Some Morphological Aspects of the Western North Pacific Minke Whales; Preliminary Analyses of Materials from the JARPN Surveys in 1994-5

Yoshihiro Fujise* and Hidehiro Kato**

*: *The Institute of Cetacean Research, 4-18, Toyomi-cho, Chuo-ku, Tokyo 104, Japan,*
**: *National Research Institute of Far Seas Fisheries, 5-7-1, Orido, Shimizu, Shizuoka 424, Japan.*

ABSTRACT

The present study examines morphological data of 121 individuals of the North Pacific minke whales taken under the special permit (the JARPN) in 1994-5, comparing with samples taken under the past commercial whaling operation in 1987. It was revealed through the linear discriminant function analysis on external body proportion that most of samples (97.2%) taken from the offshore waters (sub-area 9) belong to same group of the coastal samples (Sanriku coast, sub-area 7). Furthermore, the same flipper coloration was shared by animals between two areas. However, in order to obtain more firm conclusion, the present study is still insufficient because larger individuals were not available in the data set of the coastal region.

INTRODUCTION

Morphological studies in the North Pacific minke whale related to the stock identity issue were conducted between the Sea of Japan, Okhotsk Sea and Pacific coast of northern part of Japan, using data obtained from the past Japanese coastal whaling (Kato *et al.*, 1992). They examined geographical differences using morphological data, baleen plate characters and color patterns of flipper, and reported a linear discriminant function to discriminate the Sea of Japan stock from the Western Pacific stock of minke whale. However, no morphological examination has been conducted between samples from waters around Japan and pelagic waters in the western North Pacific. Fujise and Kato (1995) reported a preliminary comparative analysis between minke whales from the coastal waters (sub-area 7) and offshore waters of the western North Pacific (sub-area 9) using 21 samples taken during the 1994 JARPN survey. This paper reports an additional morphological analysis of both areas using minke whales collected by the 1995 JARPN survey in the same sub-area 9.

MATERIALS AND METHOD

Whale samples in sub-area 9 were collected by two JARPN surveys: 1994 (from 5 July to 7 September) and 1995 (from 13 June to 22 August). A total of 121 whales (109 males and 12

females) were sampled and measured on 39 points of body proportion onboard the research base (Fujise *et al.*, 1995, 1996).

Most of the morphological data from samples in sub-area 7 are derived from catches of the small-type whaling operations in Ayukawa in 1987 (Kato *et al.*, 1992). A few data from this sub-area (2 individuals) were obtained from Omura and Sakiura (1956). Data in other sub-areas (8, 10 and 11) were cited from Kato *et al.* (1992). Summary of items of body proportion measurements are shown in Fig. 1. Of 39 items, 18 items were used in this study because of missing values in several measurements.

To compare the body proportion data, each measurement item was plotted to body length and adopted to the linear discriminant function reported by Kato *et al.* (1992).

RESULTS AND DISCUSSION

Table 1 shows the statistics of three measurement points (V1, V2 and V9) by sub-area. Mean body length (V1) of males was relatively higher in sub-area 9 than in the southern part of Okhotsk Sea (S. Okhotsk) and Sanriku, and it is similar to those in samples from the northern part of Okhotsk Sea (N. Okhotsk). On the other hand, mean body length in females was also higher in sub-area 9 than in Sanriku and similar to those in samples from S. Okhotsk.

Table 2 and Figs. 2-4 shows the relative proportion (V2 to V20) to body length in males, for sub-areas 7 and 9. Most of items of body proportions in samples from sub-area 9 seem to be similar to those of samples from sub-area 7. Although some of items such as V10, V11, V12, and V15 seems to be different between sub-areas 7 and 9. This could reflect differences in the facility of attainment of measurements. In sub-area 7, most of survey were conducted by the authors themselves, but the measurements were conducted within limited time due to the nature of commercial whaling regarding the landing position of the whale. In contrast, in sub-area 9, all survey items were conducted with adequate time, and positioning of whales could be corrected. Then, a full analysis should take this situations into account.

To discriminate minke whales between 'Japan Sea' (probably 'Sea of Japan stock') and 'Sanriku' (probably 'Okhotsk Sea/Western Pacific stock'), Kato *et al.* (1992) applied a discriminant analysis (Jover, 1986). They calculated a linear discriminant function using V2% and V9% . The function is:

$$Z= 57.703(V2\%) + 73.494(V9\%) - 27.494.$$

If morphological data in sub-area 9 are adopted to the function, most of samples are discriminated to 'Sanriku' ('Okhotsk Sea/Western Pacific stock') (Table 3). This suggests that whales, at least males, could belong to the Okhotsk Sea/Western Pacific stock as same as 'Sanriku'. Only three animals were discriminated to 'Japan Sea' (Sea of Japan stock), but this is not serious because percentage of correct discrimination of this function are 65.2% (Kato *et al.*, 1992). Further analysis including multi-variates of body proportion should be required in future.

Furthermore, Kato *et al.* (1992) reported that 'flipper coloration seems to be a more useful factor with respect to stock identification.' They found that whales with flipper type III (an obscure white band as confirmed by Wada and Numachi, 1979) is occurred in the Sea of Japan and some of S. Okhotsk, and no whale with this type found in N. Okhotsk, Sanriku and E. Hokkaido. If this category is applied to the samples from sub-area 9 (Table 4), all whales are classified with flipper coloration Type IV, which had a clear white band, and coincide to that of whales in Sanriku, N. Okhotsk and E. Hokkaido (which could considered as of the Okhotsk Sea/Western Pacific stock).

As a result of a morphological comparison, at least on flipper coloration pattern, whales in sub-area 9 are similar to those from Pacific coast of Japan. This result is the same as those derived from studies such as mtDNA, isozyme and pollutants (Aono *et al.*, 1996; Fujise, 1996; Goto and Pastene, 1996; Wada, 1996). However, this study is not conclusive, because available data is too small except in case of sub-area 9. Further studies required additional morphological data for coastal regions.

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Table 1. Statistics for the three variables by area.

Locality	Sex		V1	V2	V9
N.Okhotsk*	Male	mean	744.2	99.3	197.5
		SD	34.0	8.5	11.8
		max.	800	120	226
		min.	670	82	184
	Female	mean	776.3	109.5	207.4
		SD	33.1	15.2	9.0
		max.	820	139	225
		min.	710	96	195
S.Okhotsk*	Male	mean	673.6	89.3	182.8
		SD	61.1	8.3	18.4
		max.	739	96	206
		min.	560	68	148
	Female	mean	712.5	95.0	188.7
		SD	110.7	16.4	27.4
		max.	857	124	230
		min.	510	67	150
Sanriku*	Male	mean	628.3	83.8	167.2
		SD	81.1	10.4	24.3
		max.	794	99	213
		min.	550	69	137
	Female	mean	551.6	70.0	152.3
		SD	43.3	8.2	13.3
		max.	620	81	174
		min.	461	54	135
Sea of Japan*	Male	mean	717.2	104.7	193.4
		SD	46.6	20.3	12.1
		max.	770	163	213
		min.	600	80	165
	Female	mean	763.3	109.3	211.7
		SD	23.6	3.3	13.1
		max.	780	113	230
		min.	730	105	200
Sub-area 9	Male (n=109)	mean	738.2	91.5	193.1
		SD	47.0	7.1	13.6
		max.	454	57	118
		min.	840	109	224
	Female (n=13)	mean	734.4	95.9	189.0
		SD	103.1	15.5	26.0
		max.	479	58	125
		min.	820	110	209

*: After Kato *et al.* (1992).

Table 2. Statistics of measurements and relatiove proportions for the 18 variables in male minke whales taken from sub-areas 7 and 9.

Measurements	Sub-area 7					Sub-area 9				
	Mean	S.D.	Min.	Max.	n	Mean	S.D.	Min.	Max.	n
V1	622	84	470	799	22	738	47	454	840	109
V2%	13.1	1.3	11.3	16.7	13	12.4	0.6	10.9	13.9	109
V3%	16.1	1.2	14.9	18.4	6	15.0	0.6	13.4	16.2	108
V4%	20.6	0.7	19.3	21.4	15	20.0	0.7	18.3	21.8	109
V5%	40.5	1.2	38.7	42.2	11	41.0	1.4	30.7	43.4	109
V6%	56.4	0.6	56.0	56.8	2	55.0	1.1	52.7	57.9	109
V7%	48.8	0.6	48.4	49.3	2	47.4	0.9	44.9	49.6	109
V8%	-	-	-	-	0	32.7	0.8	31.1	34.6	108
V9%	26.8	0.9	24.9	28.4	14	26.1	0.8	24.3	28.2	108
V10%	6.8	1.6	5.4	10.1	7	7.5	0.5	6.3	8.7	107
V11%	3.7	0.5	3.0	4.3	6	4.4	0.4	2.8	5.5	107
V12%	14.6	2.3	11.8	19.6	8	16.4	0.5	15.0	17.7	106
V13%	9.5	0.8	8.1	10.3	7	10.1	0.4	9.2	11.2	106
V14%	3.6	0.2	3.3	3.8	8	3.7	0.2	3.3	4.1	106
V15%	7.2	0.5	6.3	8.5	10	7.7	0.3	7.0	8.6	109
V16%	28.5	0.3	28.2	28.8	3	29.2	1.4	24.7	32.9	107
V17%	23.4	-	23.4	23.4	1	25.5	1.7	21.1	29.3	107
V18%	15.7	0.8	14.2	17.2	14	16.4	1.0	14.4	19.5	107

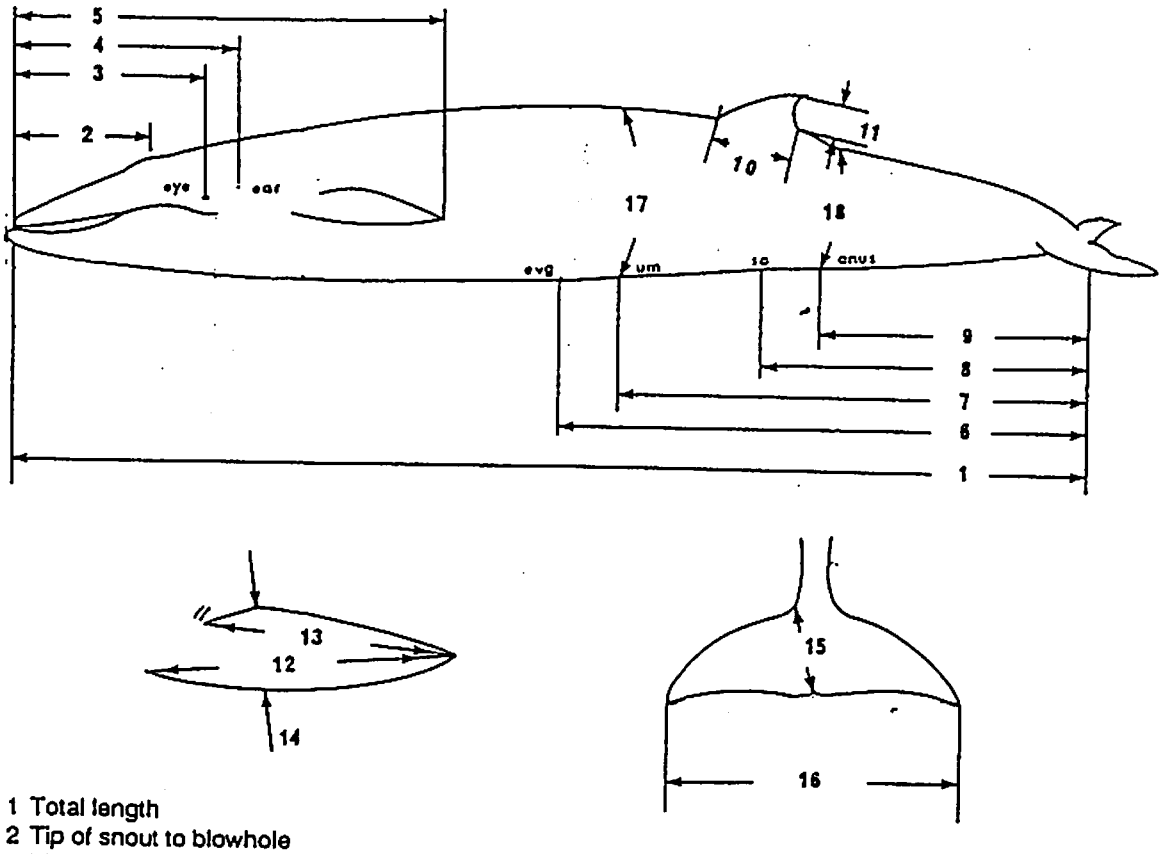
Table 3. Results for the discrimination of samples of the sub-area 9 using the following function as reported Kato *et al.* (1992).
Z=57.7029(V2%)+73.4939(V9%)-27.4941,

		'Sea of Japan'	'Sanriku'
Sub-area 9			
1994 JARPN	n=18	0 (0.0%)	18 (100%)
1995 JARPN	n=90	3 (3.3%)	87 (96.6%)
Total	n=108	3 (2.8%)	105 (97.2%)

Table 4. Incidence of whales for flipper color type by sampling area.

Locality	Flipper coloration*			
	Type I	Type II	Type III	Type IV
N. Okhotsk**	0	0	0	96 (100%)
S. Okhotsk**	0	0	2 (2.7%)	71 (97.3%)
Sanriku**	0	0	0	34 (100%)
Sea of Japan**	0	0	18 (34.6%)	45 (35.4%)
Sub-area 9	0	0	0	121 (100%)

*: Type I: uniformly black, Type II: with dark line, Type III: with faint greyish band, Type IV: with clear white band (Wada and Numachi, 1987).
**: After Kato *et al.* (1992).



1 Total length
2 Tip of snout to blowhole
3 Tip of snout to eye (centre)
4 Tip of snout to ear
5 Tip of snout to tip of flipper
6 Notch of flukes to end of ventral groove
7 Notch of flukes to umbilicus
8 Notch of flukes to reproductive aperture
9 Notch of flukes to anus
10 Dorsal fin, length at base
11 Dorsal fin, height
12 Flipper, tip to anterior insertion
13 Flipper, tip to posterior insertion
14 Flipper, maximal width
15 Flukes, depth
16 Flukes, tip to tip
17 Girth at umbilicus
18 Girth at anus

Fig. 1. Schematic diagrom showing the bosy proportion measurements (After Kato *et al.*, 1992)

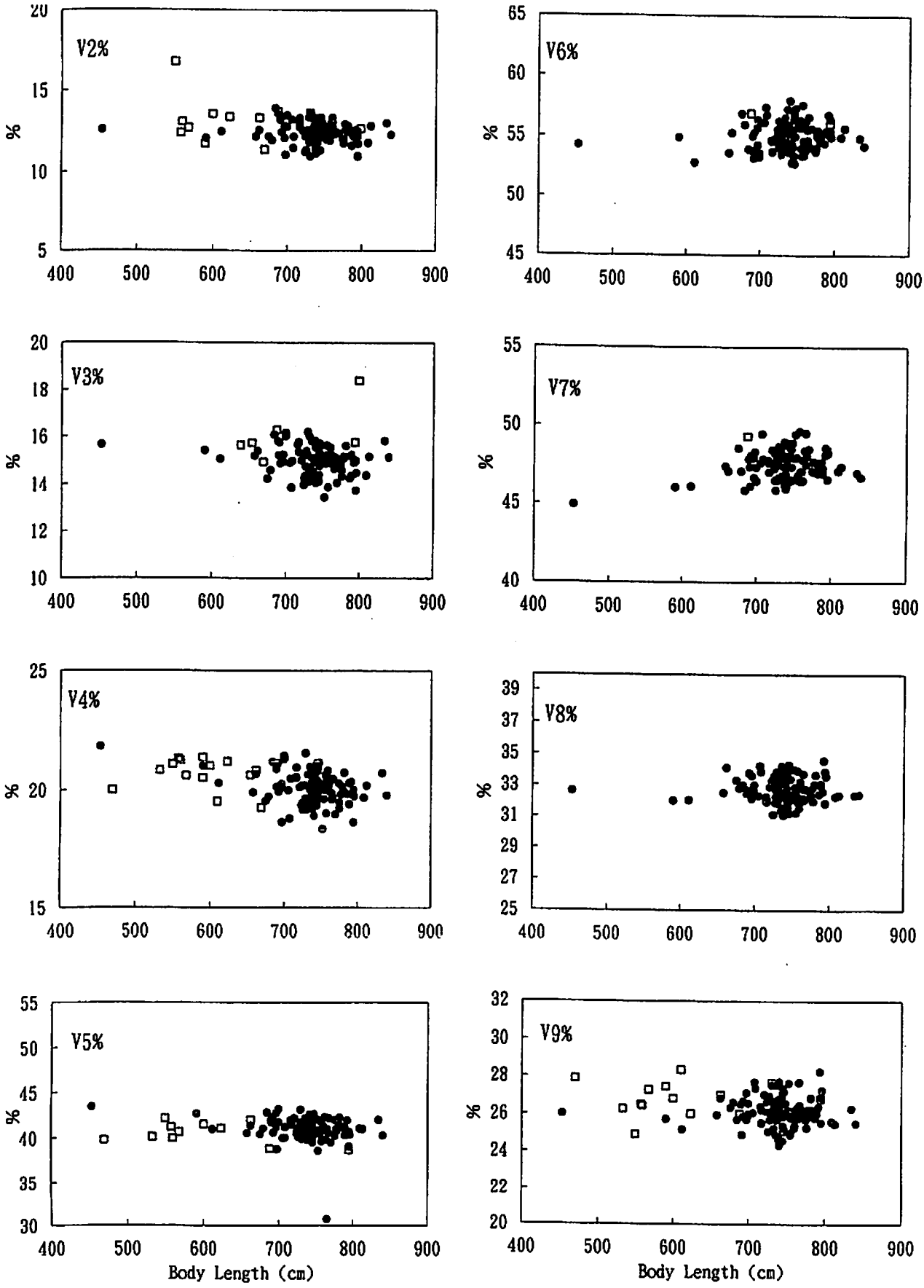


Fig. 2. Plots of relative proportions of V2 - V9 to body length (cm) by sampling area.
□ : sub-area 7, ● : sub-area 9.

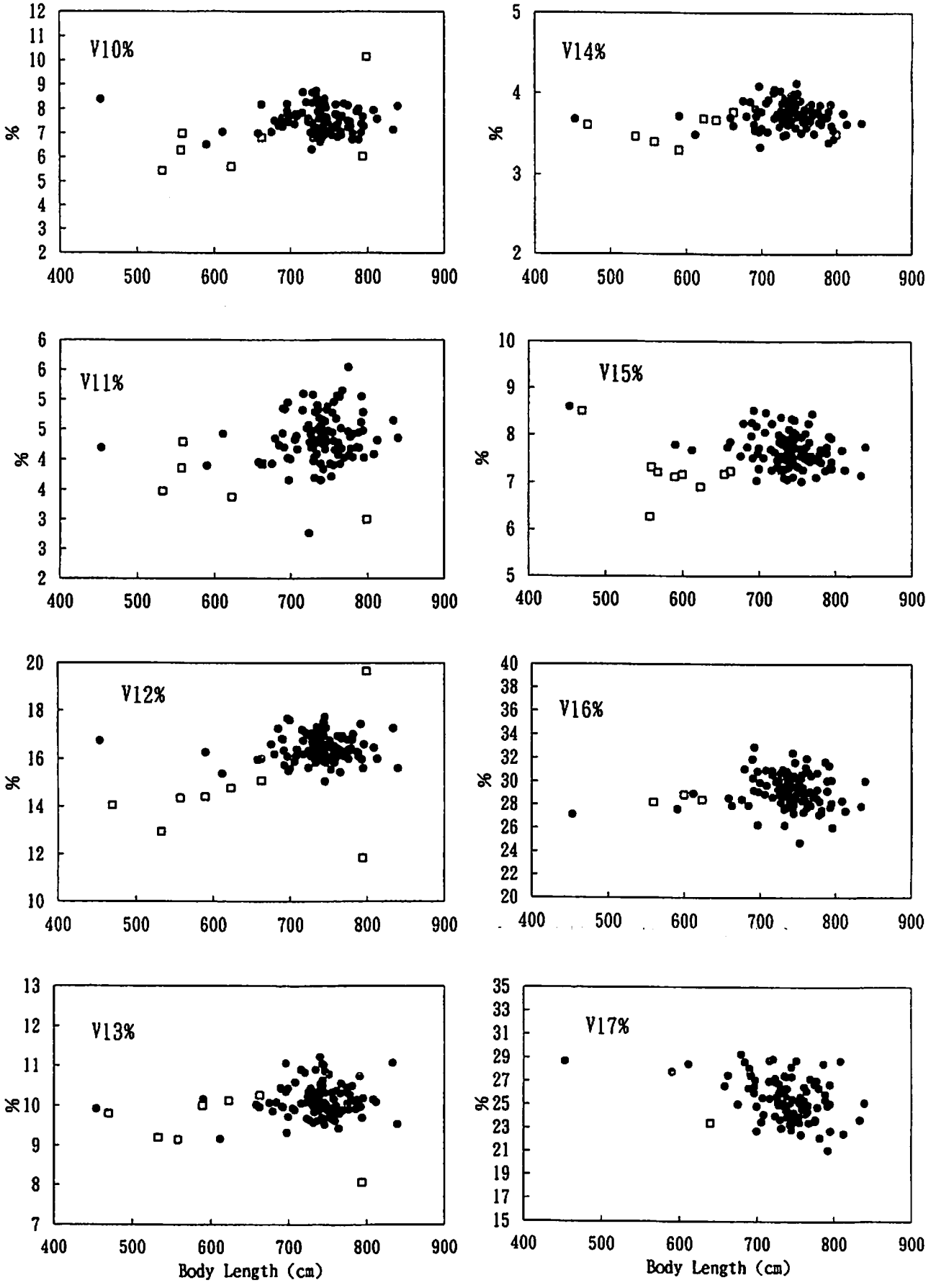


Fig. 3. Plots of relative proportions of V10 - V17 to body length (cm) by sampling area.
□ : sub-area 7, ● : sub-area 9.

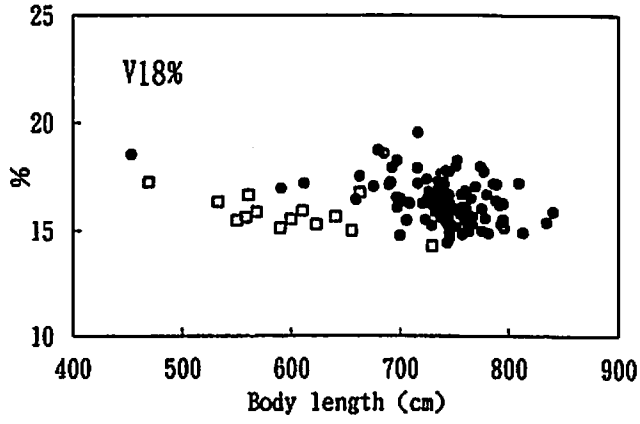


Fig. 4. Plot of relative proportion of V18 to body length (cm) by sampling area.
□ : sub-area 7, ● : sub-area 9.