22**	**06:45~**
St. 16	**07˚59'S 080˚29' E**	**16**	**29**	**39**	**40**	**11**	**-19.1**	**8.2**	**H.m.**	**5th instar**	**Oct 22**	**06:45~**
St. 16	**07˚59'S 080˚29' E**	**16**	**29**	**39**	**41**	**12**	**-16.3**	**6.1**	**H.m.**	**Adult(female)**	**Oct 22**	**06:45~**
St. 16	**07˚59'S 080˚29' E**	**16**	**29**	**40**	**41**	**12**	**-18.6**	**7.3**	**H.m.**	**5th instar**	**Oct 22**	**06:45~**
St. 16	**07˚59'S 080˚29' E**	**16**	**29**	**41**	**41**	**12**	**-8.1**	**0.6**	**H.m.**	**Adult(female)**	**Oct 22**	**06:45~**
St. 17	**08˚00'S 080˚29'E**	**17**	**29**	**30**	**40**	**11**	**-11.0**	**5.0**	**H.g.**	**Adult(female)**	**Oct 23**	**06:45~**
St. 17	**08˚00'S 080˚29'E**	**17**	**29**	**37**	**40**	**11**	**-17.6**	**5.2**	**H.m.**	**5th instar**	**Oct 23**	**06:45~**

Table 4-Sheet 8. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from

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base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St. 17	**08˚00'S**	**080˚29'E**	**17**	**29**	**38**	**40**	**11**	**-14.1**	**6.8**	**H.m.**	**Adult (female)**	**Oct 23**	**06:45~**
St. 17	**08˚00'S**	**080˚29'E**	**17**	**29**	**40**	**40**	**11**	**-14.9**	**9.3**	**H.m.**	**5th instar**	**Oct 23**	**06:45~**
St. 17	**08˚00'S**	**080˚29'E**	**17**	**29**	**41**	**41**	**12**	**-8.6**	**5.3**	**H.m.**	**5th instar**	**Oct 23**	**06:45~**
St. 17	**08˚00'S**	**080˚29'E**	**17**	**29**	**41**	**41**	**12**	**-11.0**	**0.5**	**H.m.**	**5th instar**	**Oct 23**	**06:45~**
St. 17	**08˚00'S**	**080˚29'E**	**17**	**29**	**41**	**41**	**12**	**-11.6**	**4.1**	**H.g.**	**Adult (female)**	**Oct 23**	**06:45~**

Table 5-A. Comparison of Temperature for Heat Semi-Coma Temperature (HSCT), Heat Coma Temperature (HCT), Gap Temperature for Heat Coma (GTHC), Super-Cooling Temperature (SCP) and Increased Temperature at Super Cooling Point (ITSCP) between *Halobates micans* and *H. germanus*. Experiments were performed in the period of 28 Sep to 23rd Oct, 2011 in the wet-laboratory 2 of R/V Mirai during the cruise of MR-11-07 [Mean±SD(n)]

.	HSCT	HCT	GTHC	SCP	ITSCP
H .micans	36.8±2.9(125)	38.4±2.4(133)	9.7±2.2(133)	-16.0±2.7(131)	6.8±2.3(131)
H. germanus	34.9±3.9(18)	39.8±1.1(20)	11.0±1.2(20)	-15.7±3.3(19)	6.0±2.3(19)
Total	36.6±3.1(143)	38.6±2.3(153)	9.8±2.2(153)	-16.0±2.8(150)	6.7±2.3(150)
Mann-Whitney U-test between H. micans and H. germanus					
Z	*-1.889*	*-2.848*	*-2.718*	*-0.339*	*-1.382*
P	*0.059*	*0.004*	*0.007*	*0.735*	*0.167*

Table 5-B. Comparison of Temperature for Heat Semi-Coma Temperature (HSCT), Heat Coma Temperature (HCT), Gap Temperature for Heat Coma (GTHC), Super-Cooling Temperature (SCP) and Increased Temperature at Super Cooling Point (ITSCP) between females and males in mostly *Halobates micans* and partically *H.germanus*. Experiments were performed in the period of 28 Sep to 23rd Oct, 2011 in the wet-laboratory 2 of R/V Mirai during the cruise of MR-11-07 [Mean±SD(n)]

Adult stage	HSCT	HCT	GTHC	SCP	ITSCP

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Females	37.0±3.1(55)	38.9±2.4(61)	10.2±2.3(61)	-15.6±3.1(61)	6.8±2.3(61)
Males	36.7±2.6(54)	38.4±1.8(57)	9.6±1.7(57)	-16.3±2.3(56)	6.3±2.3(56)
Total	36.9±2.9(109)	38.6±2.2(118)	9.9±2.1(118)	-15.9±2.8(117)	6.6±2.3(117)
Mann-Whitney U-test between females and males					
Z	*-1.178*	*-2.870*	*-3.149*	*-1.332*	*-1.356*
P	*0.239*	*0.004*	*0.002*	*0.183*	*0.175*

Table 5-C. Comparison of Temperature for Heat Semi-Coma Temperature (HSCT), Heat Coma Temperature (HCT), Gap Temperature for Heat Coma (GTHC), Super-Cooling Temperature (SCP) and Increased Temperature at Super Cooling Point (ITSCP) among 3rd to 5th larval instars and adult stages in mostly *Halobates micans* and partically *H.germanus*. Experiments were performed in the period of 28 Sep to 23rd Oct, 2011 in the wet-laboratory 2 of R/V Mirai during the cruise of MR-11-07 [Mean±SD(n)]

	HSCT	**HCT**	**GTHC**	**SCP**	**ITSCP**	
Adults	36.9±2.9(109)	38.6±2.2(118)	9.9±2.1(118)	-15.9±2.8(117)	6.6±2.3(117)	
5th instars	36.2±3.7(28)	38.6±2.9(29)	9.7±2.8(29)	-16.3±2.6(28)	7.3±2.4(28)	
4th instars	33.4±1.5(5)	38.6±0.5(5)	9.8±0.8(5)	-15.7±2.5(4)	5.4±1.5(4)	
3rd instar	35(1)	37(1)	9.0	-9.7(1)	4.4(1)	
Total	36.6±3.1(143)	38.6±2.3(153)	9.8±2.2(153)	-16.0±2.8(150)	6.7±2.3(150)	
Kruskal-Wallis-test among stages						
X^2 value	*5.966*	*1.528*	*1.015*	*0.453*	*5.539*	
df	*2*	*2*	*2*	*2*	*2*	
P	*0.051*	*0.466*	*0.602*	*0.797*	*0.063*	***One-Way ANOVA***
F	*2.407*	*0.175*	*0.085*	*1.950*	*1.490*	
df	*3*	*3*	*3*	*3*	*3*	
P	*0.070*	*0.913*	*0.968*	*0.124*	*0.220*	

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Table 6. Effect of the application of Heat Coma Experiment (HC exp.) before measuring Super-Cooling Point (SCP) and Increased Temperature at SCP (ITSCP) on these two values. Data on the specimens collected at around 08º00'S, 080º30'E (Stations 2-17) were analyzed. Experiments were performed in the period of 1st Oct to 23rd Oct, 2011 in the wet-laboratory 2 of R/V Mirai during the cruise of MR-11-07 [Mean±SD(n)]

	Stage			
	5th Instar		Adult	
	SCP	**ITSCP**	**SCP**	**ITSCP**
After HC exp.	-16.4±2.6(27)	7.3±2.4(27)	-16.1±2.7(108)	6.7±2.3(108)
Without HC exp.	-16.4±1.9(13)	7.3±1.9(13)	-18.4±2.0(48)	7.3±2.0(48)
Mann-Whitney U-test				
Z	*-0.231*	*-0.448*	*-4.897*	*-1.740*
P	*0.817*	*0.669*	*<0.001*	*0.082*

Table 7-Sheet 1. Results of salinity experiment (Experiment 1) performed on larvae and adults of *Halobates micans* (H. m.) HS: hours in survival under starvation on one of 5 brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰) ; "Date" when experiments started. (MR-11-07-Leg2: Oct 28-Dec 2, 2011) Water temperature: 28.6Cº; Air Temperature: 29.5Cº

St.No.	Latitude(N)	Longitude(E)	Exp.No.	HS	Species	Stage (sex)	Date	Salinity conc..
St.18-24	08˚00'S	080˚30'E	1	12	H. m.	5th instar	Nov 8	A
St.18-24	08˚00'S	080˚30'E	1	15	H. m.	Adult (male)	Nov 8	A
St.18-24	08˚00'S	080˚30'E	1	51	H. m.	Adult (male)	Nov 8	A
St.18-24	08˚00'S	080˚30'E	1	63	H. m.	Adult (female)	Nov 8	A
St.18-24	08˚00'S	080˚30'E	1	109	H. m.	Adult (female)	Nov 8	A
St.18-24	08˚00'S	080˚30'E	1	2	H. m.	5th instar	Nov 8	B
St.18-24	08˚00'S	080˚30'E	1	17	H. m.	Adult (female)	Nov 8	B
St.18-24	08˚00'S	080˚30'E	1	25	H. m.	Adult (female)	Nov 8	B
St.18-24	08˚00'S	080˚30'E	1	29	H. m.	Adult (male)	Nov 8	B

St.18-24	08˚00'S	080˚30'E	1	32	H. m.	Adult (male)	Nov 8	B
St.18-24	08˚00'S	080˚30'E	1	13	H. m.	Adult (male)	Nov 8	C
St.18-24	08˚00'S	080˚30'E	1	19	H. m.	Adult (female)	Nov 8	C
St.18-24	08˚00'S	080˚30'E	1	23	H. m.	Adult (female)	Nov 8	C
St.18-24	08˚00'S	080˚30'E	1	25	H. m.	Adult (male)	Nov 8	C
St.18-24	08˚00'S	080˚30'E	1	29	H. m.	Adult (female)	Nov 8	C
St.18-24	08˚00'S	080˚30'E	1	6	H. m.	Adult (male)	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	7	H. m.	Adult (male)	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	8	H. m.	Adult (female)	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	9	H. m.	Adult (female)	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	9	H. m.	5^{th} instar	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	25	H. m.	Adult (female)	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	4	H. m.	Adult (female)	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	4	H. m.	Adult (female)	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	7	H. m.	Adult (female)	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	7	H. m.	Adult (male)	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	8	H. m.	Adult (male)	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	12	H. m.	5^{th} instar	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	3	H. m.	Adult (female)	Nov 8	F
St.18-24	08˚00'S	080˚30'E	1	3	H. m.	Adult (female)	Nov 8	F
St.18-24	08˚00'S	080˚30'E	1	4	H. m.	Adult (female)	Nov 8	F
St.18-24	08˚00'S	080˚30'E	1	4	H. m.	Adult (male)	Nov 8	F
St.18-24	08˚00'S	080˚30'E	1	5	H. m.	Adult (female)	Nov 8	F
St.18-24	08˚00'S	080˚30'E	1	5	H. m.	Adult (male)	Nov 8	F

Table 7-Sheet 2. Results of salinity experiment (Experiment 2) performed on larvae and adults of

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Halobates micans (H. m.) HS: hours in survival under starvation on one of 5 brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰) ; "Date" when experiments started. (MR-11-07-Leg2: Oct 28-Dec 2, 2011) Water temperature: 28.8C°; Air Temperature: 29.6C°

St.No.	Latitude(N)	Longitude(E)	Exp.No.	HS	Species	Stage (sex)	Date	Salinity conc..
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	5th instar	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	15	H. m.	Adult (female)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	21	H. m.	Adult (male)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	30	H. m.	Adult (female)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	37	H. m.	Adult (female)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	45	H. m.	Adult (male)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	>48	H. m.	Adult (female)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	>48	H. m.	Adult (male)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	15	H. m.	Adult (female)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	25	H. m.	Adult (male)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	29	H. m.	5th instar	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	37	H. m.	Adult (female)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	39	H. m.	Adult (female)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	41	H. m.	Adult (female)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	46	H. m.	Adult (female)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	>48	H. m.	Adult (male)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	5	H. m.	5th instar	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	Adult (female)	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	Adult (male)	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	12	H. m.	Adult (female)	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	16	H. m.	Adult (female)	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	19	H. m.	Adult (female)	Nov 13	C

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St.25-28	08˚00'S	080˚30'E	2	27	H. m.	Adult (male)	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	3	H. m.	Adult (female)	Nov 13	D
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	5th instar	Nov 13	D
St.25-28	08˚00'S	080˚30'E	2	7	H. m.	Adult (female)	Nov 13	D
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	Adult (male)	Nov 13	D
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	Adult (female)	Nov 13	D
St.18-24	08˚00'S	080˚30'E	2	8	H. m.	Adult (female)	Nov 13	D
St.18-24	08˚00'S	080˚30'E	2	9	H. m.	Adult (male)	Nov 13	D
St.18-24	08˚00'S	080˚30'E	2	2	H. m.	Adult (female)	Nov 13	E

Table 7-Sheet 3. Results of salinity experiment (Experiment 2) performed on larvae and adults of *Halobates micans* (H. m.) HS: hours in survival under starvation on one of 5 brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰) ; "Date" when experiments started. (MR-11-07-Leg2: Oct 28-Dec 2, 2011) Water temperature: 28.8C°; Air Temperature: 29.6C°

St.No.	Latitude(N)	Longitude(E)	Exp.No.	HS	Species	Stage (sex)	Date	Salinity conc..
St.25-28	08˚00'S	080˚30'E	2	3	H. m.	Adult (female)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	5	H. m.	Adult (male)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	5	H. m.	Adult (male)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	Adult (female)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	7	H. m.	Adult (male)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	Adult (female)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	5th instar	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	2	H. m.	5th instar	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	3	H. m.	Adult (female)	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	3	H. m.	5th instar	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	4	H. m.	Adult (female)	Nov 13	F

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St.25-28	08˚00'S	080˚30'E	2	5	H. m.	Adult (male)	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	Adult (male)	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	Adult (male)	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	Adult (female)	Nov 13	F

Table 7-Sheet 4. Results of salinity experiment (Experiment 2) performed on larvae and adults of *Halobates micans* (H. m.) HS: hours in survival under starvation on one of 5 brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, A': 9‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰) ; "Date" when experiments started. (MR-11-07-Leg2: Oct 28-Dec 2, 2011) Water temperature: 28.6Cº; Air Temperature: 29.6Cº

St.No.	Latitude(N)	Longitude(E)	Exp.No.	HS	Species	Stage (sex)	Date	Salinity conc..
St.29-34	08˚00'S	080˚30'E	3	29	H. m.	Adult (male)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	42	H. m.	Adult (male)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	44	H. m.	Adult (male)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	62	H. m.	Adult (male)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	64	H. m.	Adult (female)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	89	H. m.	Adult (female)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	2	H. m.	Adult (female)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	17	H. m.	Adult (female)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	25	H. m.	Adult (male)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	31	H. m.	Adult (male)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	38	H. m.	Adult (female)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	62	H. m.	Adult (male)	Nov 22	A'
St.18-24	08˚00'S	080˚30'E	3	72	H. m.	Adult (female)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	20	H. m.	Adult (male)	Nov 22	B
St.29-34	08˚00'S	080˚30'E	3	29	H. m.	Adult (female)	Nov 22	B
St.29-34	08˚00'S	080˚30'E	3	36	H. m.	Adult (female)	Nov 22	B

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St.29-34	08˚00'S	080˚30'E	3	37	H. m.	Adult (female)	Nov 22	B
St.29-34	08˚00'S	080˚30'E	3	50	H. m.	Adult (female)	Nov 22	B
St.29-34	08˚00'S	080˚30'E	3	12	H. m.	Adult (female)	Nov 22	C
St.29-34	08˚00'S	080˚30'E	3	14	H. m.	Adult (female)	Nov 22	C
St.29-34	08˚00'S	080˚30'E	3	16	H. m.	Adult (female)	Nov 22	C
St.29-34	08˚00'S	080˚30'E	3	25	H. m.	Adult (male)	Nov 22	C
St.29-34	08˚00'S	080˚30'E	3	26	H. m.	Adult (male)	Nov 22	C
St.29-34	08˚00'S	080˚30'E	3	28	H. m.	Adult (male)	Nov 22	C
St.29-34	08˚00'S	080˚30'E	3	2	H. m.	Adult (female)	Nov 22	D
St.18-24	08˚00'S	080˚30'E	2	2	H. m.	Adult (female)	Nov 22	D
St.18-24	08˚00'S	080˚30'E	2	3	H. m.	Adult (male)	Nov 13	D
St.18-24	08˚00'S	080˚30'E	2	4	H. m.	Adult (female)	Nov 13	D
St.18-24	08˚00'S	080˚30'E	2	4	H. m.	Adult (male)	Nov 13	D
St.18-24	08˚00'S	080˚30'E	2	8	H. m.	Adult (male)	Nov 13	D

Table 7-Sheet 5. Results of salinity experiment (Experiment 2) performed on larvae and adults of *Halobates micans* (H. m.) HS: hours in survival under starvation on one of 5 brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, A': 9‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰) ; "Date" when experiments started. (MR-11-07-Leg2: Oct 28-Dec 2, 2011) Water temperature: 28.6C°; Air Temperature: 29.6C°

St.No.	Latitude(N)	Longitude(E)	Exp.No.	HS	Species	Stage (sex)	Date	Salinity conc..
St.29-34	08˚00'S	080˚30'E	3	2	H. m.	Adult (female)	Nov 22	E
St.29-34	08˚00'S	080˚30'E	3	2	H. m.	Adult (female)	Nov 22	E
St.29-34	08˚00'S	080˚30'E	3	3	H. m.	5th instar	Nov 22	E
St.29-34	08˚00'S	080˚30'E	3	4	H. m.	Adult (male)	Nov 22	E
St.29-34	08˚00'S	080˚30'E	3	4	H. m.	Adult (male)	Nov 22	E
St.29-34	08˚00'S	080˚30'E	3	5	H. m.	Adult (male)	Nov 22	E

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St.29-34	08˚00'S	080˚30'E	3	5	H. m.	Adult (female)	Nov 22	E
St.29-34	08˚00'S	080˚30'E	3	2	H. m.	Adult (female)	Nov 22	F
St.29-34	08˚00'S	080˚30'E	3	2	H. m.	Adult (male)	Nov 22	F
St.29-34	08˚00'S	080˚30'E	3	3	H. m.	Adult (female)	Nov 22	F
St.29-34	08˚00'S	080˚30'E	3	4	H. m.	Adult (female)	Nov 22	F
St.29-34	08˚00'S	080˚30'E	3	5	H. m.	Adult (male)	Nov 22	F
St.18-24	08˚00'S	080˚30'E	3	5	H. m.	5th instar	Nov 22	F
St.29-34	08˚00'S	080˚30'E	3	6	H. m.	Adult (male)	Nov 22	F

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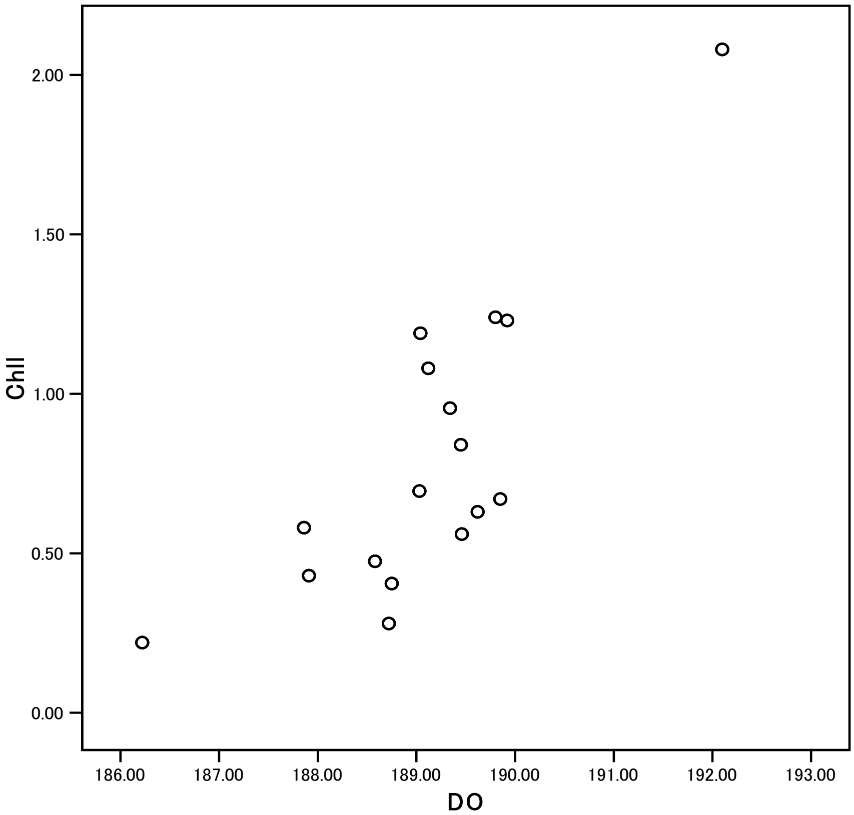

Fig.1 : Positive correlation between dissolved oxygen (μmol/kg) and chlorophyll (relative fluorescent value) contents in surface sea water. Very clear positive correlation can be seen (Pearson's correlation test: $r=0.803$, $p<0.001$, $n=51$). Such positive correlation means very low contents ratio of animals in comparison with plants.

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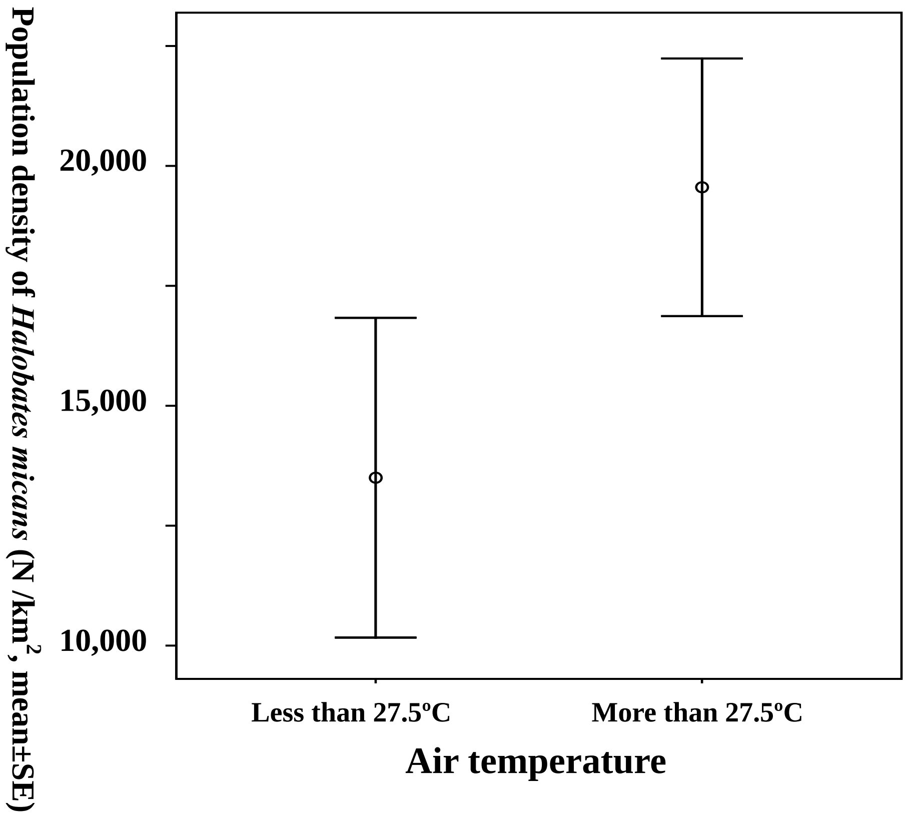

Fig.2: Comparison of population density (number of individuals in all larval and adult stages / km^2) of *Halobates micans* when air temperature was more than 27.5 ºC at sampling site to the population density when it was less than 27.5ºC.

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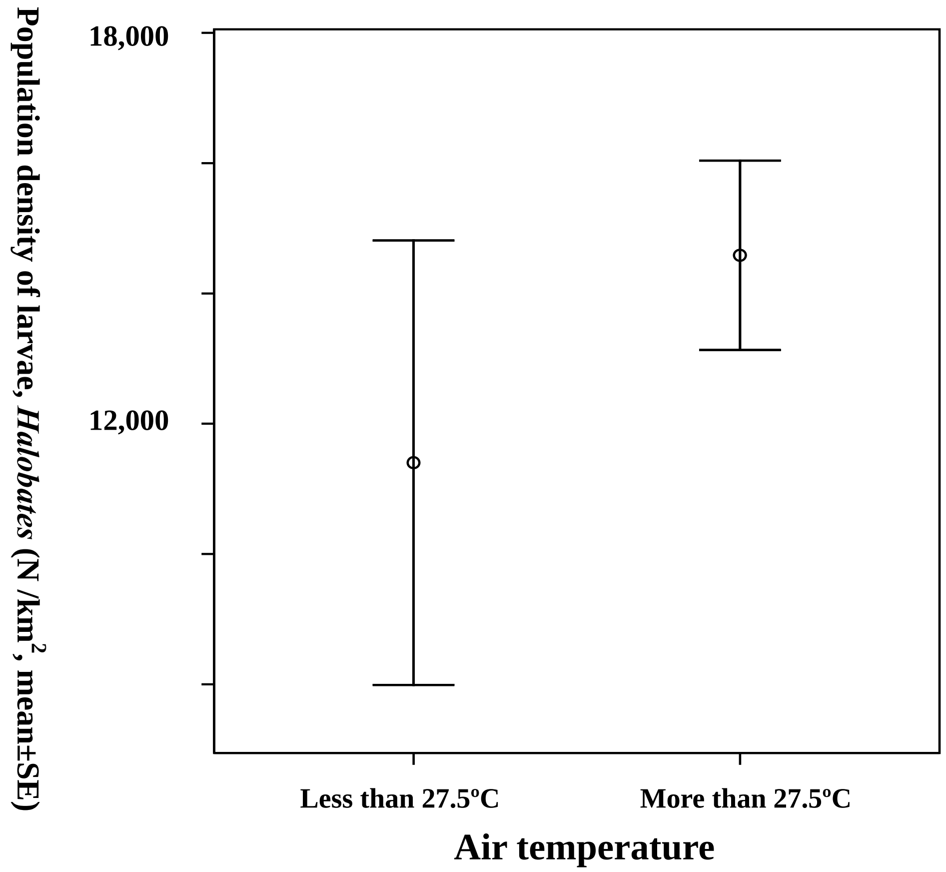

Fig.3: Comparison of population density (number of individuals / km^2) of larvae of *Halobates* (mostly *H. micans;* plus *H. germanus*) when air temperature was more than 27.5 ºC at sampling site to the population density when it was less than 27.5ºC.

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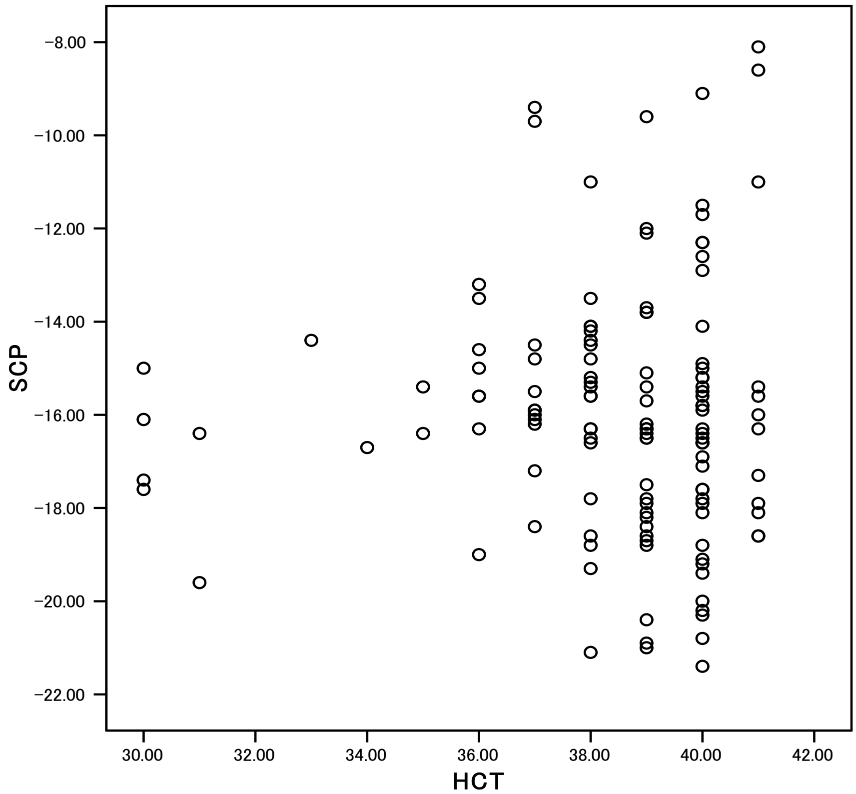

Fig. 4: Correlative analysis of Super-cooling point (SCP) and Heat Coma Temperature shown by all specimens of *Halobates micans* collected at Stations 1-17 and applied to these measurements No correlation was shown (Pearson's correlation test: r=0.013, p=0.883, n=131).

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Photo 1: A trailing scene of Neuston-NET

Photo 2: Washing the "pants" of the Neuston net just after the trailing to collect all *Halobates* individuals into the round-shaped transparent aquarium.

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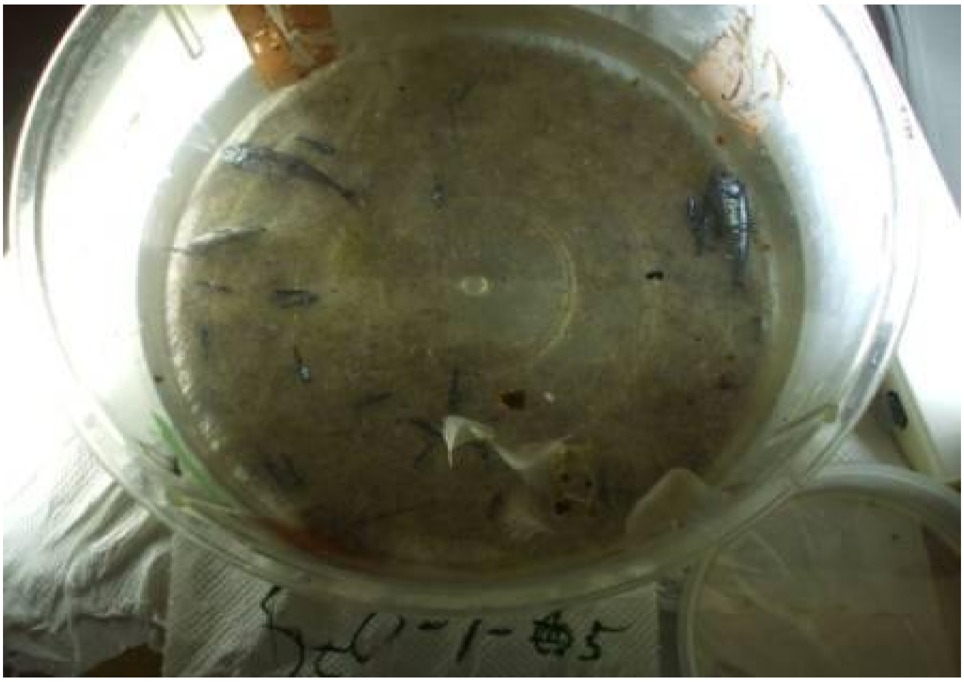

Photo 3: An example of the sample of Neuston-NET trailing.

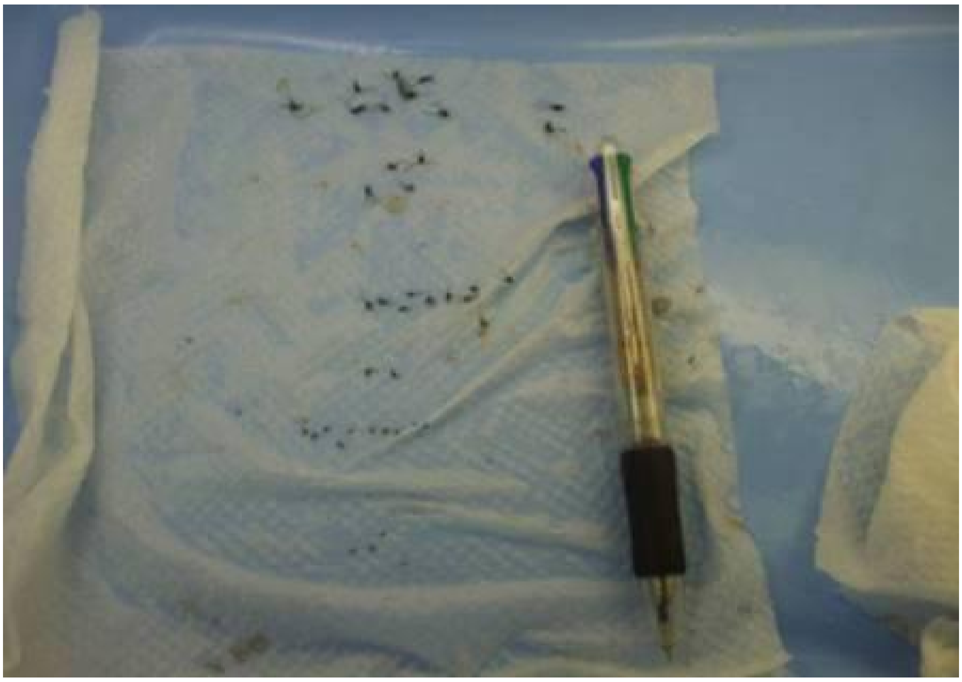

Photo 4: Example of larval and adult individuals of *Halobates* collected by a Neuston Net Sampling for 15min.

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Photo 5: An example of scene showing the heat paralysis experiment arena (on the left) and incubating aquaria filled with sea water Air and sea water temperature was kept within 29±2℃ with air-conditioners or a heater.

Photo 6: A scene of measuring super cooling point (SCP) with automatic temperature recorders with a thermo-sensor consisting of nickel-bronze coupling and freezer in which temperature was kept at -35℃. When heat coma occurred for a specimen applied to the Heat Coma Experiment, ventral surface of thespecimen's thorax and abdomen was attached with the thermo-coupling at ventral surface of abdomen. Then the specimen was transferred into a box made of high-dense-type-polystyrene-form (another box can be seen on the freezer) and put into the freezer to measure SCP and ITSCP. See text for the detailed.