Ecological Indicators 45 (2014) 687–691

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Short Communication

Past biodiversity: Historical Japanese illustrations document the distribution of whales and their epibiotic barnacles

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ARTICLE INFO

Article history:
Received 9 April 2014
Received in revised form 26 May 2014
Accepted 28 May 2014

Keywords:
Whale barnacle
Cirripedia
Cetacea
Honzou Gaku
Natural history
Classical record

ABSTRACT

In recent centuries, excessive fishing has been a major driver in the decline of marine animals. To manage and restore ecosystems, it is necessary to determine the richness of past biodiversity. This report describes the whales and barnacles recorded in classic monographs (called *Honzou Gaku*) written by Japanese naturalists in the 18th–19th centuries. Past Japanese fauna and flora were documented in these monographs with detailed illustrations; however, many such monographs have been neglected by modern biologists. The whale barnacles illustrated in these monographs were identified as *Coronula diadema* (Linnaeus, 1767), *Coronula reginae* Darwin, 1854, and *Conchoderma auritum* (Linnaeus, 1767). A case study of historical biodiversity is presented here, and shows just one example of the many organisms recorded in the *Honzou Gaku*. Such information has important implications for the use of historical works to assess past or lost biodiversity all over the world.

1. Introduction

> Udano Takakini Shigiwana Haru Wagamatsuya Shigiwa Wayarazu Isukuwashi Isana Sayaru
>
> [The snipe, for which I laid a snipe-snare and waited in the high castle of Uda, strikes not against it; but a brave whale strikes against it.]
>
> A poem by the Japanese First Emperor Jimmu (711–585 BC), recorded in Kojiki

As documented in *Kojiki*, the oldest extant Japanese book (Ōno, 712), Japanese people have praised nature and used marine products including whales. Ancient Japanese naturalists recorded information on past biodiversity and nature. The knowledge of these pioneers is called *Honzou Gaku* and encompasses natural history and Japanese classic taxonomy. Recently, the importance of historical materials has been highlighted for assessing the long-term impact of humans on marine animals and ecosystems (Jackson et al., 2001; Lotze and Worm, 2009; Haelters et al., 2010; McClenachan et al., 2012; Kittinger et al., 2013). Josephson et al. (2008) found substantial changes in North Pacific right whale populations on analyzing archival holdings and fisheries records. Right whales, the host animal for epibiotic barnacles, were hunted for their meat and blubber during the 19th and 20th centuries, but they have become critically endangered in recent decades (Wade et al., 2011). This report presents new findings regarding whales and epibiotic barnacles recorded in the *Honzou Gaku* monographs, along with identification of the barnacles. These findings have important implications for assessing past biodiversity.

2. Description of whale barnacles

The artist and scholar Koukan Shiba (1747–1818) wrote a book entitled *Saiyu Ryotan* in 1794; this book included a diary of his trip from Edo (modern-day Tokyo) to the center of traditional Japanese whaling in Nagasaki Prefecture (Supporting information, Fig. S1). This text describes the epibiotic organisms on whales (Fig. 1A). The barnacles in the illustration on the right side of Fig. 1A are identified as *Coronula diadema* (Linnaeus, 1767) and *Conchoderma auritum* (Linnaeus, 1758). Some epibiotic organisms on the left side of the figure were also described; however, these sketches are simple drawings, making it difficult to identify the species of barnacle. The 5-plated barnacle illustrated on the left side of Fig. 1A was a drawing error by Shiba. At the time, naturalists copied previous materials, possibly including previous mistakes. Shiba's error with respect to the 5-plated barnacle (Fig. 1A) remained in *Kaikaku Kihinsen* (Musashi, after 1843, Fig. 2H) through other publications (see Figs. 1B and C, 2G). Tanshu Kurimoto (1756–1834), a physician and pharmacist, copied the illustration of the 5-plated barnacle from *Saiyu Ryotan* in his monograph *Sen Chu Fu* (Fig. 1B).

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http://dx.doi.org/10.1016/j.ecolind.2014.05.031
1470-160X/

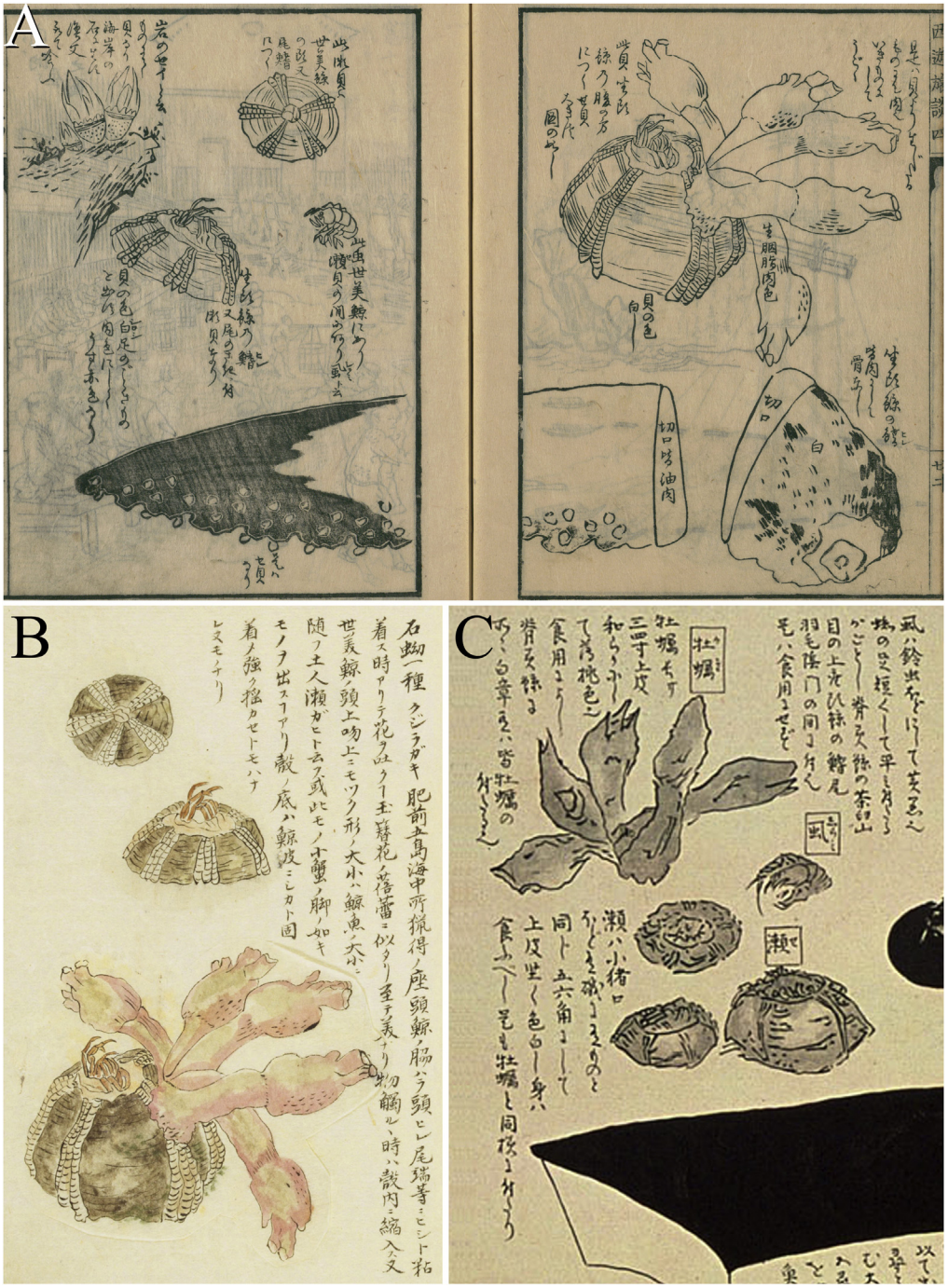

Fig. 1. (A) Illustrations of whale barnacles from Saiyu Ryotan. (B) Sen Chu Fu. (C) Isana Torie Kotoba.

He described crab-like organisms that lived in shells and believed these invertebrates to be a type of mollusk called *Kujira Gaki*, which means "whale oyster" in Japanese (Kurimoto, 1811). Tomokiyo Oyamada (1783–1847) published a celebrated book *Isana Torie Kotoba* regarding traditional whaling in Nagasaki (Oyamada, 1829); this book has been referenced by many researchers (Clarke, 1966; Omura, 1986; Scarff, 1986). This book includes instructions on how to cook whale meat and intriguing descriptions of the epibiotic organisms on whales. He describes several epibiotic organisms on right whales, *Eubalaena japonica* (Lacépède, 1804), including coronulid barnacles, stalked barnacles, and whale lice (Fig. 1C). Whale lice are described as being the size of a "bell-ringing cricket"; they are darkish yellow in color, with short appendages attached to the head and around the tail and vulva of right and humpback whales *Megaptera novaeangliae* (Borowski, 1781). Stalked barnacles (9–12 cm) are described as edible. Coronulid barnacles are described as hexagonal with a hard white shell, similar to intertidal barnacles, the size of a "small *sake* cup," and edible. However, these sketches are simple drawings, making the identification of the species of barnacle difficult.

Classic texts of Japanese fauna and flora such as *Kougai Gun-bunhin-i* (Musashi, 1836), *Moku Hachi Fu* (Musashi, 1843), and *Kaikaku Kihinsen* (Musashi, after 1843) written by the Japanese samurai naturalist Sekiju Musashi (1766–1861), include monochrome and