

# Intermediate-water dynamics and ocean ventilation effects on the Indonesian Throughflow during the past 15,000 years: Ostracod evidence

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## ABSTRACT

The Indonesian Throughflow (ITF) is thought to influence thermohaline circulation dynamics and is important for understanding global climate and the marine ecosystem. The physical and chemical properties of North Pacific Intermediate Water (NPIW) and the underlying deep water incorporated into the ITF appear to be the result of climate-related preconditioning in the North and South Pacific. Thus, these high-latitude source waters play an important role in the Indo-Pacific oceanography. Here, we present the results of down-core faunal analyses of fossil ostracods (Crustacea) that we argue reflect NPIW variability in the central part of the Makassar Strait in the ITF over the past 15 k.y. The results show that the warm-water and low-oxygen-water fauna, and species diversity, rapidly increased at ca. 12 ka, reaching maxima during the Younger Dryas (YD). We interpret the faunal change and the diversity maximum at ca. 12 ka as a response to the stagnation of intermediate water due to the decline in ITF intensity during the YD. After ca. 7 ka, the ostracod faunal composition clearly changed from a relatively shallower, warmer, and low-oxygen fauna to a relatively deeper, colder, and high-oxygen fauna. Our interpretation is that the ostracod fauna was responding to the deglacial–early Holocene sea-level rise and the ventilation variations due to the mixing of the NPIW and the underlying deep water. The intermediate-water environment and the ecosystem in the ITF could have been driven by the intensification of the influence of the underlying deep water, caused by changes in the southern high-latitude source due to the latitudinal displacements of the southwesterly winds.

## INTRODUCTION

The Western Pacific Warm Pool (WPWP) presently exhibits the world's highest mean annual sea-surface temperature (Fig. 1). The WPWP influences the dynamics of the El Niño–Southern Oscillation and the East Asian monsoon (Linsley et al., 2010) and, in conjunction with the Kuroshio Current and Leeuwin Current, transmits a large amount of heat and water to middle–high-latitude regions. Transporting  $\sim 9\text{--}10 \times 10^6 \text{ m}^3/\text{s}$  from the WPWP to the eastern Indian Ocean, the Indonesian Throughflow (ITF) constitutes an important component of the global thermohaline circulation (Gordon et al., 1999). Several studies of the ITF region over the Holocene Epoch summarize the paleoceanographic and paleoclimatic evolution of this region (e.g., Visser et al., 2003; Griffiths et al., 2010; Linsley et al., 2010; Tierney et al., 2012; Rosenthal et al., 2013; Dubois et al., 2014; Schröder et al., 2016). However, the effects of changes in

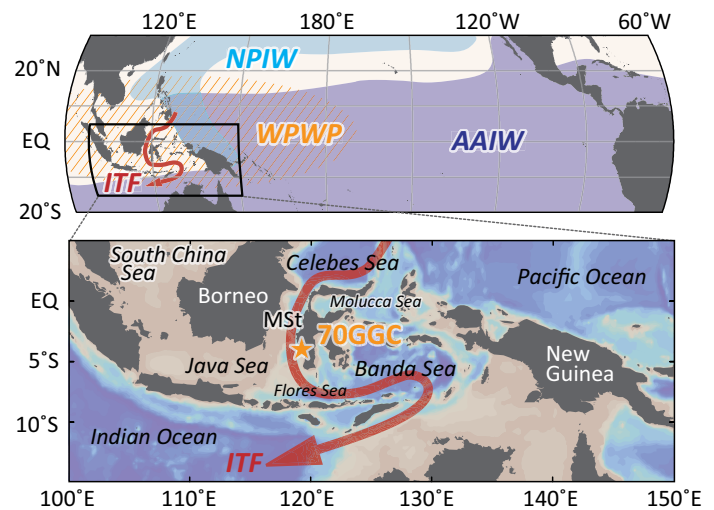


Figure 1. Location of study core (BJ8-03-70GGC, Makassar Strait, Indonesia; 3.566°S, 119.383° E) and oceanography. AAIW—Antarctic Intermediate Water; EQ—equator; ITF—Indonesian Throughflow; NPIW—North Pacific Intermediate Water; MSt—Makassar Strait; WPWP—Western Pacific Warm Pool (orange shaded region). Distributions of NPIW (light-blue shaded region) and AAIW (dark-blue shaded region) are based on Talley (1999). Maps were created using Ocean Data View (Schlitzer, 2017).

Pacific intermediate-water (IW) contributions to the ITF over time are not well understood.

The ITF flows through the Makassar Strait, which is located between the islands of Borneo and Sulawesi and connects the Celebes and Java Seas (Fig. 1). Oceanographic studies (Fine et al., 1994; Gordon, 2005; Rosenthal et al., 2013) show that the ITF's thermocline component is divided into three layers (Fig. DR1 in the GSA Data Repository<sup>1</sup>). The upper thermocline component ( $\sim 0\text{--}200 \text{ m}$  water depth) is characterized by a subsurface salinity maximum zone and originates from the North Pacific Ocean and, to a lesser extent, from the South Pacific subtropics. The intermediate-depth thermocline component ( $\sim 200\text{--}500 \text{ m}$  water depth) is predominantly sourced from the North Pacific Intermediate Water (NPIW) based on analysis of instrumental data. The NPIW is a

<sup>1</sup>GSA Data Repository item 2018188, Table DR1 (ostracod faunal list), Table DR2 [NMDS1 and  $E(S_{30})$ ], Figure DR1 (CTD profiles), Figure DR2 (scatter plots of  $\Delta T$  and ostracod results), and Figure DR3 (cross sections of salinity and dissolved oxygen), is available online at <http://www.geosociety.org/datarepository/2018/> or on request from [editing@geosociety.org](mailto:editing@geosociety.org).

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water mass with salinity minima and relatively low oxygen content that is widely distributed around the North Pacific Ocean (Talley, 1993). The primary source of the NPIW is the North Pacific subpolar gyre, particularly in the Sea of Okhotsk (Yasuda, 1997). The source water flows southward and mixes with subtropical gyre water, forming the NPIW in the Kuroshio Extension region. In the tropical western Pacific, the distribution of NPIW, identified by relatively low salinity at mid-depths, is overlapped with the core of low-dissolved-oxygen water, and the core of the NPIW becomes shallower (~500 m) toward the low latitudes (Schlitzer, 2017) (Fig. DR3). The lower thermocline component in the southern ITF region (~450–1000 m water depth) contains Indonesian Intermediate Water that has higher and relatively uniform salinity, and is formed by strong vertical mixing between shallow, warm, and relatively fresh water and deep, cold, and relatively salty water in the Banda Sea (Fine et al., 1994; Gordon, 2005; Rosenthal et al., 2013).

We investigated the paleoenvironmental evolution of the IW in the ITF during the past 15 k.y. using high-resolution faunal analyses of fossil benthic ostracods. Ostracoda are small bivalved crustaceans, and their fossils serve as an effective paleoenvironmental indicator (e.g., Cronin et al., 2002). Our results indicate the dynamic nature of deglacial–Holocene IW in this region, even during periods when the regional surface climate did not show significant change.

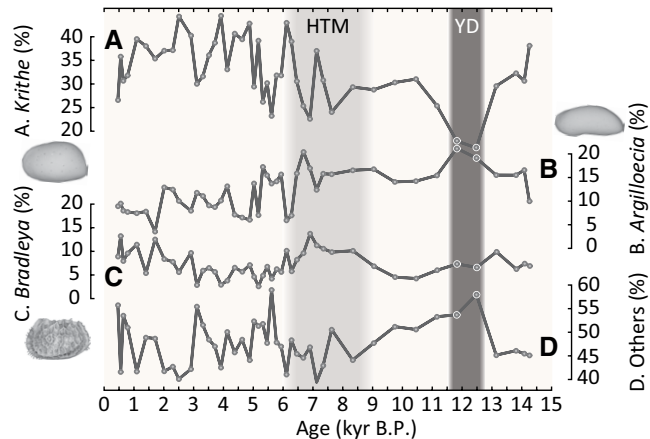
## MATERIALS AND METHODS

We examined the ostracod faunal diversity and composition in core BJ8-03-70GGC (3.566°S, 119.383° E, 482 m water depth; Rosenthal et al., 2006), which was collected from the central part of the Makassar Strait in the eastern Java Sea (Fig. 1). We used an age model for the core based on radiocarbon dates reported by Linsley et al. (2010). The sediment core covers the past ~15 k.y., and the average resolution between samples for this study is ~300 yr. Therefore, this study focuses on millennial-scale paleoceanographic environment transitions.

For the fossil ostracod analyses, we separated specimens from sediments coarser than 0.15 mm. Note that the number of specimens refers to the sum of each single valve and carapace as one individual. We used non-metric multidimensional scaling (NMDS) based on Bray-Curtis dissimilarity to explore the significant differences and changes in the ostracod faunal composition. NMDS is a statistical method that represents the relationships of the observed values in a reduced number of orthogonal dimensions. We interpreted the first NMDS axis (NMDS1) as a principal signal of the transition in the faunal composition. For the NMDS, we used the relative abundances of 80 taxa that show a >1% relative abundance in at least one sample. For the species diversity, we used rarefaction,  $E(S_n)$ , which shows the expected number of species in  $n$  individuals. In this study, we selected a sampling threshold of  $n = 50$  for the rare function analysis. We performed NMDS and rare function analyses using the statistical programming environment R version 3.4.0 (R Development Core Team, 2016) with the package “vegan” version 2.4-3 (Oksanen et al., 2017).

## RESULTS

In Figure 2, we show the vertical changes in the three dominant taxa, namely, those containing >500 individuals (Table DR1 in the Data Repository). The most dominant genus, *Krithe* (32.7% of the total ostracod fauna), is a typical psychrospheric (cold and deep oceanic) ostracod (Zhao and Whatley, 1997). In the South China Sea, *Krithe* is distributed at water depths of 480–4100 m (Zhao and Zheng, 1996). *Krithe* shows a minimum abundance between ca. 13 and 11 ka and millennial-scale large-amplitude fluctuations after ca. 7 ka. The second most dominant genus, *Argilloecia* (12.4%), predominates in modern low-oxygen and commonly organic-rich bottom sediments during climatic transitions, suggesting an opportunistic ecology (Yasuhara et al., 2008). In the South China Sea, *Argilloecia* is distributed at water depths of 181–2950 m (Zhao and Zheng, 1996). These taxa have high abundance in the lower to middle parts (before ca. 7 ka)



**Figure 2.** Changes in abundance of dominant ostracods within study core BJ8-03-70GGC (Makassar Strait, Indonesia). Scanning electron microscopy images show examples of *Krithe*, *Argilloecia*, and *Bradleya*; all are <1 mm in length. Dark- and light-shaded periods represent Younger Dryas (YD) and Holocene Thermal Maximum (HTM), respectively.

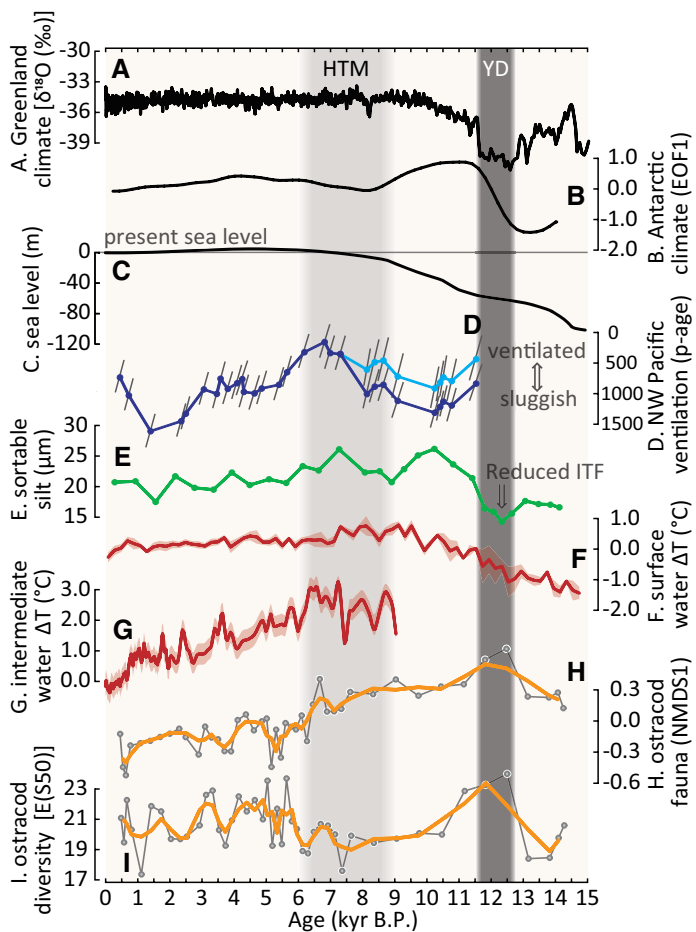
and low abundance in the upper part of the studied core (after ca. 7 ka). Temporal changes in the *Argilloecia* abundance are inversely correlated with the fluctuations of *Krithe*. The third most dominant genus is *Bradleya*, specifically *Bradleya cf. albatrossia* (7.1%). *B. albatrossia* is distributed at water depths of 181–3375 m in the South China Sea (Zhao and Zheng, 1996). This species is relatively abundant in the middle (ca. 7 ka) and upper (after ca. 3 ka) parts of the studied core.

The faunal composition (NMDS1) continually decreased after ca. 12 ka. Species diversity,  $E(S_{50})$ , ranges between 17.4 and 24.0, with an average of 20.6, and shows a peak between ca. 13 and 11 ka (Table DR2).

## DISCUSSION AND CONCLUSIONS

The NMDS1 scores are correlated with the relative abundance of *Krithe* ( $R^2 = 0.3593$ ,  $p < 0.0001$ ) and inversely correlated with that of *Argilloecia* ( $R^2 = 0.4996$ ,  $p < 0.0001$ ) (Fig. DR2). Other studies in the North Atlantic found that the dominance of *Krithe* and *Argilloecia* corresponds to the glacial and interglacial intervals, respectively, during the Quaternary (e.g., Cronin et al., 1996). In addition, in the eastern equatorial Pacific, the glacial assemblages are characterized by *Krithe* during the Quaternary (Stepanova and Lyle, 2014). It is likely that the relationship between *Krithe* and *Argilloecia* corresponds to changes in bottom-water temperature over time. That is, *Krithe* favors relatively cold water temperatures, and *Argilloecia* favors relatively warm water temperatures. This might be the reason why *Krithe* is universally distributed in deeper water in modern seas than is *Argilloecia*. Moreover, *Argilloecia* is reported in modern low-oxygen and commonly organic-rich bottom sediments (Cronin, 1983) and is thought to be a low-oxygen indicator (Alvarez Zarikian et al., 2009; Angue Minto’o et al., 2015). Conversely, *Krithe* indicates well-oxygenated cold-water environments (Angue Minto’o et al., 2015).

In the Flores Sea, the high concentrations of authigenic uranium, which suggests high organic carbon in sediment and low oxygen concentration of bottom-water conditions, was reported in the early part of the Holocene, and decreased toward the present (Muller et al., 2012). This declining trend agrees with the ostracod faunal changes (decreasing in NMDS values) over time (Fig. 3H). Accordingly, NMDS1 might be recording changes in the temperature and oxygen conditions in the bottom water (Fig. 3H). Because the oscillation of *Krithe* versus *Argilloecia*, corresponding with differences in the temperature and/or dissolved oxygen, is reported across the Atlantic (Cronin et al., 1996; Yasuhara et al., 2008) and Pacific Oceans (this study), it might be perceivable as a global biotic sign.



**Figure 3.** Changes in ostracod faunal composition and diversity within study core BJ8-03-70GCG (Makassar Strait, Indonesia) with proxy records of deglacial–Holocene climate. **A:**  $\delta^{18}\text{O}$  record from Greenland ice core GISP2 (Greenland Ice Sheet Project Two; Grootes and Stuiver, 1999). **B:** Antarctic temperature records based on empirical orthogonal function (EOF) of five ice core  $\delta^{18}\text{O}$  records (Masson-Delmotte et al., 2011). **C:** Sea-level curve of Southeast Asia (Hanebuth et al., 2011). Gray line denotes present sea level. **D:** Projection ages (p-age) for assumed source regions reservoir ages of ~1000 yr (blue) and ~1400 yr (light blue) in northwest Pacific Ocean. Error bars as described in Rella and Uchida (2014). **E:** Sortable silt mean values in Makassar Strait (Hendrizan et al., 2017). **F:** Surface-water temperature anomalies ( $\Delta T$ ) (Linsley et al., 2010). **G:** Intermediate-water temperature anomalies ( $\Delta T$ ) (Rosenthal et al., 2013). **F** and **G** from Indonesian Throughflow region cores, including study core. Shaded bands in panels **F** and **G** represent standard error. **H:** Ostracod faunal composition (non-metric multidimensional scaling axis NMDS1) in study core. **I:** Ostracod species diversity [expected number of species in 50 individuals,  $E(S_{50})$ ] in study core. Orange lines in panels **H** and **I** show three-point moving-average values. Dark- and light-shaded periods represent Younger Dryas (YD) and Holocene Thermal Maximum (HTM), respectively.

The most prominent diversity maximum appears at ca. 11–13 ka and coincides with the interval of the Younger Dryas (YD) (Fig. 3I). Water temperature is known to be a fundamental controlling factor for biodiversity in marine ecosystems (Tittensor et al., 2010), and most temperature-diversity relationships are positive, with higher temperatures corresponding to higher diversity (e.g., Yasuhara and Danovaro, 2016). Positive relationships between bottom-water temperature and deep-sea ostracod diversity are broadly reported in the North Atlantic as a response to glacial-interglacial cycles (e.g., Cronin and Raymo, 1997). Accordingly, we interpret peaks of NMDS1 and the diversity at ca. 11–13 ka as a response to an increase in IW temperature and a decrease in dissolved oxygen concentrations during the YD.

The ITF thermocline-depth flow is thought to have slowed during the YD based on evidence from paleocurrent indicators (sortable silt and X-ray fluorescence [XRF] scanner-derived  $\log[\text{Zr}/\text{Rb}]$ ) measured in a core at ~640 m paleowater depth in the Makassar Strait (Hendrizan et al., 2017) (Fig. 3E). This weaker thermocline flow is considered to reduce the winnowing and resuspension of fine-grained particles of the Makassar Strait. The high NMDS1 values and diversity during the YD, which is thought to indicate low-oxygen and high-temperature conditions, might be a result of stagnant IW due to the decline in ITF intensity.

Benthic foraminiferal Mg/Ca records at the study site show that bottom water in the Makassar Strait, at 480 m, was warmer during the Holocene Thermal Maximum (HTM) than in recent decades, and began decreasing after ca. 6 ka (Rosenthal et al., 2013) (Fig. 3G). Rosenthal et al. (2017) compared the changes in the IW temperatures of three oceans (the western and eastern equatorial Pacific Ocean and the equatorial Atlantic Ocean). In all three regions, the reconstructed IW temperature was warmer during the early Holocene than during the pre-industrial late Holocene, and the cooling trends to modern levels are more prominent than the sea-surface water changes (Linsley et al., 2010) (Fig. 3F). Accordingly, the long-term cooling in the underlying water does not directly correspond to changes in the local radiative forcing, but is more likely sourced from higher latitudes and transported as heat anomalies to the ocean interior (Rosenthal et al., 2017). Rella and Uchida (2014) revealed (on the basis of radiocarbon content; Fig. 3D) that the ventilation of the mid-depth water in the northwest Pacific Ocean increased from the early Holocene to the middle Holocene. They suggested that this ventilation of mid-depth water in the northwest Pacific during the early Holocene may have been sourced from the Southern Ocean, with overturning driven by latitudinal displacements of the Southern Hemisphere westerly winds. This would have resulted in the formation of deep water in the Southern Ocean due to the increase in temperatures in Antarctica and the Southern Ocean because this would have temporarily intensified the atmospheric circulation around Antarctica due to the southern westerly winds moving southward (Rella and Uchida, 2014).

In the subsurface of the western equatorial Pacific, NPIW and the underlying Antarctic Intermediate Water (AAIW) (Talley, 1999) are sourced from the northern and southern high latitudes, respectively (Fig. 1). A tongue of the AAIW extends into the Indonesian archipelago, reaching the Molucca and Banda Seas (Qu and Lindstrom, 2004). Although the contribution of South Pacific waters to the ITF via oceanic pathways north of the Banda Sea remains an open question (Sprintall et al., 2014), it is likely that the underlying water in the ITF region is derived from both northern and southern high latitudes. Thus, there is also a possibility that changes in the ventilation derived from the high southern latitudes are recorded in the study site.

The ostracod faunal changes observed throughout the Holocene suggest variability in water temperature and dissolved oxygen due to variations in the source of IW. In the early Holocene, ventilation was low in the northwest Pacific (Rella and Uchida, 2014) (Fig. 3D) and water depth at the study site was shallower than at present (Hanebuth et al., 2011) (Fig. 3C). Accordingly, *Argilloecia*, an ostracod genus indicative of relatively shallower, warmer, and low-oxygen conditions, was dominant due to the enhanced influence of the NPIW. The IW ventilation became stronger toward the middle Holocene (ca. 7 ka) (Fig. 3D), and sea level increased to approximately the present level (Hanebuth et al., 2011) (Fig. 3C). These changes might be reflected in the slightly decreasing NMDS1 during the early to middle Holocene. After the middle Holocene, *Krithe*, the ostracod genus indicative of relatively deeper, colder, and high-oxygen conditions, increased in abundance due to the high sea level and the reduced mixing and influence of the NPIW. Collectively, our results suggest that the evolution of the marine climate and ecosystem in the ITF region could have been driven by changes in the southern high-latitude source of IW due to the latitudinal displacements of the southern westerly winds.

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# Intermediate-water dynamics and ocean ventilation effects on the Indonesian throughflow during the last 15,000 years:

## Ostracod evidence

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Table DR1 (part 1 of 4). Ostracod faunal list of the study core BJ8-03-70GGC.

Taxonomic name/ Depth (cm)	041	049	057	065	073	081	089	097	105	113	121	129	137	145	153	161	169	177	185	193	201	209	217	225
<i>Actinocythereis</i> cf. <i>levinsoni</i> Bhatia & Mandwal	0	0	6	4	2	6	6	3	4	2	6	3	0	3	4	5	7	2	3	0	5	2	1	3
<i>Alataconcha pterogona</i> (Zhao)	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	3	1	0	0	0	0
<i>Ambostoracon?</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Argilloecia</i> spp.	7	5	8	12	11	13	5	17	16	9	17	9	25	15	14	17	14	21	13	8	11	27	11	25
<i>Aurila</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Bradleya</i> cf. <i>albatrossia</i> Benson	7	7	8	15	17	9	18	11	10	5	13	11	6	8	10	11	4	6	12	7	13	9	4	7
<i>Bradleya</i> sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Buntoria</i> sp.	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	1	0	1
<i>Bythoceratina</i> sp. 1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bythoceratina</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Bythoceratina</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bythoceratina</i> sp. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bythocypris</i> sp. 1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	4	1	0	1	0	0
<i>Bythocypris</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Callistocythere</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Cardobairdia balcombensis</i> McKenzie	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Caudites</i> sp.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Caudites?</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
<i>Chejudocythere</i> cf. <i>higashikawai</i> Ishizaki	0	0	1	2	0	0	4	0	1	0	7	6	6	1	2	3	0	0	0	0	0	2	1	0
<i>Chejudocythere</i> sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0
<i>Copytus posterosulcus</i> Wang	0	3	2	1	0	1	0	1	0	1	0	2	1	0	0	2	4	1	3	2	0	2	4	0
<i>Comucoquimba</i> sp. 1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Comucoquimba</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
<i>Cytherella</i> spp.	3	1	0	4	0	2	2	3	3	3	7	2	10	4	3	14	4	10	7	3	0	7	4	2
<i>Cytherelloidea</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	1	0	0	0	0	0	0	0
<i>Cytherelloidea</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Cytherois</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0
<i>Cytheropteron excism</i> Bonaduce Masoli & Pugliese	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Cytheropteron hanaii</i> Ishizaki	5	0	1	1	0	2	0	2	1	0	0	0	0	0	1	1	1	0	2	0	2	1	0	1
<i>Cytheropteron miurense</i> s.l. Hanai	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	4	2	1	0	0	1
<i>Cytheropteron</i> aff. <i>miurense</i> Hanai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
<i>Cytheropteron testudo</i> Sars	4	3	1	6	5	5	1	4	2	2	1	2	11	5	8	12	4	4	9	4	4	5	9	5
<i>Cytheropteron uchioi</i> Hanai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cytheropteron</i> sp. 1	1	1	2	2	3	2	1	3	2	4	5	0	8	1	1	4	2	4	3	4	6	5	0	2
<i>Cytheropteron</i> sp. 2	2	1	4	2	0	3	4	1	2	0	2	1	3	3	2	2	3	1	2	2	6	6	4	14
<i>Cytheropteron</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Cytheropteron</i> sp. 4	0	0	1	0	1	1	5	2	2	1	1	0	3	0	0	2	0	0	0	0	0	0	0	0
<i>Cytheropteron</i> sp. 5	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cytheropteron</i> sp. 6	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Cytheropteron</i> sp. 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Eucytherura</i> aff. <i>spinosa</i> Ruan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	0
<i>Eucytherura</i> sp. 1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Eucytherura</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Eucytherura?</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Falsobuntonia omata</i> (Zhao)	4	2	11	18	11	18	11	7	10	4	13	5	13	6	13	13	5	10	4	6	12	8	15	9
<i>Forcipicythere</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Hemiparacytheridea</i> cf. <i>minaminipponica</i> (Ishizaki)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
<i>Javanella</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Javanella?</i> sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	1
<i>Kotoracythere</i> sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1	1	0	0
<i>Krithe</i> spp.	21	19	31	50	59	64	51	49	48	40	71	46	64	43	56	76	62	53	75	49	79	58	62	38
<i>Lankacythere</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Legitimocythere</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Loxoconcha</i> aff. <i>uranouchiensis</i> Ishizaki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Loxoconcha alata</i> Brady	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Loxoconcha</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Loxoconchidea</i> sp.	4	1	1	5	2	1	2	1	0	0	5	5	1	2	2	0	0	1	0	1	2	3	2	3
<i>Loxocomiculum georgei</i> (Hartmann)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Macrocypris</i> spp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Microcythere vittata</i> Ruan	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Microcythere</i> sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Miocyprideis</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Neomonoceratina</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

Table DR1 (part 2 of 4). Ostracod faunal list of the study core BJ8-03-70GGC.

Taxonomic name/ Depth (cm)	041	049	057	065	073	081	089	097	105	113	121	129	137	145	153	161	169	177	185	193	201	209	217	225
<i>Neonesidea</i> spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
<i>Pacambocythere</i> aff. <i>reticulata</i> (Jiang & Wu)	0	0	3	7	4	3	2	5	6	0	3	2	1	4	0	2	4	5	3	1	4	6	4	1
<i>Pacambocythere</i> sp. 1	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	2	0	0	0	0	1	0	0
<i>Pacambocythere</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Pacambocythere</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1	6	2
<i>Paijenborchella</i> <i>cymbula</i> Ruggieri	5	2	5	3	8	3	5	3	3	2	3	2	6	3	6	1	1	2	9	3	6	5	3	2
<i>Paijenborchella</i> <i>iocosa</i> Kingma	1	0	1	4	7	5	1	3	3	3	5	2	4	2	6	4	4	6	0	5	4	2	1	2
<i>Paijenborchella</i> cf. <i>iocosa</i> Kingma	1	0	0	1	0	0	0	1	3	0	0	0	1	1	0	0	0	1	0	0	1	2	0	1
<i>Paijenborchella</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Palmoconcha</i> <i>semistriata</i> (Kingma)	0	1	0	5	6	6	5	3	0	2	2	2	2	3	5	0	3	2	2	1	2	0	1	1
<i>Palmoconcha</i> sp.	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Paracypris</i> sp.	0	2	0	2	2	2	0	2	0	2	0	10	8	4	0	0	0	2	3	2	5	3	3	3
<i>Paracytheridea</i> <i>echinata</i> Hu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Paracytheris</i> sp.	0	1	1	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	1	0	4	0	0
<i>Paradoxostoma</i> spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
<i>Parahemingwayella</i> <i>dowingae</i> Coles & Whatley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0
<i>Parakrithe</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Parakrithe</i> sp. 2	0	1	0	0	0	4	3	2	1	0	0	2	1	3	0	7	2	4	7	0	0	6	12	6
<i>Parakrithe</i> sp. 3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0
<i>Parakrithe</i> sp. 4	0	2	1	0	2	2	1	0	0	2	1	0	0	1	1	1	1	0	9	0	0	0	0	0
<i>Parakrithe</i> <i>oblongata</i> Hu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0
<i>Parakrithe</i> aff. <i>oblongata</i> Hu	0	0	2	0	0	0	0	0	0	1	1	0	1	1	0	1	0	1	0	0	0	0	0	0
<i>Paranesidea</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pedicythere</i> cf. <i>atroposopetasi</i> Yasuhara, Okahashi & Cronin	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Pedicythere</i> <i>lacheisisopetasi</i> Yasuhara, Okahashi & Cronin	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Perissocytheridea</i> sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Phlyctocythere</i> <i>hamanensis</i> Ikeya & Hanai	2	0	0	1	0	0	2	1	1	0	0	1	2	1	0	0	3	0	0	0	1	0	2	0
<i>Phlyctocythere</i> <i>reticulosa</i> Hao	0	0	0	1	2	4	1	1	2	0	1	0	4	4	1	0	0	1	0	0	1	2	3	1
<i>Pistocythereis</i> cf. <i>bradyformis</i> (Ishizaki)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pistocythereis</i> sp. 1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	3	0	0	0	1	0	0	0
<i>Pistocythereis</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Polycope</i> spp.	1	0	0	0	1	1	0	0	0	2	1	0	0	0	0	0	0	0	0	0	1	0	1	1
<i>Pontocythere</i> <i>suprema</i> Hao	0	0	1	0	0	0	0	0	0	0	0	1	0	1	4	0	0	0	0	1	0	0	0	0
<i>Profundocythere</i> sp.	0	0	1	1	0	0	2	0	0	2	2	0	1	1	1	3	1	0	0	2	2	4	0	0
<i>Propontocypris</i> spp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
<i>Pseudocythere</i> <i>caudata</i> Sars	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	1	0	1	0	1	0	1
<i>Pseudocythere</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudocythere</i> sp. 2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudocythere?</i> sp.	3	0	0	0	1	2	0	0	0	2	1	7	3	3	3	3	0	4	2	2	1	7	2	3
<i>Rimacytheropteron</i> <i>sinense</i> Gou	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	2	0	3	0	0	0
<i>Saida</i> <i>torresi</i> (Brady)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Semicytherura</i> <i>indonesiaensis</i> Whatley & Zhao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Semicytherura</i> cf. <i>minaminipponica</i> Ishizaki	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	2	0	1	0
<i>Semicytherura</i> cf. <i>prona</i> Ruan	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Semicytherura</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Semicytherura</i> sp. 2	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	1	0	0	1	1	1	0	0	1
<i>Semicytherura</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Semicytherura</i> sp. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Tanella</i> <i>gracilis</i> Kingma	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Xestoleberis</i> <i>hanaii</i> s.l. Ishizaki	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
<i>Xestoleberis</i> cf. <i>okinawensis</i> Ruan	3	0	1	1	2	0	1	0	1	1	1	0	2	3	1	0	1	0	0	0	0	0	0	0
<i>Xestoleberis</i> <i>variegata</i> Brady	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Xestoleberis</i> sp. 1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Xestoleberis</i> sp. 2	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
<i>Xestoleberis</i> sp. 3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Xestoleberis</i> sp. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
<i>Xestoleberis</i> sp. 5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Xylocythere</i> sp.	0	1	1	1	1	1	2	0	0	1	0	1	3	0	0	3	2	0	0	2	1	0	0	0
Gen et sp. indet 1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Gen et sp. indet 2	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Gen et sp. indet 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gen et sp. indet 4	0	0	0	1	0	0	0	0	1	0	1	2	3	0	0	0	0	0	0	0	1	1	0	2
No. of specimens	79	53	101	157	149	168	144	132	129	90	180	114	213	136	155	196	139	160	184	124	184	197	158	145

Table DR1 (part 3 of 4). Ostracod faunal list of the study core BJ8-03-70GGC.

Taxonomic name/ Depth (cm)	233	241	249	257	265	273	281	289	297	305	313	321	329	337	345	353	361	369	377	385	393	401	407
<i>Actinocythereis</i> cf. <i>levinsoni</i> Bhatia & Mandwal	1	4	2	5	0	0	0	0	2	2	1	0	2	1	0	1	2	0	3	0	0	1	1
<i>Alataconcha pterogona</i> (Zhao)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
<i>Ambostoracon?</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Argilloecia</i> spp.	23	23	16	28	11	6	29	30	21	22	21	32	36	32	25	27	31	32	35	22	35	27	13
<i>Aurila</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bradleya</i> cf. <i>albatrossia</i> Benson	10	7	7	10	19	5	15	14	17	20	14	20	22	13	8	8	12	11	12	14	14	12	9
<i>Bradleya</i> sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1
<i>Buntonia</i> sp.	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bythoceratina</i> sp. 1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bythoceratina</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bythoceratina</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Bythoceratina</i> sp. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Bythocypris</i> sp. 1	0	0	0	0	1	0	0	0	0	0	0	2	0	1	0	2	3	6	3	1	2	1	0
<i>Bythocypris</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
<i>Callistocythere</i> sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Cardobairdia balcombensis</i> McKenzie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Caudites</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Caudites?</i> sp.	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Chejudocythere</i> cf. <i>higashikawai</i> Ishizaki	1	1	0	0	10	1	6	0	1	1	2	1	2	1	0	0	1	1	2	1	2	5	2
<i>Chejudocythere</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Copytus posterosulcus</i> Wang	2	1	0	2	1	2	2	2	6	3	1	3	0	3	2	0	0	0	1	2	4	2	1
<i>Cornucoquimba</i> sp. 1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cornucoquimba</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cytherella</i> spp.	0	4	0	3	0	4	3	4	2	7	0	8	10	13	16	15	1	1	3	2	9	4	5
<i>Cytherelloidea</i> sp. 1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Cytherelloidea</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Cytherois</i> sp.	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cytheropteron excism</i> Bonaduce Masoli & Pugliese	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	2	0	0	0	0	0	0
<i>Cytheropteron hanai</i> Ishizaki	0	3	0	5	0	1	1	0	0	0	2	0	5	2	5	0	2	0	0	0	0	0	0
<i>Cytheropteron miurense</i> s.l. Hanai	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	2	0	1	2	1	
<i>Cytheropteron</i> aff. <i>miurense</i> Hanai	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	3	2	0	0	0	0	0
<i>Cytheropteron testudo</i> Sars	8	3	2	6	6	5	8	1	6	5	6	9	3	0	2	1	3	1	0	2	0	1	2
<i>Cytheropteron uchiui</i> Hanai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Cytheropteron</i> sp. 1	2	6	3	6	4	3	2	6	3	1	5	8	2	8	3	8	6	7	1	7	12	4	0
<i>Cytheropteron</i> sp. 2	5	6	3	11	9	3	16	10	7	5	12	16	14	8	6	12	5	7	7	7	9	8	2
<i>Cytheropteron</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Cytheropteron</i> sp. 4	1	0	0	3	2	1	2	1	1	1	2	9	1	8	3	2	2	4	5	1	1	1	0
<i>Cytheropteron</i> sp. 5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0
<i>Cytheropteron</i> sp. 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0
<i>Cytheropteron</i> sp. 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
<i>Eucytherura</i> aff. <i>spinosa</i> Ruan	1	0	4	0	1	3	1	2	0	0	0	1	0	0	2	0	4	0	0	0	0	0	0
<i>Eucytherura</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0
<i>Eucytherura</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Eucytherura?</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Falsobuntonia ornata</i> (Zhao)	12	12	11	6	6	6	4	1	2	7	2	3	2	4	2	3	3	7	1	2	1	2	2
<i>Forcipicythere</i> sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Hemiparacytheridea</i> cf. <i>minaminipponica</i> (Ishizaki)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Javanella</i> sp.	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Javanella?</i> sp.	0	2	1	1	2	0	3	0	1	0	1	1	2	0	0	2	1	1	2	0	0	0	0
<i>Kotoracythere</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Krithe</i> spp.	45	39	36	57	81	34	56	37	28	66	41	49	64	55	54	59	51	27	30	42	73	50	50
<i>Lankacythere</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
<i>Legitimocythere</i> sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	2	0	0	0	1	0	0
<i>Loxoconcha</i> aff. <i>uranouchiensis</i> Ishizaki	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Loxoconcha alata</i> Brady	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
<i>Loxoconcha</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Loxoconchidea</i> sp.	2	3	3	5	1	1	0	0	1	3	1	2	1	1	0	2	1	0	1	1	3	0	0
<i>Loxocomiculum georgei</i> (Hartmann)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Macrocypis</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Microcythere vittata</i> Ruan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Microcythere</i> sp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Miocypideis</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
<i>Neomonoceratina</i> sp.	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1	0	1	0	2	0	0	0	0

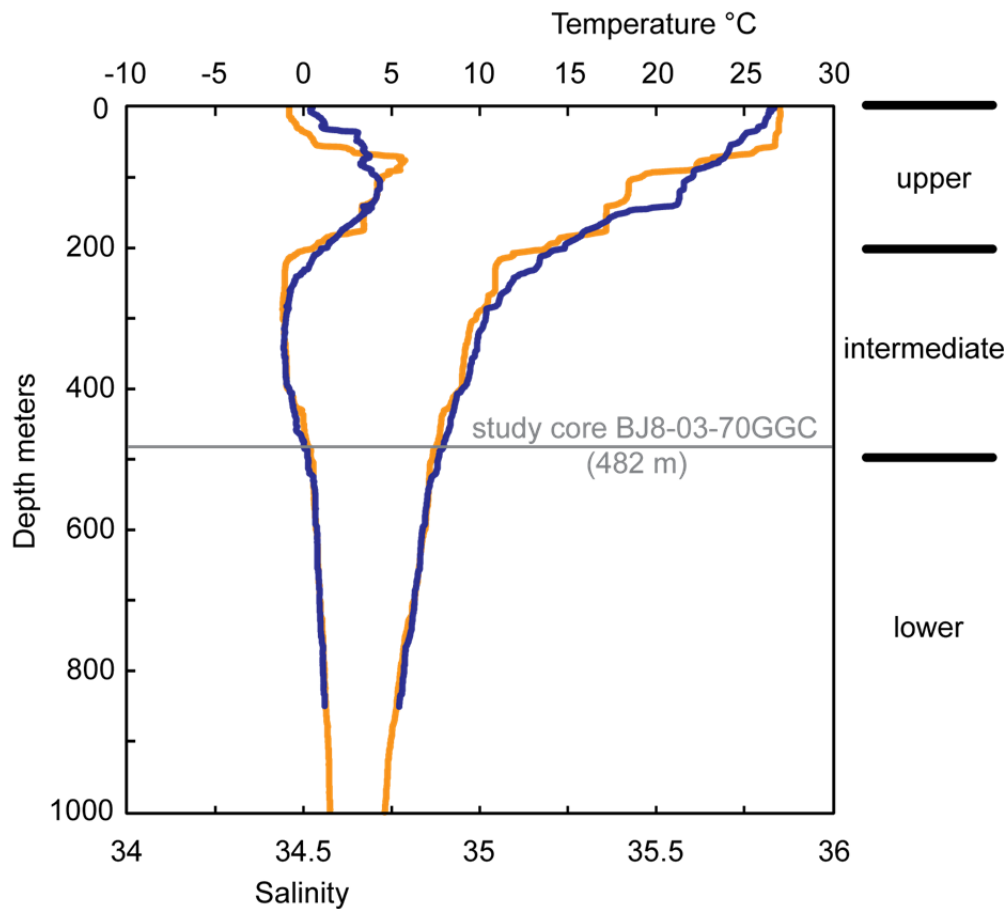


**Table DR1 (part 4 of 4).** Ostracod faunal list of the study core BJ8-03-70GGC.

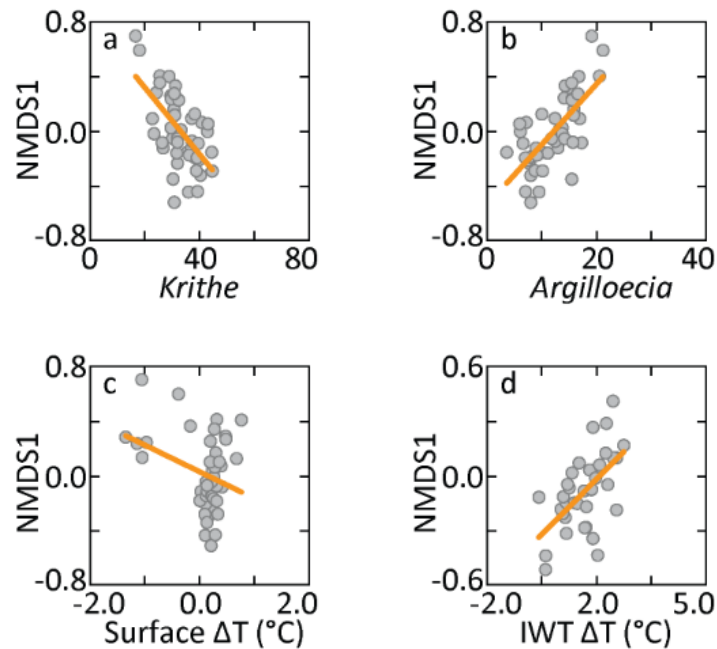
Taxonomic name/ Depth (cm)	233	241	249	257	265	273	281	289	297	305	313	321	329	337	345	353	361	369	377	385	393	401	407
<i>Neonesidea</i> spp.	0	2	0	0	0	0	1	3	1	0	0	0	1	0	0	0	0	1	1	0	1	0	0
<i>Pacambocythere</i> aff. <i>reticulata</i> (Jiang & Wu)	1	5	3	0	0	2	2	2	1	3	0	1	4	2	4	3	5	1	6	1	4	2	2
<i>Pacambocythere</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0
<i>Pacambocythere</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pacambocythere</i> sp. 3	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0
<i>Paijenborchella cymbula</i> Ruggieri	3	4	2	8	3	4	2	4	3	4	5	5	10	2	12	8	16	5	8	10	18	9	9
<i>Paijenborchella iocosa</i> Kingma	0	3	0	1	4	1	0	4	0	1	4	5	5	4	8	3	4	2	4	8	5	1	5
<i>Paijenborchella</i> cf. <i>iocosa</i> Kingma	0	0	1	0	0	0	1	0	0	1	0	2	2	1	1	2	0	0	2	0	0	1	3
<i>Paijenborchella</i> sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Palmoconcha semistriata</i> (Kingma)	1	2	0	1	1	1	0	3	0	2	1	2	4	7	4	8	7	4	4	1	8	11	5
<i>Palmoconcha</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Paracypris</i> sp.	2	2	3	4	2	0	0	0	2	0	1	0	1	0	0	0	0	0	1	0	0	0	0
<i>Paracytheridea echinata</i> Hu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Paracytherois</i> sp.	0	5	0	0	0	0	3	0	0	3	0	2	0	7	0	4	5	4	0	2	0	1	1
<i>Paradoxostoma</i> spp.	0	0	0	1	0	0	0	2	0	0	1	0	0	1	0	1	1	9	0	0	1	0	0
<i>Parahemingwayella dowingae</i> Coles & Whatley	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Parakrithes</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Parakrithes</i> sp. 2	12	14	3	3	6	1	5	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
<i>Parakrithes</i> sp. 3	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Parakrithes</i> sp. 4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	1	0	0	4	3	3	1
<i>Parakrithella oblongata</i> Hu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Parakrithella</i> cf. <i>oblongata</i> Hu	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Paranesidea</i> sp.	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Pedicythere</i> cf. <i>atroposopetasi</i> Yasuhara, Okahashi & Cronin	0	0	1	0	2	0	1	1	1	1	1	0	4	2	0	1	2	0	1	1	1	1	0
<i>Pedicythere lachesisopetasi</i> Yasuhara, Okahashi & Cronin	0	1	0	0	0	0	1	0	1	0	1	0	1	0	2	0	1	0	1	0	1	0	1
<i>Perissocytheridea</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Phlyctocythere hamanensis</i> Ikeya & Hanai	0	2	0	0	0	0	1	0	0	2	0	0	0	1	2	1	1	0	2	0	2	0	1
<i>Phlyctocythere reticulosa</i> Hao	1	2	0	4	1	0	3	1	0	3	2	1	2	0	2	2	1	1	0	1	1	1	1
<i>Pistocythereis</i> cf. <i>bradyformis</i> (Ishizaki)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Pistocythereis</i> sp. 1	0	0	1	0	0	0	2	3	1	1	0	1	2	1	1	4	6	1	7	0	2	1	0
<i>Pistocythereis</i> sp. 2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Polycypris</i> spp.	0	0	0	1	4	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Pontocythere suprema</i> Hao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Profundocythere</i> sp.	1	1	3	1	7	2	5	1	7	0	6	6	4	2	0	0	0	0	0	0	0	0	0
<i>Propontocypris</i> spp.	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudocythere caudata</i> Sars	0	0	1	0	0	0	1	0	0	1	0	1	2	1	0	0	1	1	0	1	1	0	0
<i>Pseudocythere</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0
<i>Pseudocythere</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudocythere?</i> sp.	0	1	0	3	0	0	3	1	3	1	0	0	1	0	1	0	1	0	2	1	1	1	1
<i>Rimacytheropteron sinense</i> Gou	2	2	1	0	0	0	1	0	1	1	0	0	1	1	1	2	3	2	0	1	1	2	0
<i>Saida torresi</i> (Brady)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Semicytherura indonesiaensis</i> Whatley & Zhao	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Semicytherura</i> cf. <i>minaminipponica</i> Ishizaki	2	1	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	0	0	0	0	0	0
<i>Semicytherura</i> cf. <i>prona</i> Ruan	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Semicytherura</i> sp. 1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Semicytherura</i> sp. 2	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	1	2	0	0	0	1	0
<i>Semicytherura</i> sp. 3	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
<i>Semicytherura</i> sp. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Tanella gracilis</i> Kingma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
<i>Xestoleberis hanaii</i> s.l. Ishizaki	0	0	0	0	0	0	0	0	0	3	1	0	1	0	1	0	0	3	4	0	4	2	0
<i>Xestoleberis</i> cf. <i>okinawensis</i> Ruan	0	0	0	0	0	0	1	1	0	0	1	0	1	0	1	0	0	0	0	1	2	1	1
<i>Xestoleberis variegata</i> Brady	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
<i>Xestoleberis</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	1
<i>Xestoleberis</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Xestoleberis</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Xestoleberis</i> sp. 4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Xestoleberis</i> sp. 5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Xylocythere</i> sp.	0	1	0	1	0	0	1	2	1	0	1	0	3	0	2	0	4	0	0	2	3	0	3
Gen et sp. indet 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gen et sp. indet 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gen et sp. indet 3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Gen et sp. indet 4	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0
No. of specimens	149	168	113	179	188	87	183	146	124	178	133	204	218	191	178	190	201	151	183	142	226	163	131

**Table DR2.** Ostracod results of the study core BJ8-03-70GGC.

Age BP kyr (Linsley et al., 2010)	Relative abundance (%)				Faunal composition	Species diversity
	<i>Krithe</i>	<i>Argilloecia</i>	<i>Bradleya</i>	Others	NMDS1	E(S50)
468.00	26.58	8.86	8.86	55.70	-0.13	21.09
558.00	35.85	9.43	13.21	41.51	-0.45	19.48
648.00	30.69	7.92	7.92	53.47	-0.52	22.27
793.00	31.85	7.64	9.55	50.96	-0.24	20.31
1101.00	39.60	7.38	11.41	41.61	-0.21	17.37
1408.00	38.10	7.74	5.36	48.81	-0.19	21.87
1716.00	35.42	3.47	12.50	48.61	-0.16	21.53
2024.00	37.12	12.88	8.33	41.67	-0.12	19.71
2312.00	37.21	12.40	7.75	42.64	-0.07	19.69
2514.00	44.44	10.00	5.56	40.00	-0.16	19.85
2918.00	40.35	7.89	9.65	42.11	-0.33	20.60
3120.00	30.05	11.74	2.82	55.40	-0.05	22.61
3322.00	31.62	11.03	5.88	51.47	-0.16	22.90
3524.00	36.13	9.03	6.45	48.39	-0.18	20.29
3726.00	38.78	8.67	5.61	46.94	-0.29	19.26
3928.00	44.60	10.07	2.88	42.45	-0.29	20.94
4139.00	33.13	13.13	3.75	50.00	0.01	22.51
4391.00	40.76	7.07	6.52	45.65	0.06	21.52
4642.00	39.52	6.45	5.65	48.39	-0.09	22.27
4894.00	42.93	5.98	7.07	44.02	0.00	21.00
5041.00	29.44	13.71	4.57	52.28	0.02	23.55
5189.00	39.24	6.96	2.53	51.27	-0.44	19.26
5336.00	26.21	17.24	4.83	51.72	-0.08	21.70
5484.00	30.20	15.44	6.71	47.65	-0.35	19.36
5631.00	23.21	13.69	4.17	58.93	-0.02	23.68
5798.00	31.86	14.16	6.19	47.79	-0.06	20.87
5955.00	31.84	15.64	5.59	46.93	-0.08	20.36
6132.00	43.09	5.85	10.11	40.96	0.05	18.91
6299.00	39.08	6.90	5.75	48.28	-0.20	18.75
6477.00	30.60	15.85	8.20	45.36	0.16	20.18
6699.00	25.34	20.55	9.59	44.52	0.41	20.69
6922.00	22.58	16.94	13.71	46.77	0.09	20.59
7145.00	37.08	12.36	11.24	39.33	0.09	20.01
7367.00	30.83	15.79	10.53	42.86	0.12	17.60
7651.00	24.02	15.69	9.80	50.49	0.28	19.92
8359.00	29.36	16.51	10.09	44.04	0.26	19.45
9067.00	28.80	16.75	6.81	47.64	0.40	19.72
9775.00	30.34	14.04	4.49	51.12	0.25	20.08
10483.00	31.05	14.21	4.21	50.53	0.33	20.00
11191.00	25.37	15.42	5.97	53.23	0.36	22.87
11856.00	17.88	21.19	7.28	53.64	0.59	23.29
12520.00	16.39	19.13	6.56	57.92	0.70	24.00
13185.00	29.58	15.49	9.86	45.07	0.24	18.40
13849.00	32.30	15.49	6.19	46.02	0.23	18.46
14126.00	30.67	16.56	7.36	45.40	0.28	19.78
14300.00	38.17	9.92	6.87	45.04	0.13	20.60

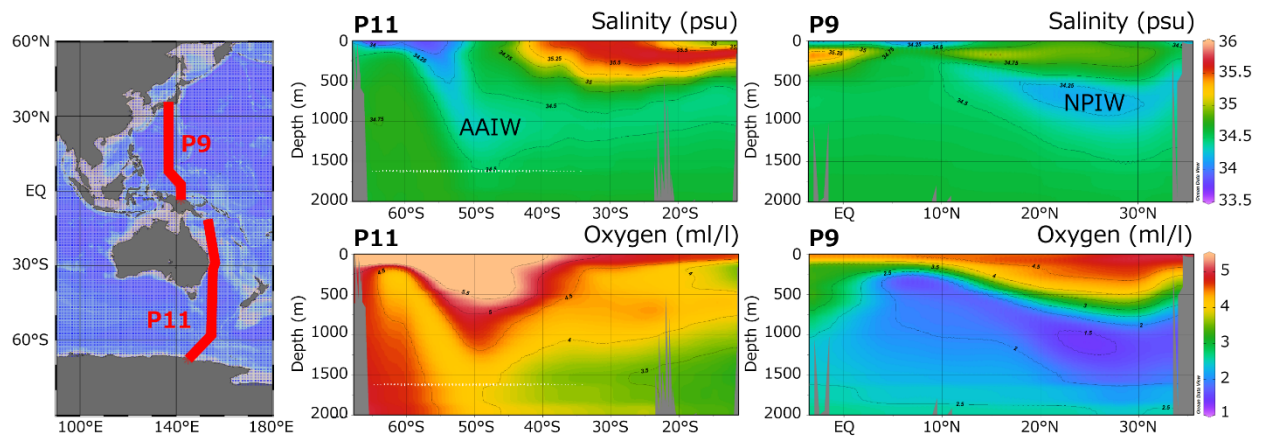


**Figure DR1.** CTD profiles of temperature and salinity obtained near the study site in the Makassar Strait (Orange lines: latitude: 4° 2'S, longitude: 118° 36'E, Blue lines: latitude: 3° 38'S, longitude: 119° 9'E) during the BJ8-2003 cruise (Rosenthal et al., 2013).



**Figure DR2.** Scatter plots of the paleoenvironmental variables and the ostracod results.

Relationships between the ostracod faunal composition (NMDS1), and **a**: the relative abundance of *Krithe* ( $n = 46$ ,  $R^2 = 0.3593$ ,  $p < 0.0001$ ), and **b**: the relative abundance of *Argilloecia* ( $n = 46$ ,  $R^2 = 0.4996$ ,  $p < 0.0001$ ), and **c**: the surface water temperatures anomalies from the ITF region cores including the study core BJ8-03-70GGC (Linsley et al., 2010) ( $n = 46$ ,  $R^2 = 0.1127$ ,  $p = 0.0226$ ), and **d**: the intermediate water temperatures anomalies from the ITF region cores including the study core BJ8-03-70GGC (Rosenthal et al., 2013) ( $n = 36$ ,  $R^2 = 0.3362$ ,  $p = 0.0002$ ).



**Figure DR3.** Cross sections of the salinity and dissolved oxygen (0–2000 m) along the World Ocean Circulation Experiment P9 (north Pacific along 137°E) and P11 (south Pacific along 155°E) lines. The diagrams were created using Ocean Data View (Schlitzer, 2017).

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