An analysis of cookie cutter shark-induced body scar marks of common minke whales sampled by JARPN II in the context of stock structure hypotheses

TAKEHARU BANDO[1], NAOHISA KANDA[1], LUIS A. PASTENE[1], TOSHIYA KISHIRO[2], HIDEYOSHI YOSHIDA[2] and HIROSHI HATANAKA[1]

[1] *The Institute of Cetacean Research, 4-5, Toyomi-cho, Chuo-ku, Tokyo, 104-0055, Japan.*
[2] *National Research Institute of Far Seas Fisheries, 2-12-4 Fukuura, Kanazawa-ku, Yokohama, Kanagawa 236-8648, Japan*
Contact e-mail:bando@cetacean.jp

ABSTRACT

Cookie cutter shark-induced scar marks was used as an ecological marker to determine stock structure in western North Pacific common minke whale. Samples collected by JARPN II surveys during 2002-2007 were used in the analysis. First the samples were assigned to J and O stock minke whales based on a previous microsatellite analysis. Prevalence of scars differed clearly between J and O stock animals, however this ecological marker can not be considered as an absolute marker to differentiate both stocks. J-stock animals had fewer scars than O-stock animals. In both stocks prevalence increased with body length and almost all animals of more than 7m in body length had scar marks. Prevalence of scars in O stock animals was compared between two Pacific areas off Japan (coastal sub-areas: 7CN and 7CS and offshore sub-areas: 7E, 8 and 9), considering body length. No differences were found between these two areas in scar prevalence. Therefore results for this ecological marker provide no evidence for sub-division of the O stock into OW and OE (Hypothesis III). Rather these results are consistent with the occurrence of two stocks J and O, the former with fewer scars distributes in coastal areas while the latter with more scars distributes in both coastal and offshore areas.

KEY WORDS: COMMON MINKE WHALE, ECOLOGICAL MARKER, STOCK IDENTIFICATION, JARPNII, NORTH PACIFIC

INTRODUCTION

Most of the common minke whales taken by the JARPN/JARPN II surveys in the Pacific side of Japan had numerous scars on the skin. These scars are thought to be caused by cookie cutter shark (*Insitus brasiliensis*). However, some whales had no or a few scars. Fujise *et al.* (2001) examined relationship between genetically (mtDNA) identified O or J stock animals and occurrence of scars, based on samples of minke whales taken by JARPN. Their results showed high correlations between occurrence of scar and each stock. Goto *et al.* (2009) examined prevalence of scar marks in the common minke whales sampled by JARPN II in 2002-2007 and found significant differences between J and O stock animals and between mature and immature animals. They concluded that scar marks is not a fully diagnostic marker for differentiating J and O stock common minke whales. They noted that there is a strong likelihood that animals with no scars were immature J stock animals.

During the Preparatory Meeting toward the First Intersessional Workshop of western North Pacific common minke whale a hypothesis of six stocks (Hypothesis III) was specified. This hypothesis suggests that there are two J stocks, one in the Sea of Japan side of Japan (JW) and the other in the Pacific side of Japan (JE) and two O stocks (OW/OE) in the Pacific side of Japan. In this hypothesis differences in prevalence of cookie cutter shark marks was used as an evidence to separate OW and OE stocks (Wade *et al.*, 2010). The analysis by these authors was based in the data presented by Goto *et al.* (2009), which unfortunately contained some errors. In addition the analysis by Wade *et al.* (2010) did not consider body length as a variant.

MATERIALS AND METHODS

Samples

Common minke whales collected in 2002-2007JARPN II offshore and coastal surveys were used in this study (Table 1). Prevalence of scar was classified as following criteria (Fig. 1).

Type 1: No scar on the body
Type 2: 1-20 scars on a single side
Type 3: More than 20 scars on a single side

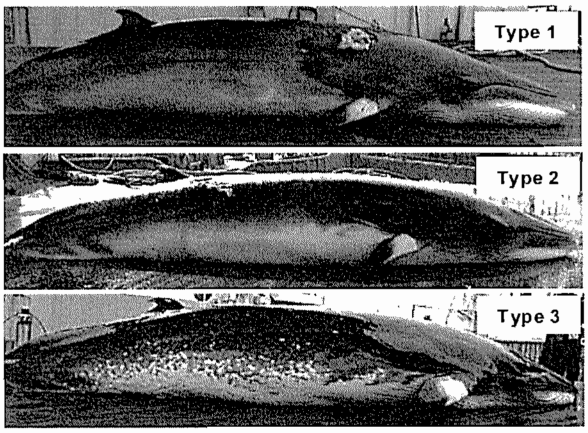

Fig. 1. Scar types of common minke whales.

Table 1. Number of samples used in this study by sub-area, type of scar and microsatellite allocation. Samples were collected by offshore and coastal components of JARPN II during 2002 and 2007.

Sub-area	Type of scar	Microsatellite allocation O	?	J
7CN	Type 1 None	0	2	17
	Type 2 1-20 scars	14	5	31
	Type 3 more than 20 scars	291	31	5
	Total	305	38	53
7CS	Type 1 None	0	3	19
	Type 2 1-20 scars	10	5	22
	Type 3 more than 20 scars	213	25	2
	Total	223	33	43
7W	Type 1 None	0	0	0
	Type 2 1-20 scars	1	0	0
	Type 3 more than 20 scars	20	2	0
	Total	21	2	0
7E	Type 1 None	0	0	0
	Type 2 1-20 scars	0	0	0
	Type 3 more than 20 scars	8	1	0
	Total	8	1	0
8	Type 1 None	0	0	0
	Type 2 1-20 scars	3	1	0
	Type 3 more than 20 scars	95	11	0
	Total	98	12	0
9	Type 1 None	0	0	0
	Type 2 1-20 scars	4	1	0
	Type 3 more than 20 scars	203	23	1
	Total	207	24	1
Grand total		862	110	97

Data analysis

First we re-examined all photographs and found some errors in classification in the dat set used by Goto *et al.* (2009) as follow:

In the 2006 offshore survey scar mark was classified only by two types (type 1: "no exist" and type 2: "exist"). Therefore many whales with type 3 were misclassified as type 2. The classification for all animals in that survey was corrected (n=100). Data of some other whales (n=8) were also corrected.

Fig. 8 in Wade *et al.* (2010) should be read as follow following the data correction:

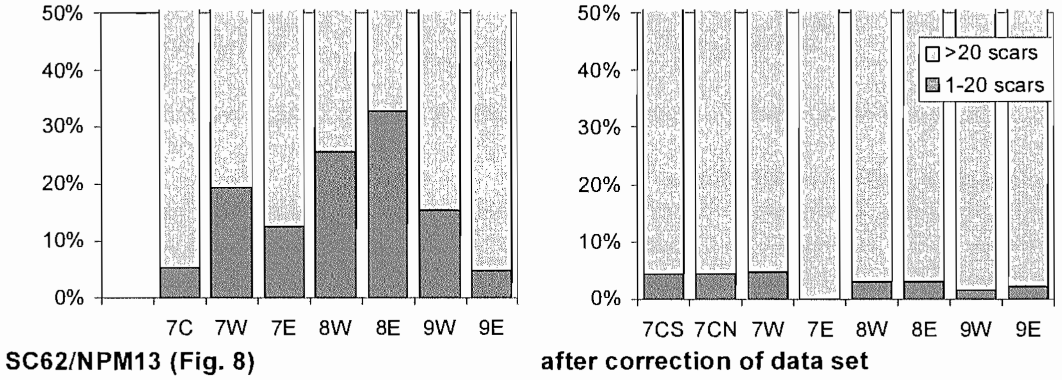

Fig. 2. Prevalence of scars in whales identified as O-stock by microsatellite analysis in each sub-area. Left figure is Wade *et al.* (2010, Fig.8) and right figure shows the same figure after correction of the data set.

Assignment of JARPN II minke whales to J and O stocks

Each whale was classified into three DNA types, according to the criteria established by Kanda *et al.* (2009).

J stock: Assigned as J-stock with membership probability of over 90%

O stock: Assigned as O-stock with membership probability of over 90%

Type ?: Could not be assigned to stock with probability of over 90%

RESULTS AND DISCUSSION

Distribution pattern of scar marks by body length and stock

The proportion of scar types by body length classes and stock was shown in Fig. 3. In both stocks prevalence increased with body length and almost all animals of more than 7m in body length had scar marks. In J-stock, type 1 whales appeared till 7.5m and type 3 animals appeared only in body length class of more than 6.5m. On the other hand, most of the O-stock whales were type 3, and type 2 animal appeared only in small length class. These results indicate that scar prevalence differed between stocks. However scar prevalence is not an absolute marker for stock identification of these stocks except in the case of small (immature) animals with no scar (type 1).

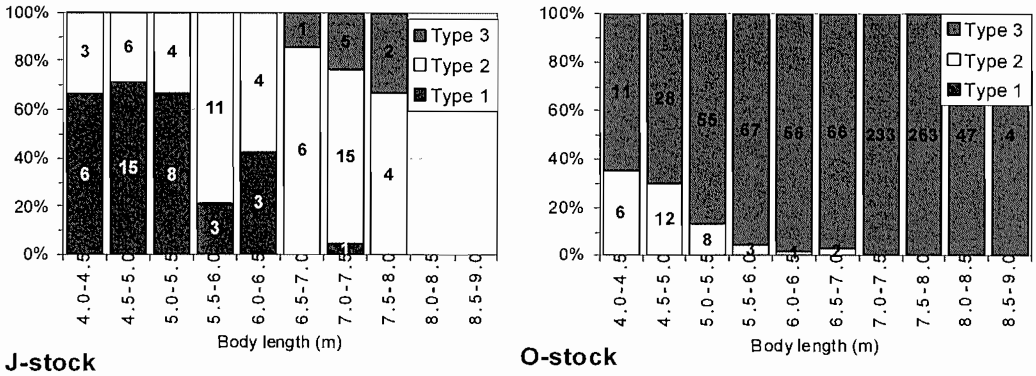

Fig. 3. Proportion of scar types by length classes and stocks. Number in the figures are the sample size.

Comparison of OW and OE stocks

In the hypothesis III difference of scar prevalence between coastal and offshore areas was used as evidence of OW and OE stocks (Wade *et al.*, 2010). It should be noted again that such analysis was based on the uncorrected data used in Goto *et al.* (2009).

A similar analysis was repeated using the corrected data set (Fig. 4). However, no remarkable difference was observed between coastal (SA7CN and 7CS) and offshore (SA 7E, 8 and 9) areas considering body length (Fig. 4).

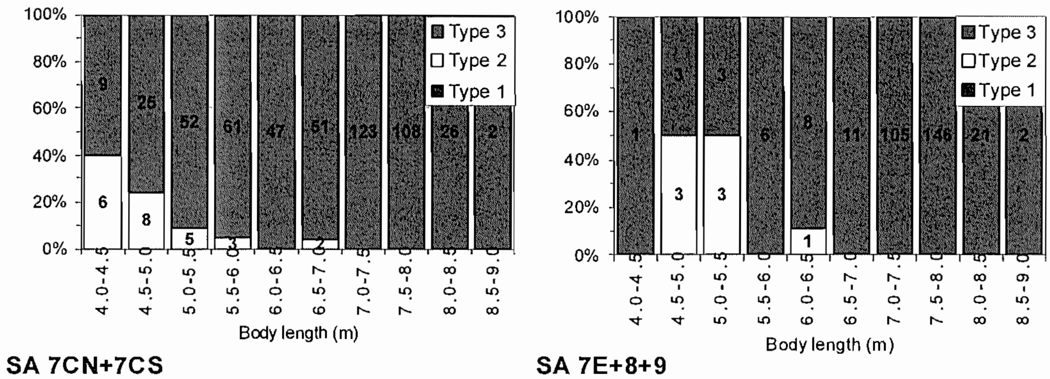

Fig. 4. Proportion of scar types by length classes of O-stock common minke whales sampled in coastal (SA 7CN+7CS) and offshore (SA 7E+8+9) sub-areas.

Plausible stock structure hypothesis inferred from scar marks

Prevalence of scar increased with body length and almost all whales with more than 7m body length had scar marks. This means that scars increase with growth. As the distribution area of cookie cutter shark is restricted within southern deep sea in the North Pacific (Compagno, 1984), scar would be put when whales migrates to low latitude breeding area. Breeding area of J stock animals is thought to be East China Sea or Yellow Sea, where water depth is shallow and distribution of cookie cutter shark was not reported (Compagno, 1984). On the other hand, breeding area of O stock was thought to be southern part of north Pacific, which would lead the difference of prevalence between these stocks.

The present results for this ecological marker provide no evidence for sub-division of the O stock into OW and OE (Hypothesis III). Rather these results are consistent with the occurrence of two stocks J and O, the former with fewer scars distributes in coastal areas while the latter with more scars distributes in both coastal and offshore areas.

ACKNOWLEDGMENTS

Our sincere thanks are due to all researchers and crews who participated in the JARPN II surveys. We thank to Mutsuo Goto, the Institute of Cetacean Research, for useful suggestion on this analysis.

REFERENCES

Compagno, L.J.V. 1984. FAO Species Catalogue - Sharks of the World part 1. Rome.

Fujise, Y., Zenitani, R. and Goto, M. 2001. Utility of non-genetic information for stock identification -The case of the western North Pacific minke whale-. Paper SC/53/SD5 presented to the IWC scientific committee. 9pp.

Goto, M., Kanda, N., Pastene, L.A., Bando, T. and Hatanaka, H. 2009. Differences in cookie cutter shark-induced scar marks between J and O stocks of common minke whales in the western North Pacific. SC/J09/JR18

Kanda, N., M. Goto, T. Kishiro, H. Yoshida, H. Kato, and L. A. Pastene. 2009. Individual identification and mixing of the J and O stocks around Japanese waters examined by microsatellite analysis. SC/J09/JR26.

Wade, P. R., Brownell, Jr, R. L. and Kasuya, T. 2010 A review of the biology of western North Pacific minke whales relevant to stock structure. SC/62/NPM13.