

Importance of two river mouths in the southern Izu Peninsula of Japan as habitats for endangered macrobenthic species

Takeshi Yuhara*¹, Hiroyuki Yokooka², Gen Kanaya³, Masaatsu Tanaka⁴, Tomoo Unagami⁵,
Kosaku Yokoyama⁶, Masanori Taru⁷

¹Graduate School of Life Science, Tohoku University, 6-3 Aoba, Aramaki, Aoba-ku, Sendai, Miyagi 980-8578, Japan. ²IDEA Consultants, Inc. Institute of Environmental Ecology, 1334-5 Riemon, Yaizu, Shizuoka 421-0212, Japan. ³National Institute for Environmental Studies (NIES), 16-2 Onogawa, Tsukuba, Ibaraki 305-8506, Japan. ⁴Department of Biology, Keio University, 4-1-1 Hiyoshi, Kohoku-ku, Yokohama, Kanagawa 223-8521, Japan. ⁵Center for Environmental Studies, 2-1-22 Nishiki-cho, Tachikawa, Tokyo 190-0022, Japan. ⁶The Oceanic Wildlife Society, 4-27-13 Sendagaya, Shibuya-ku, Tokyo 151-0051, Japan. ⁷Faculty of Science, Toho University, 2-2-1 Miyama, Funabashi, Chiba 274-8510, Japan.

*Corresponding author; email: takeshi.yuhara@gmail.com

Abstract

An inventory of the macrobenthic invertebrate fauna of the temperate tidal flats on southern Izu Peninsula, Pacific coast of Japan is presented. Surveys conducted during from 2014 to 2018 in the Aono and Ogamo River mouths. A total of 74 macrobenthic taxa, including 24 endangered species were recorded in these areas of diverse intertidal habitats including bare tidal flats, salt marshes and semi-mangrove *Hibiscus hamabo*. The faunal diversity and number of endangered species were comparable to those reported from adjacent regions (e.g., Tokyo Bay and southern Fukushima Prefecture), with 15 of the endangered species specific to the southwest Pacific Japanese coast, suggesting that these populations were nearly their northeastern distribution limits. New records for the gastropod *Cerithium corallium* and bivalve *Isognomon ehippium* on southern Izu Peninsula represented the northeastern distribution limits of both species. The inventory will serve as a faunal reference for conservation of biodiversity in the study areas, and aid future monitoring under any environmental changes occurred in the region.

Key words: Aono River; endangered species; Izu Peninsula; macrobenthic animals; Ogamo river

Introduction

The coastline of southern Izu Peninsula, southeastern Honshu Island, is strongly influenced by the Kuroshio Current, which carries warm subtropical waters in a northeasterly direction along the coast (Otsuka 1985; Ambe et al. 2004). Although the short steeply graded rivers characteristic of the peninsula largely restrict the formation of tidal flats at the river mouths, those of the Aono and Ogamo Rivers are characterized by very small tidal flats. The intertidal habitats of these two rivers maintain the easternmost stable

populations of several endangered crab taxa, including sesarmids (e.g., *Clistocoeloma villosum*), varunids (e.g., *Ptychognathus capillidigitatus*), camptandriids (e.g., *Deiratonotus japonicus*), and ocypodids (e.g., *Austruca lactea*) (Tanaka et al. 2004; Ito 2014; Yokooka et al. 2015; Yuhara and Yokooka 2019), however, detailed faunal investigations focusing on the highly variable macrozoobenthic taxa in these regions have not conducted yet.

Therefore, the present study was conducted to 1) develop a detailed faunal list of the macrobenthic

invertebrates inhabited these areas with various environments, 2) identify the endangered species, as designated by the Red Lists issued by the Ministry of the Environment, Government of Japan (2017, 2020), and 3) determine, by reviewing previous studies, whether or not such endangered species had attained their distribution range limits. Finally, an evaluation was made regarding the appropriateness of future conservation efforts for the Aono and Ogamo River mouths.

Materials and Methods

Study site

The Aono River mouth ($34^{\circ}38'04.99''$ – $34^{\circ}38'51.76''$ N, $138^{\circ}53'11.54''$ – $138^{\circ}52'37.19''$ E), located near Minami-Izu Town, southern Izu Peninsula, (Shizuoka Prefecture), provides an intertidal habitat characterized by mud flats, gravel, cobble stones, oyster beds and salt marshes. (Figs. 1 and 2; Table 1). Vegetation at the sampling sites included the common reed *Phragmites australis*, semi-mangrove plants (Nakanishi 2001), such as

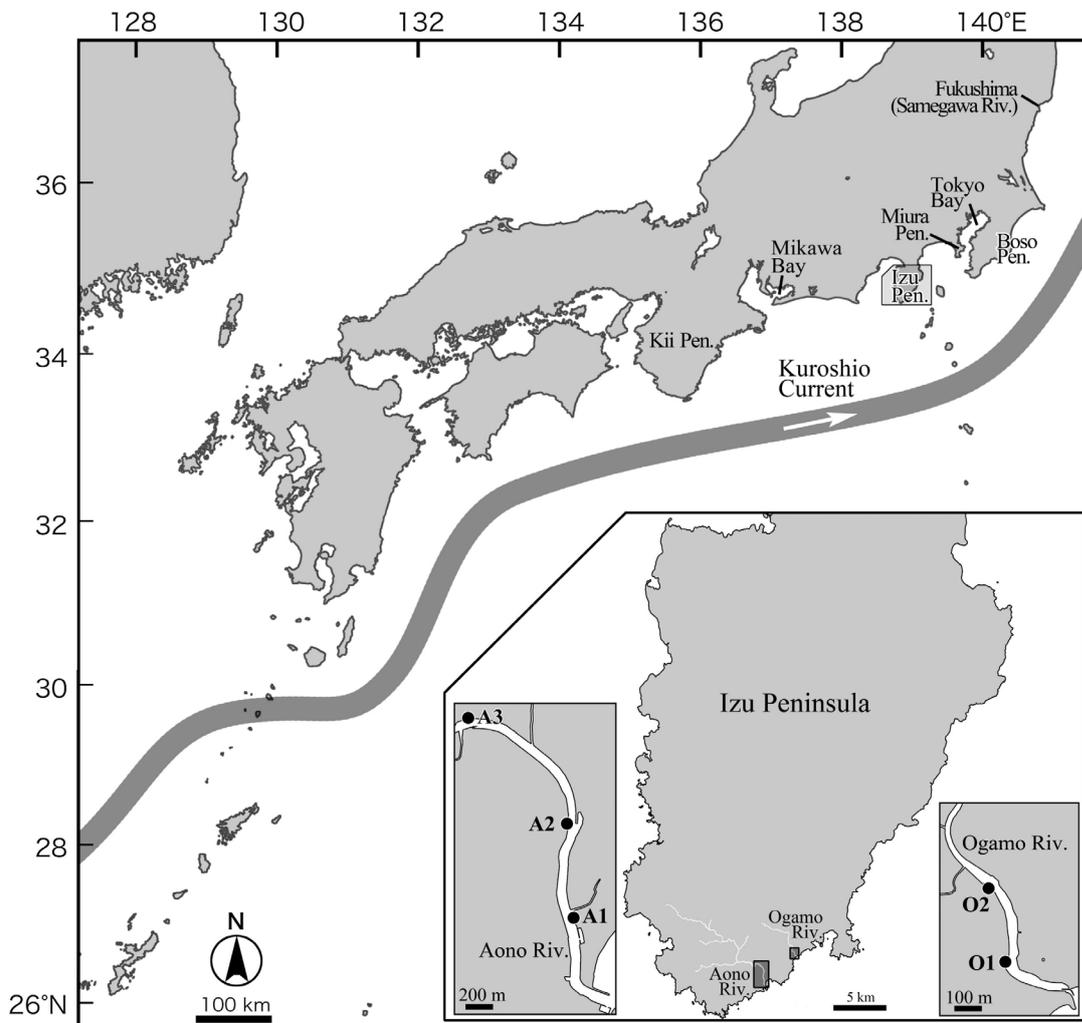


Fig. 1. Map of the study region in southern Izu Peninsula, Japan. Three sampling sites for Aono River (A1, A2, and A3) and 2 for Ogamo River (O1, O2) are also shown.



Fig. 2. Three sampling sites in the Aono River mouth. A1, located 0.8 km from the river mouth, is a protected area for mangroves, designated by Shizuoka Prefecture. A1-1 shows mud flat, gravel, cobble stone, oyster bed, and salt marsh habitats, A1-2, the common reed *Phragmites australis* and semi-mangrove plant *Hibiscus hamabo*, and A1-3, the mangrove *Kandelia obovata*. A2 was located 1.4 km from the river mouth. A2-1 shows sandy-mud flat habitat, A2-2, sandy-mud flat habitat with the common reed *P. australis*, and A2-3, cobblestone habitat. A3 was located 2.7 km from the river mouth. A3-1 and 2 show sandy flat, gravel, and cobblestone habitats, and A3-3, gravel habitat with the common reed *P. australis*.

Hibiscus hamabo, and the mangrove *Kandelia obovata*, which was introduced in 1958 from Iriomote Island, a subtropical region of Japan, (Iijima and Hayashi 1999; Masuda 1999). The characteristics of three sampling sites at the Aono River mouth (A1, A2, and A3) are summarized in Table 1, and the locations and landscapes are shown in Figs. 1 and 2, respectively. Site A1 included a protected area of mangrove forests, designated by the prefectural authority (Fig. 2).

The Ogamo River mouth, located on approximately 3.5 km east of the Aono River

mouth (34°39'19.53"–34°39'27.25" N, 138°55'07.04"–138°55'05.46" E), provides intertidal habitats similar to those of the Aono River mouth. Vegetation at the sampling sites included the common reed *P. australis*, sedge *Carex scabrifolia*, and semi-mangrove plants *H. hamabo*. The characteristics of these two sites (O1 and O2) are detailed in Table 1, and locations and landscapes are shown in Figs. 1 and 3, respectively.

Data collection

Surveys were performed during daytime low

Table 1. Sampling sites located on the Aono (A1, A2, and A3) and Ogamo Rivers (O1 and O2), southern Izu Peninsula, Japan (see Fig. 1).

Site	Coordinate (N, E)		Distance from the mouth (km)	Salinity	Description of the site
A1	34°38'04.99"	138°53'11.54"	0.8	11.7–21.7	Mud flats, gravel, cobble stones, oyster beds, and salt marshes. Plants included the common reed <i>Phragmites australis</i> , semi-mangrove <i>Hibiscus hamabo</i> , and the mangrove <i>Kandelia obovata</i> . This site is a protected area for the mangroves, designated by Shizuoka Prefecture.
A2	34°38'24.70"	138°53'09.03"	1.4	13.9–17.2	Sandy-mud flat, cobble stones, and salt marshes.
A3	34°38'51.76"	138°52'37.19"	2.7	4.0–14.9	Sandy flat, gravel, cobble stones, and salt marshes.
O1	34°39'19.53"	138°55'07.04"	0.3	15.3–17.0	Mud flats, sandy-flat, gravel, cobble stones, and salt marshes. Plants included the common reed <i>Phragmites australis</i> , the saltmarsh sedge <i>Carex scabrifolia</i> and semi-mangrove <i>Hibiscus hamabo</i> .
O2	34°39'27.25"	138°55'05.46"	0.55	No Data	Mud flats, oyster beds, and salt marshes. Plants included the common reed <i>Phragmites australis</i> , semi-mangrove <i>Hibiscus hamabo</i> .

tide in May, August, November, and December 2014, March 2015, May 2016, August and September 2017, and October 2018 at the five sampling sites (Table 1). At each site, a 30-min survey was conducted qualitatively by two or more investigators for collecting epifaunal and mobile benthos on the substrate by hand. In March 2015 and August 2017, the sediment was excavated (approximately 20 cm depth) and sieved using a 1-mm mesh sieve to collect infaunal invertebrate animals. The collected specimens were fixed with 5 % seawater formalin, then stored in 70 % ethanol, and identified to the lowest possible taxonomic level using the available taxonomic literature. In this study, the macrobenthic invertebrate species, which assessed as Vulnerable (VU), Near Threatened (NT) and Data Deficient (DD) by the Red List of Ministry of the Environment (Ministry of the Environment 2017, 2020), were defined as “Endangered species”. Almost specimens were

deposited in the Osaka Museum of Natural History or the Museum of Natural and Environmental History, Shizuoka.

Salinity of river waters was measured in August 2017 at survey sites A1, A2, A3, and O1 during low tide, using a hand-held conductivity meter (CM-31P, TOA-DKK) placed in river water 1 cm above the sediment. The measurements were conducted for three times with a 3 to 5 m interval at each sampling point.

Results

Seventy-four taxa, representing 17 gastropods, eight bivalves, nine annelids, and 40 arthropods (31 decapods and nine others) (Table 2), were recorded at the intertidal zones of the Aono and Ogamo River mouths. Regard to the Aono River sites, 59 macrobenthic animal species were recorded, representing 11 gastropods, two bivalves, nine annelids, and 37 arthropods (29 decapods and



Fig. 3. Two sampling sites in the Ogamo River mouth. O1 was located 0.3 km, and O2 was 0.55 km from the river mouth. O1-1 and 2 show sandy flat habitat with the saltmarsh sedge *Carex scabrifolia*, and O1-3, mud flat and cobblestone habitat with the common reed *Phragmites australis*. O2-1 shows mud flat habitat with the common reed *P. australis*, O2-2, mud flat habitat with the semi-mangrove plant *Hibiscus hamabo*, and O2-3, mud flat and oyster bed habitats.

eight others) (Table 2). Seventeen species were considered the endangered ones (Ministry of the Environment 2017, 2020). The salinities of sites A1, A2 and A3 were showed the range of 4.0-21.7, regarding brackish water (Table 1). As for the Ogamo River sites, 59 macrobenthic animal species were recorded, 16 gastropods, seven bivalves, three annelids, and 33 arthropods (27 decapods and six others) (Table 2).

Nineteen species were considered the endangered ones (Ministry of the Environment 2017, 2020). The salinity of site O1 ranged of 15.3-17.0 (Table 1), almost half salinity of the seawater. In total, 24 endangered species (Fig. 4), consisted of three vulnerable, 20 near threatened, and one data deficient species (Ministry of the Environment 2017, 2020) were recorded over the intertidal zones of the two river mouths.

In addition, two of new distributional records on southern Izu Peninsula were established for the

gastropod *Cerithium coralium* and bivalve *Isognomon ephippium*. Short descriptions and photographs (Fig. 4) of both species are provided herein.

Order indet.

Family Potamididae

Cerithium coralium Kiener, 1841

Threatened category: NT (Near Threatened)

Material examined: OMNH-Mo39087; Shell height 22.3 mm, Shell length 7.9 mm, Table 2; Fig. 3B.

Diagnosis: Shell tall, with short siphonal canal. Whorls weakly inflated, with three spiral ribs crossed by narrower axial ribs forming granules at intersections. Color uniformly dark brown. The collected specimens corresponded closely to the descriptions of *C. coralium* provided by Hasegawa (2017).

Geographical distribution: *C. coralium* is widely

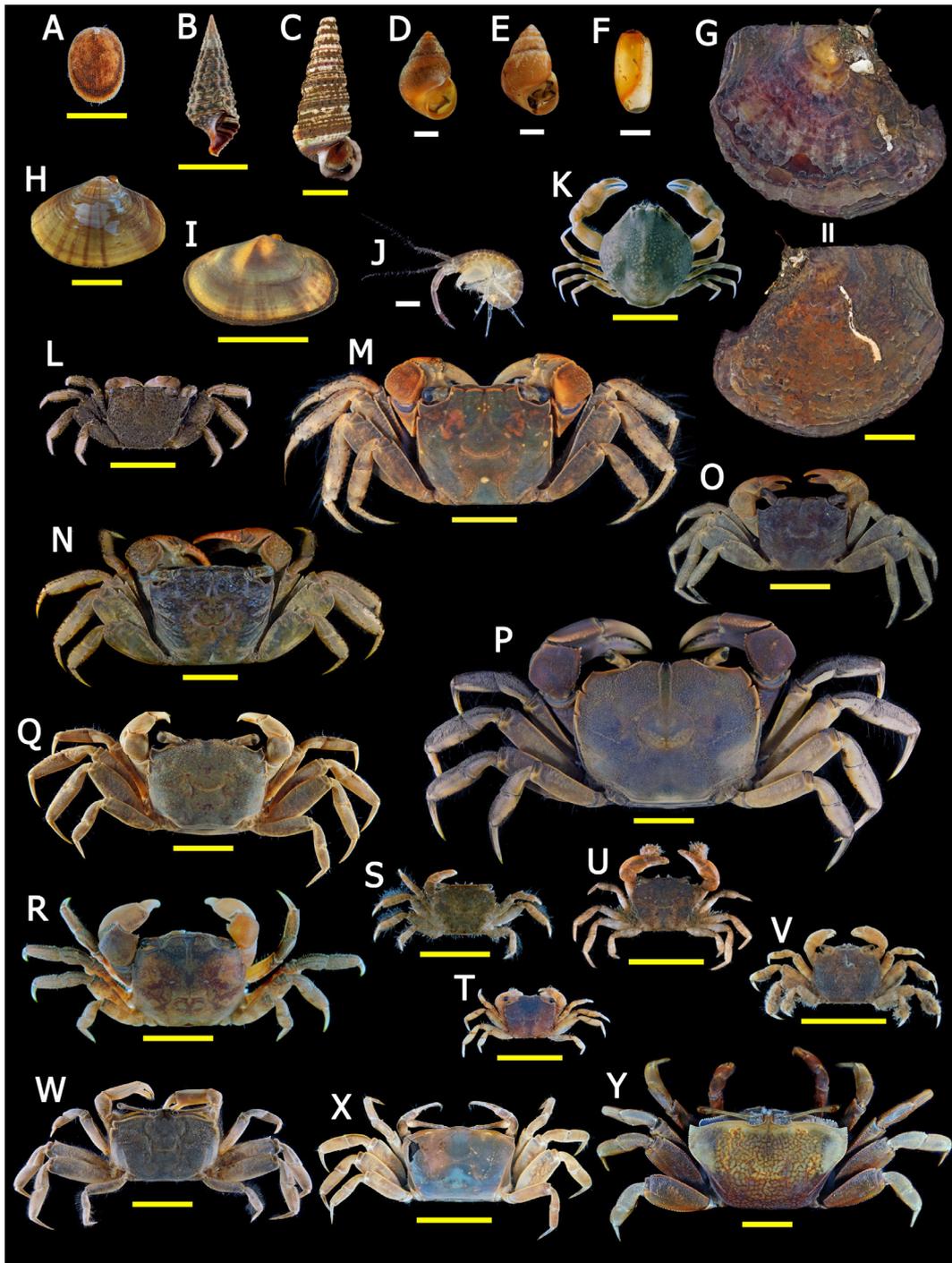


Fig. 4. Endangered and newly recorded species of macrobenthic animals collected from the Aono and Ogamo Rivers mouths, southern Izu Peninsula, Japan. A: *Phenacolepas pulchella*, B: *Cerithium coralium*, C: *Cerithidea moerchii*, D: *Angustassiminea castanea*, E: *Assiminea* aff. *parasitologica*, F: *Acteocina koyasensis*, G: *Isognomon ehippium*, H: *Gari crassula*, I: *Gari chinensis*, J: *Grandidierella osakaensis*, K: *Pyrhila pisum*, L: *Clistocoeloma villosum*, M: *Orisarma intermedium*, N: *Parasesarma affine*, O: *Parasesarma tripectinis*, P: *Chasmagnathus convexus*, Q: *Helicana japonica*, R: *Pseudohelice subquadrata*, S: *Parapyxidognathus deianira*, T: *Ptychognathus capillidigitatus*, U: *Ptychognathus ishii*, V: *Deiratonotus japonicus*, W: *Macrophthalmus banzai*, X: *Austruca lactea*, Y: *Tubuca arcuata*. Yellow bar indicates 1cm and white bar indicates 1 mm. *Cerithium coralium* (B) and *Isognomon ehippium* (G) are new distributional records in this study area.

distributed on Kii Peninsula, and southwards to the tropical Indo-Pacific, and north eastern Indian Ocean.

Habitat: *C. coralium* were found on muddy flats in brackish water at site O1 of Ogamo River mouth.

Order Ostreida

Family Isognomonidae

Isognomon ehippium (Linnaeus, 1758)

Material examined: OMNH-Mo39088; Shell height 63.1 mm, Shell length 49.5 mm, Table 2; Fig. 3G.

Diagnosis: Small or medium-sized, subequivalve, linguiform to suborbicular, relatively thick to thin, weakly convex. Umbo terminal, projecting forward. Cardinal area relatively wide, with several multivincular pits. Outer surface purplish, imbricated with micaceous growth lamellae. Inner surface pearly. The collected specimens corresponded closely to the descriptions of *I. ehippium* provided by Hayami (2017).

Geographical distribution: *I. ehippium* is widely distributed on Kii Peninsula, and southwards to the tropical Indo-Pacific.

Habitat: *I. ehippium* were attached intertidally to concrete blocks in brackish water at site O1 of Ogamo River mouth.

Discussion

The Aono and Ogamo River mouth surveys resulted in identification of 74 macrobenthic taxa. Significantly, 24 endangered species were found, comprising 32.4 % of the total species recorded. Faunal surveys of adjacent East Japan tidal flats, utilizing similar survey methods, recorded 98 taxa

in Tokyo Bay representing 26 gastropods, 20 bivalves, 17 annelids, and 33 arthropods (27 decapods and six others) (Yuhara et al. 2013) and 140 taxa in the Samegawa River, Fukushima Prefecture representing 22 gastropods, 24 bivalves, 25 annelids, and 33 arthropods (26 decapods and 22 others) (Kanaya et al. 2019). The present study showed that the arthropods were almost equivalent numbers though the taxon number of gastropods, bivalves, and annelids were low.

The endangered species in prior reports recorded 29 species in Mikawa Bay (Ministry of the Environment 2019), 29 species in Tokyo Bay (Yuhara et al. 2013), and 26 species in the Samegawa River (Kanaya et al. 2019). The present study for the southern Izu Peninsula is consistent with these prior reports, with a roughly equivalent number of endangered species based on the Red List of Ministry of the Environment. The relatively high number of the endangered species may have been occurred in the southern Izu Peninsula due to the variety of habitats, including bare tidal flats, salt marshes, and semi-mangrove, despite the very small tidal flats.

However, the following 15 endangered species, specific to the southwest Pacific Japanese coast suggesting that these populations are nearly their northeastern distribution limits, are worthy of further mention, having been classified into three distribution patterns: 1) The gastropod *Cerithium coralium* (Fig. 4B) is suggested as extending its distribution eastward from Kii Peninsula to Izu Peninsula, the species being primarily distributed southwest from Kii Peninsula, with a stable population at Tanabe Bay, southernmost Kii Peninsula (Sakamoto and Wada 2016). 2) The

amphipod *Grandidierella osakaensis* (Fig. 4J) and brachyuran crabs *Parasesarma tripectinis* (Fig. 4O), *Pseudohelice subquadrata* (Fig. 4R), *Macrophthalmus banzai* (Fig. 4W), and *Austruca lactea* (Fig. 4X), recorded in the present study, have been sporadically detected on Miura Peninsula, east of Izu Peninsula (Kishi et al. 2013, 2015; Ariyama and Taru 2017; Ito and Suguro 2018; Ito and Shimazu 2018). 3) The snail *Phenacolepas pulchella* (Fig. 4A), bivalves *Gari crassula* (Fig. 4H) and *G. chinensis* (Fig. 4I), brachyuran crabs *Clistocoeloma villosum* (Fig. 4L), *Parapyxidognathus deianira* (Fig. 4S), *Ptychognathus capillidigitatus* (Fig. 4T), *P. ishii* (Fig. 4U), *Deiratonotus japonicus* (Fig. 4V), and *Tabuca arcuata* (Fig. 4Y), all recorded during the present study, have been rarely recorded on the coastal areas of southern Boso Peninsula or Tokyo bay (Asakura and Moriue 2007; Yuhara and Aizawa 2016; Inui et al. 2019; Takakura and Komai 2019).

The inventory compiled here of macrobenthic fauna inhabiting the intertidal zones of two river mouths in southern Izu Peninsula suggests that these study sites are important habitats for many macrobenthic invertebrates, with respect to a number of endangered species. By comparison, human activities and natural disasters have severely modified the Japanese Pacific coastal area of northeast of Tokyo Bay. Tokyo Bay itself having lost approximately 90 % of previous tidal flat areas since the end of the 1970s (Furota 2007). In the Tohoku region, the Great East Japan Earthquake caused extensive tsunamis, creating intense high impact disturbances to diverse ecosystems along the coastline (Urabe and

Nakashizuka 2016; Kanaya et al. 2016). As a result, many macrobenthic animals became extinct or endangered in these regions (Furota 2007; Yuhara et al. 2013; Yuhara et al. 2016; Kanaya et al. 2019). Accordingly, it is of utmost importance that these depleted regions may be supplied with planktonic larvae from southwestern zones such as Izu Peninsula, to recover their macrobenthic community assemblages disrupted by natural disasters and human activities. The present inventory will also serve as a faunal reference for conservation management in these study areas, and will aid future monitoring under any future environmental changes occurred in southern Izu Peninsula.

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Table 2. Inventory of benthic macroinvertebrates recorded in the Aono and Ogamo River mouths. “○” indicates presence of taxa at each sampling site. “●” indicates presence of endangered species included in the Red List 2020 (Ministry of the Environment, 2020) and Red List of threatened marine species (Ministry of the Environment, 2017). VU: Vulnerable, NT: Near Threatened, DD: Data deficient. “OMNH” and “SPMN” indicate to have been deposited in “Osaka Museum of Natural History” and “Museum of Natural and Environmental History, Shizuoka”, respectively.

Phylum	Class	Order	Family	Aono River			Ogamo River		Red list	Voucher Number				
				A1	A2	A3	O1	O2						
Mollusca	Gastropoda	Trochida	Turbinidae	○	○	○	○	○	○	OMNH-Mo39259				
			Neritidae	○	○	○	○	○	○	SPMN-MO 1003, 1005				
	Cycloneritida	Cycloneritida	<i>Clithon faba</i>	○	○	○	○	○	○	SPMN-MO 1004, 1010, OMNH-Mo39256				
			<i>Clithon retropictum</i>	●	○	○	○	○	○	○	SPMN-MO 1011, OMNH-Mo39249			
	Order indet.	Order indet.	Phenacolepadidae	●	○	○	○	○	○	○	NT			
			Batillariidae	○	○	○	○	○	○	○	○	○	SPMN-MO 1013, OMNH-Mo39250, 39253, 39255	
	Potamidiidae	Potamidiidae	<i>Cerithium coralium</i>	○	○	○	○	○	○	○	○	VU		
			<i>Cerithidea moerchii</i>	○	○	○	○	○	○	○	○	○	NT	
	Assimineidae	Assimineidae	<i>Angustassiminea castanea</i>	●	○	○	○	○	○	○	○	NT		
			<i>Angustassiminea</i> aff. <i>satumana</i>	○	○	○	○	○	○	○	○	○	NT	
	Assimineidae	Assimineidae	<i>Assiminea</i> aff. <i>parasitologica</i>	○	○	○	○	○	○	○	○	○	NT	
			<i>Assiminea</i> "hiradoensis"	○	○	○	○	○	○	○	○	○	○	○
	Assimineidae	Assimineidae	<i>Assiminea</i> "japonica"	○	○	○	○	○	○	○	○	○	○	○
			<i>Reticulonassa festiva</i>	○	○	○	○	○	○	○	○	○	○	○
Olividae	Olividae	<i>Olivella japonica</i>	○	○	○	○	○	○	○	○	○	○	○	
		<i>Acteocina koyasensis</i>	○	○	○	○	○	○	○	○	○	○	○	
Aplysiida	Aplysiida	<i>Bursatella leachii</i>	○	○	○	○	○	○	○	○	○	○	○	
		<i>Cingulina circinata</i>	○	○	○	○	○	○	○	○	○	○	○	
Mytilida	Mytilida	<i>Musculista senhousia</i>	○	○	○	○	○	○	○	○	○	○	○	
		<i>Saccostrea</i> spp.	○	○	○	○	○	○	○	○	○	○	○	
Pteriidae	Pteriidae	<i>Isognomon ephippium</i>	○	○	○	○	○	○	○	○	○	○	○	
		<i>Barbatia virescens</i>	○	○	○	○	○	○	○	○	○	○	○	
Cardiida	Cardiida	<i>Gari crassula</i>	○	○	○	○	○	○	○	○	○	○	○	
		<i>Gari chinensis</i>	○	○	○	○	○	○	○	○	○	○	○	
Venerida	Venerida	<i>Nuttallia japonica</i>	○	○	○	○	○	○	○	○	○	○	○	
		<i>Ruditapes philippinarum</i>	○	○	○	○	○	○	○	○	○	○	○	

Table 2 (continued)

Phylum	Class	Order	Family	Species	Aono River			Ogamo River		Red list	Voucher Number			
					A1	A2	A3	O1	O2					
Annelida	(Polychaeta)	Phyllodoceida	Nereitidae	<i>Namaneis litoralis</i> species group	○	○	○	○	○		OMNH-Iv6904			
				<i>Hediste ditadroma</i>	○	○	○	○	○		SPMN-OI 4, OMNH-Iv6910, 6911			
				<i>Priotospio japonica</i>	○	○	○	○	○		OMNH-Iv6905			
				<i>Pseudopolydora cf. kempfi</i>	○	○	○	○	○		OMNH-Iv6906, 6913			
				<i>Notomastus</i> sp.	○	○	○	○	○		OMNH-Iv6907, 6912			
Order indet.	Capitellidae		<i>Capitella</i> sp.	○	○	○	○	○		OMNH-Iv6908				
			<i>Cirriformia</i> sp.	○	○	○	○	○		SPMN-OI 1, SPMN-OI 5				
Sabellida	Sabellidae		<i>Laonome</i> sp.	○	○	○	○	○		OMNH-Iv6909				
			<i>Pontodrilus cf. litoralis</i>	○	○	○	○	○		SPMN-OI 3				
Arthropoda	(Oligochaeta)	Crassidellata	Megascolecidae	<i>Fisulobalamus albicosstatus</i>	○	○	○	○	○		OMNH-Ar6910, 6911			
				<i>Granditierella japonica</i>	○	○	○	○	○		SPMN-CR 18, 19, 22, 25			
				<i>Granditierella osakaensis</i>	●	○	○	○	○	DD	OMNH-Ar-10299, 10300, 12125			
				<i>Monocorophium cf. uenoi</i>	○	○	○	○	○		SPMN-CR 21, 24			
				<i>Sinocorophium</i> sp.	○	○	○	○	○		SPMN-CR 20			
				<i>Cyathura cf. muromiensis</i>	○	○	○	○	○		SPMN-CR 5, 15			
				<i>Ligia cinerascens</i>	○	○	○	○	○		OMNH-Ar12108, 12150			
				<i>Gnorimosphaeroma</i> sp. or spp.	○	○	○	○	○		OMNH-Ar12157			
				<i>Sinelobus</i> aff. <i>stanfordi</i>	○	○	○	○	○		SPMN-CR 23			
				Decapoda	Penaeidae	Penaeidae	<i>Penaeidae</i> gen. sp.	○	○	○	○	○		SPMN-CR 26
							<i>Upogebia yokoyai</i>	○	○	○	○	○		SPMN-CR 16
							<i>Pagurus minutus</i>	○	○	○	○	○		SPMN-CR 17, 30
							<i>Pyrhila pisum</i>	○	●	○	○	○	NT	SPMN-CR 27
							<i>Scylla cf. serrata</i>	○	○	○	○	○		OMNH-Ar12102, 12155
							<i>Metopograpsus thukuhar</i>	○	○	○	○	○		OMNH-Ar12158
							<i>Chironantes haematocheir</i>	○	○	○	○	○		OMNH-Ar12129, 12140, 12146
							<i>Clisocoloma villosum</i>	●	○	○	○	○	NT	OMNH-Ar12166
<i>Orisarma dehaani</i>	○	○	○				○	○		OMNH-Ar12100, 12128, 12138				
<i>Orisarma intermedium</i>	○	○	●				○	○	NT	OMNH-Ar12141				
		<i>Parasarma affine</i>	●	○	○	○	NT	OMNH-Ar12151						

Table 2 (continued)

Phylum	Class	Order	Family	Aono River			Ogamo River			Red list	Voucher Number
				A1	A2	A3	O1	O2	O2		
				○	○	○	○	○	○		OMNH-Ar12099, 12110, 12126, 12148, 12168
				○	○	○	○	○	○		OMNH-Ar12113, 12123, 12134
				●	●			●	●	NT	OMNH-Ar12147
			Varunidae	●	●	●	●	●	●	NT	OMNH-Ar12101, 12109, 12142, 12145, 12167
				○	○	○	○	○	○	NT	SPMN-CR 28
				○	○	○	○	○	○		OMNH-Ar12098, 12112, 12127, 12139, 12144
				●			●			NT	SPMN-CR 9, 14
				○	○	○	○	○	○		OMNH-Ar12154
				○	○	○	○	○	○		OMNH-Ar12103, 12114, 12133, 12149
				○	○	○	○	○	○		SPMN-CR 10, OMNH-Ar12104
				●	●	●	●	●	●	NT	OMNH-Ar12153
				●	●	●	●	●	●	NT	SPMN-CR 1, 3, 12
				●	●	●	○	○	○	NT	SPMN-CR 2, 7, 8, 11, OMNH-Ar12125, 12165, 12169
			Campanndriidae	●	●	●	○	○	○	NT	SPMN-CR 4
				○	○	○	○	○	○		OMNH-Ar12107, 12115, 12121, 12131
			Dotillidae	○	○	○	○	○	○		OMNH-Ar12116, 12137
				○	○	○	○	○	○		SPMN-CR 29
			Macrophthalmida	○	○	○	○	○	○	NT	OMNH-Ar12106, 12130
				●	●	●	○	○	○	VU	OMNH-Ar12111
			Ocypodidae	●	●	●	○	○	○	VU	OMNH-Ar12152
				●	●	●	●	●	●		
			Total taxa	40	42	32	51	25	59	24	

†: Treated as *Gari minor* in Ministry of the Environment (2020) (see Fukuda 2020).