

MORPHOLOGICAL VARIATION OF THE SILVER WHITING *Sillago sihama* Forskal IN INDONESIA

Sulistiono,¹ Is Yuniar,² Teguh Peristiwadi,³ Seiichi Watanabe⁴ and Masashi Yokota⁴

¹ Faculty of Fisheries and Marine Science, Bogor Agricultural University, Bogor

² National Institute for Oceanology, Jakarta

³ Faculty of Fisheries and Marine Science, Hang Tuah University, Surabaya.

⁴ Tokyo University of Marine Science and Technology, 4-5-7 Konan, Minato, Tokyo
108-8477, Japan.

ABSTRAK

Pengamatan terhadap variasi morfologi ikan putih (*Sillago sihama*) di Indonesia dilakukan dengan menggunakan sampel ikan dari beberapa lokasi (Ujung Pangkah-Jawa Timur, Segara Anakan-Jawa Tengah, Laut Arafuru-Maluku dan Dumai-Propinsi Riau) dengan menggunakan jaring insang dan mini trawl dari tahun 1995 sampai 1998. Beberapa parameter meristik dan morfometrik dilakukan pengamatannya untuk mengetahui karakter populasi.

Beberapa karakter meristik (panjang jari-jari sirip dada, sisik pada linea lateralis dan sisik pada batang ekor), dan karakter morfometrik (tinggi badan, panjang batang ekor, panjang depan sirip punggung, panjang dasar sirip punggung ke 2, panjang sirip dada, panjang sirip perut, panjang kepala, lebar kepala, panjang hidung, lebar antar mata, panjang antara mata dan tutup insang depan, lebar mata yang dibagi dengan panjang total) merupakan karakter yang penting dalam pengamatan populasi lokal. Dengan menggunakan analisis multivariate, belum menampakkan perbedaannya antar populasi *S. sihama*, namun demikian terdapat perbedaan antara kelompok populasi Laut Arafuru dibandingkan dengan yang lain.

Kata kunci: Variasi morfologi, *Sillago sihama*, Indonesia.

ABSTRACT

Study on the morphological variation of the silver whiting (*Sillago sihama*) was conducted using samples collected in some locations in Indonesia (Ujung Pangkah-East Java Province, Segara Anakan-Central Java Province, Arafuru Sea-Maluku Province and Dumai-Riau Province) using gill net and mini trawl from 1995 to 1998. Some meristics and morphometrics characters were observed to estimate population characteristics.

Some meristics characters (pectoral rays, scales at lateral line and scales at caudal peduncle), and some morphometrics characters (the body depth, caudal peduncle length, predorsal length, length of dorsal fin base 2, length of pectoral fin, length of pelvic fin, head length, head width, snout length, suborbital width, orbit to pre opercle angle and eye diameter-divided by total length) were important characters to investigate local population. Using multivariate analysis, they could not show a significations among local population of *S. sihama*, therefore it seems signification in the local population of Arafuru Sea group and others.

Key words: Morphological variation, *Sillago sihama*, Indonesia.

INTRODUCTION

Indonesia, which has wide aquatic area is one of the rich biodiversity country in the world, contributed by numerous species of fish and other aquatic organisms. It was estimated more than 4500 species of fish inhabited in fresh water, estuarine and marine area. Therefore, it was less than 1% reported economically to be explore and developed as commercially food fish such as *Chanos chanos*, *Lates calcarifer*, *Serranus* spp, *Caranx* spp, *Rastreliger* spp, *Tuna* spp etc (as marine/coastal fish). Based on development of the fisheries especially coastal fisheries, some fish habit in the area are recommended as candidate for aquaculture. McKay (1992) reported

that sillaginids are important fish in estuarine aquaculture in India, Japan and Taiwan.

Seven species of the sillaginids have been found in Indonesia such as : *Sillago sihama*, *S. macrolepis*, *S. japonica*, *S. maculata*, *S. chondropus*, *S. ciliata* (Weber and de Beaufort, 1931), dan *S. aeolus* (Fischer and Whitehead, 1974). First species is distributed almost in Indonesian waters from Aceh (western part in Sumatera), Riau, Java, Kalimantan, Sulawesi, Bali, Nusa Tenggara, Maluku and Irian Jaya (Western Papua New Guinea), which is entering and growing with other organisms cultured in brackish water pond such as *Chanos chanos*, *Oreochromis nilotica* and *Penaeus monodon*. This species is also

distributed from Africa, Asia, Australia, Micronesia through Philippine, Taiwan, Korea and Japan (McKay, 1992).

Some observations were conducted in Australia (Gunn and Milward, 1985), India (Palekar and Bal, 1959; Radhakrishnan, 1957) and Japan (Mio, 1960; Kakuda, 1970), therefore the information of the fish in Indonesia is very scarcely, but distribution and marketing. In East Java, the fish meat is useful material in home industry producing fish chips. According to the development and commercially fish value, it is important to observe the biology included life history and population.

This study was conducted to fulfill the information on the *Sillago sihama* conducted in Indonesia. Hopefully, this research can be used as an information on the management and aquacultural activity.

MATERIALS AND METHODS

Sampling was carried out in four locations : Ujung Pangkah-East Java Province, Segara Anakan-Central Java Province, Arafuru Sea-Maluku Province and Dumai-Riau Province. A total of 61 fish were used in this study : a random sample of 33 taken from the 1995 collected in Ujung Pangkah from March to November 1995 and July 1996 to June 1997 ; 11 collected in Segara Anakan in December 1994; 12 Arafuru sea in August 1998 and 5 in Dumai in August 1998.

Counting and measurements were followed McKay (1992). Some meristic characters were employed by counting the number of dorsal spines, dorsal soft rays, total pectoral rays, abdominal/ventral/pelvic rays, anal spines, anal rays and caudal rays, scales along lateral line, scales above lateral lines, scale below lateral line, scales before dorsal fin and scales around caudal peduncle. The morphometric characters were done by measuring total length (TL), fork length (FL), standard length (SL), body depth (BD), caudal-peduncle depth (CPD), caudal-peduncle length (CPL), predorsal length (PDL), length of dorsal base 1st (LDB1), length of dorsal base 2nd (LDB2), length of anal base (LA), length of pectoral fin (LP), length of pelvic fin (LV), length of longest dorsal spine (LLDS),

head length (HL), head width (HW), snout length (SNL), sub orbital width (SOW), orbit to preopercle angle (OPOA), eye diameter (ED) and upper-jaw length (UJL). The morphometric data were compared with total length.

Meristic and the morphometrics which was divided by total length characters were examined using univariate analyses as ANOVA. To verify the result, multivariate analyses (cluster and principal component analysis) were conducted using ISAC-S version 4.

RESULT

Meristics

The results of the meristic observation from the samples collected in Ujung Pangkah, Segara Anakan, Arafuru Sea and Dumai can be seen in Table 1. From the table, it can be seen that number of the dorsal spines is same among four locations. On other hand, the number of: dorsal rays, pectoral rays, anal rays, caudal rays, scales at lateral line, scales between lateral line and spinous dorsal fin origin, scales at below of lateral line, scales at predorsal fin and scales at caudal peduncle seem a little different among the four locations.

Table 2 shows the result of the analysis of variants of the species collected among four locations. Pectoral rays, scales at lateral line and scales at caudal peduncle were insignificant after testing by ANOVA, therefore the dorsal spines, anal rays, caudal rays, scales between lateral line and spinous dorsal fin origin, scales under lateral line and predorsal scales were not significant. From the result, it can be recommended that those characters can be used to show a variations the samples collected from four locations.

Morphometrics

The result of the morphometric observations is shown at Table 3. Total length of the samples varied from 130-205 mm (in Ujung Pangkah), 128-250 mm (in Segara Anakan), 154-260 mm (in Arafuru Sea) and 92-134 mm (in Dumai). The smallest fish was found in Dumai (Riau Province), and the biggest one was collected from Arafuru Sea (Maluku Province).

Table 1. Some meristics data (minimum-maximum size, and average \pm standard deviation) observed on *Sillago sihama* collected in some locations in Indonesia.

	Ujung Pangkah	Segara Anakan	Arafuru Sea	Dumai
D1	11	11	11	11
D2	1	1	1	1
d2	20-22 (21.2 \pm 0.6)	20-22 (20.8 \pm 0.6)	21	20-21 (20.5 \pm 0.6)
P	1	1	1	1
p	13-15 (13.8 \pm 0.6)	13-15 (14.1 \pm 0.5)	14-15 (14.7 \pm 0.6)	13-14 (13.5 \pm 0.6)
V	1	1	1	1
v	5	5	5	5
A	2	2	2	2
a	19-24 (22.2 \pm 1.2)	21-23 (21.8 \pm 0.7)	22	20-22 (21.5 \pm 1)
C	2	2	2	2
c	14-15 (14.5 \pm 0.5)	14-16 (14.4 \pm 0.7)	14-15 (14.3 \pm 0.6)	14-15 (14.25 \pm 0.5)
Sc LI	65-72 (67.7 \pm 2.3)	66-72 (68.3 \pm 1.9)	68-70 (69 \pm 1)	68-73 (69.8 \pm 2.1)
Sc Ltr up	4-5 (4.2 \pm 0.4)	4-5 (4.1 \pm 0.3)	4	4
Sc Ltr bel	9-12 (9.7 \pm 0.9)	9-11 (10.2 \pm 0.7)	10-11 (10.3 \pm 0.6)	10-11 (10.3 \pm 0.5)
Sc pre D	11-17 (13.5 \pm 1.9)	10-17 (14.5 \pm 2.4)	11-13 (12.3 \pm 1.2)	14-15 (14.3 \pm 0.5)
Sc ar.CP	8-10 (8.9 \pm 0.6)	7-9 (8.2 \pm 0.6)	8-9 (8.3 \pm 0.6)	9-10 (9.3 \pm 0.5)

Table 2. ANOVA test on some meristic characters in *Sillago sihama*.

Characters	F _{test}	p	Significancy
1. 2 nd dorsal rays	2,2962	0,0965	-
2. Pectoral rays	3,4381	0,0283	+
3. Anal rays	0,6286	0,6019	-
4. Caudal rays	0,1831	0,907	-
5. Scales at LI	5,268	0,3269	+
6. Scales above LI.	0,53	0,6649	-
7. Scales below LI.	1,221	0,318	-
8. Predorsal fin scales	1,2622	0,3039	-
9. Scales at caudal peduncle	6,4885	0,001	+

All data of the morphometrics were compared by total length to make proportional values. Table 4 shows the result of the analysis of variances of the samples collected from four locations in Indonesia. The proportional values of fork length, standard length, caudal peduncle depth, length of dorsal fin base 1, length of anal fin base, length of

longest dorsal spine, and upper jaw length were not significant, therefore the body depth, caudal peduncle length, predorsal length, length of dorsal fin base 2, length of pectoral fin, length of pelvic fin, head length, head width, snout length, suborbital width, orbit to pre opercle angle and eye diameter were significant.

Table 3. Some morphometrics data (minimum-maximum size, and average \pm standard deviation) observed on *Sillago sihama* collected in some locations in Indonesia.

Parameters	Ujung Pangkah	Segara Anakan	Arafuru Sea	Dumai
TL	130-205 (154.5 \pm 16.3)	128-250 (174.3 \pm 33.2)	154-260 (214.7 \pm 37.7)	92-134 (111.5 \pm 17.7)
FL	127-201 (150.7 \pm 16.2)	125-246 (171 \pm 33.2)	151-255 (209.9 \pm 37.0)	90-132 (109.5 \pm 17.7)
SL	111-182 (134.3 \pm 15.3)	113-222 (152.8 \pm 29.3)	132-225 (188.3 \pm 34.7)	78-116 (95.5 \pm 15.9)
BD	16.7-26.9 (22.0 \pm 3.3)	14.8-39 (27.7 \pm 6.8)	20.4-42.7 (34.6 \pm 7.3)	11.2-21 (15.7 \pm 4.2)
CPD	7.1-13.1 (9.7 \pm 1.4)	9.4-15.4 (11.5 \pm 1.6)	10.2-16.6 (13.6 \pm 2.3)	7-7.8 (7.1 \pm 0.6)
CPL	10.4-20.7 (13.7 \pm 2.1)	12.6-21.1 (15.6 \pm 2.6)	13.2-22.2 (17.6 \pm 3.5)	7-11.7 (8.2 \pm 2.3)
PDL	34.7-61.7 (44.3 \pm 5.3)	37.5-75.1 (49.8 \pm 10.1)	44.3-77.9 (65.0 \pm 12.3)	27.4-39.4 (32.8 \pm 5.0)
LDB1	22.5-30.3 (25.5 \pm 2.6)	23.2-45.3 (30.1 \pm 6.1)	24-44.7 (38.3 \pm 8.1)	15.8-20 (17.8 \pm 1.8)
LDB2	38.9-62.9 (46.1 \pm 6.5)	41.2-73.5 (53.9 \pm 9.3)	44.6-74.3 (64.1 \pm 12.6)	27.2-38.8 (33.1 \pm 5.1)
LAB	40.6-64.7 (47.7 \pm 6.7)	43.1-70.4 (53.9 \pm 7.8)	45-78.5 (64.6 \pm 11.1)	31.7-40.7 (35.7 \pm 4.1)
LPF	15.9-23.1 (18.7 \pm 2.0)	14.1-36.2 (22.3 \pm 5.7)	22.4-34.7 (29.3 \pm 4.9)	10.7-13.2 (11.9 \pm 1.1)
LVF	14.4-25 (19.0 \pm 2.0)	14.1-29.5 (21.8 \pm 5.1)	21.4-32.5 (29.2 \pm 4.4)	11.2-13.7 (12.9 \pm 1.2)
LLDS	20.4-29.4 (22.7 \pm 2.8)	19.2-38.3 (25.9 \pm 5.4)	22.4-42.5 (34.0 \pm 7.4)	14.3-18.5 (16.6 \pm 2.8)
HL	29.4-48.5 (36.0 \pm 4.2)	35.1-62.9 (41.2 \pm 8.7)	40.2-64.2 (54.1 \pm 8.9)	22.1-32.6 (27.3 \pm 4.3)
HW	13.7-22.8 (17.2 \pm 2.6)	15-29.2 (20.5 \pm 4.3)	17.2-32.5 (26.0 \pm 5.7)	8.9-16.3 (11.7 \pm 3.2)
SNL	12.3-18.7 (14.9 \pm 1.8)	11.9-28 (17.6 \pm 4.3)	17.2-29.8 (24.3 \pm 4.6)	7.9-12.7 (10.4 \pm 2.0)
SOW	5.6-12.9 (8.6 \pm 1.2)	6.5-13.1 (10.2 \pm 2.1)	9.3-15.5 (13.5 \pm 2.3)	4.4-8.1 (5.7 \pm 1.6)
OPOA	8.8-14.1 (10.6 \pm 1.2)	8.4-20 (13.3 \pm 3.1)	13.5-20.9 (17.1 \pm 3.2)	7.3-9.5 (8.4 \pm 0.9)
ED	7.2-11 (7.8 \pm 1.2)	6.8-10.4 (8.2 \pm 1.2)	7.9-12.6 (10.7 \pm 1.6)	5.4-6.9 (6.2 \pm 0.6)
UJL	5.5-10.1 (6.9 \pm 1.3)	6.3-12.8 (8.3 \pm 2.3)	8.6-13.9 (10.9 \pm 3.7)	4.3-6.1 (5.1 \pm 0.8)

Table 4. ANOVA test on some morphometric characters divided by total length in *Sillago sihama*.

Characters	F test	p	Significancy
1. FL/TL	2,32	0,0855	-
2. SL/TL	2,51	0,0685	-
3. BD/TL	6,36	0,0009	+
4. CPD/TL	1,51	0,0685	-
5. CPL/TL	7,27	0,0004	+
6. PDL/TL	4,65	0,0058	+
7. LDB1/TL	6,46	0,0008	+
8. LDB2/TL	2,01	0,1236	-
9. LAB/TL	1,07	0,3709	-
10. LPF/TL	15,39	3.10 ⁻⁷	+
11. LVF/TL	6,89	0,0005	+
12. LLDS/TL	2,17	0,1025	-
13. HL/TL	7,22	0,0004	+
14. HD/TL	4,86	0,0046	+
15. SNL/TL	31,84	6.10 ⁻¹²	+
16. IOW/TL	6,76	0,0006	+
17. OPOA/TL	16,15	2.10 ⁻⁷	+
18. ED/TL	4,28	0,0088	+
19. UJL/TL	2,51	0,0683	-

Note: + and - denote significant and not significant, respectively

Multivariate Analysis

Cluster analyses was conducted to estimate taxonomic distance among individual of the samples collected from four locations. Using ISAC-S version 4, the data were possessed and presented by dendrogram. Fig. 1 is a dendrogram constructed by UPGMA cluster analyses from city block distance of meristics characters showing relationship between individuals in *Sillago sihama*. From the figure, it was not easy to grouped the populations according to the locations. Some individual grouped in Arafuru Sea group, but they were collected from Ujung Pangkah and Segara Anakan. Fig. 2 is a principal component analysis of the meristics characters. The figure shows also a wide variation among individual of *S. sihama* collected from four locations, which were to be mixed each other. The cluster analysis was conducted also in morphological characters (Fig. 3). From this figure, it can be seen that populations were divided by two main group which were Arafuru Sea group and other (taxonomic distance=0.25). This condition was also

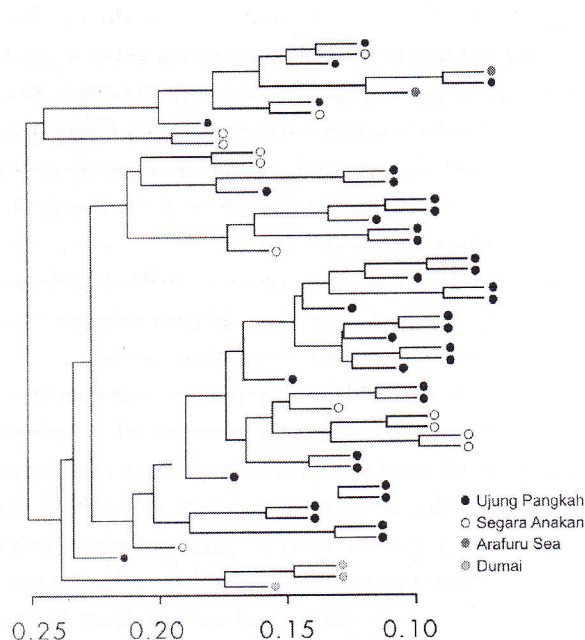


Figure 1. Dendrogram showing the relationship between individual specimens of *Sillago sihama* based on meristic data constructed by UPGMA cluster analysis from city-block distance.

supported by principal component analysis (Fig. 4) expresses two block of group (Arafuru Sea and others). Using vector loading analyses, it was estimated that some characters (as key parameters) for grouping was length of ventral, length of pectoral fin, body depth and snout length. The length of ventral fin, length of pectoral fin, body depth and snout length seem longer than others populations. From the figure, we can examine the locality of the samples.

DISCUSSION

The meristics and morphometrics characters were observed to estimate a variation among local populations of *Sillago sihama* in Indonesia. Using nine characters of meristics and twenty characters (to be nineteen after dividing by total length) were used to grouped the population. The result of meristics characters showed a little variation comparing with Mc Kay (1985) stated the dorsal fins XI, I, 20-23 and the anal fins II, 21-23. In this result, they were XI, I, 20-22 and II, 19-22 for dorsal and anal fins respectively.

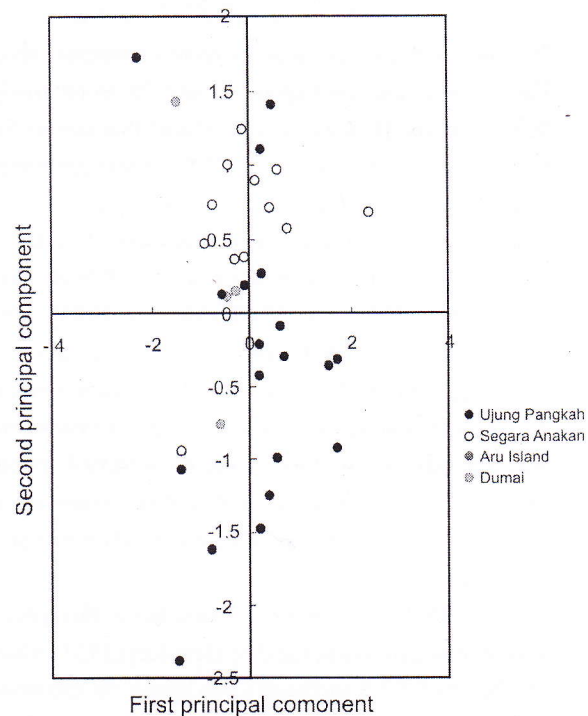


Figure 2. Principal component analysis based on meristic data of the individual specimens of *Sillago sihama*.

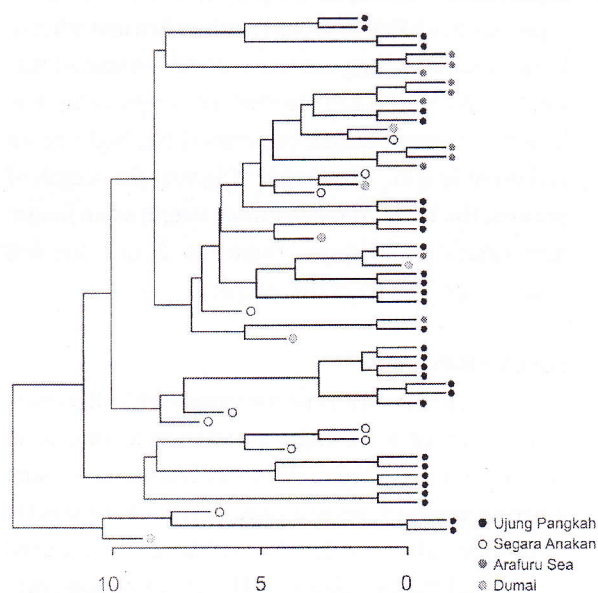


Figure 3. Dendrogram showing the relationship between individual specimens of *Sillago sihama* based on morphometric data constructed by UPGMA cluster analysis from city-block distance.

He observed also the species from Indonesia which had a dorsal and anal spine 21 and 22 respectively. Weber and de Beaufort (1931) stated that dorsal fins (X) XI, I, 20-23 and anal fins II, 22-24. These parameters (dorsal and anal spines and rays) were not significant among the local populations in this study. Number of scales in lateral line was reported as 69-73 (Weber and de Beaufort, 1931) and 67-70 (McKay, 1985). This observation presented that the scales number was 65-73 depend on the locations. In Arafuru Sea was 66-72 and in Dumai was around 68-73. The parameter was not significant after testing by ANOVA among four locations. According to this observation, it was no specification on the populations based on meristics characters.

The morphometrics characters in this species was reported by Weber and de Beaufort (1931) which was height 5.2-5.5 and head 3.5 in length. In this study, they were 5.0-7.8 and 3.6-4.2 in body height and head length respectively. McKay (85) stated that proportional dimension as percent of standard length: greatest depth of body 16-20; head length 24-30;

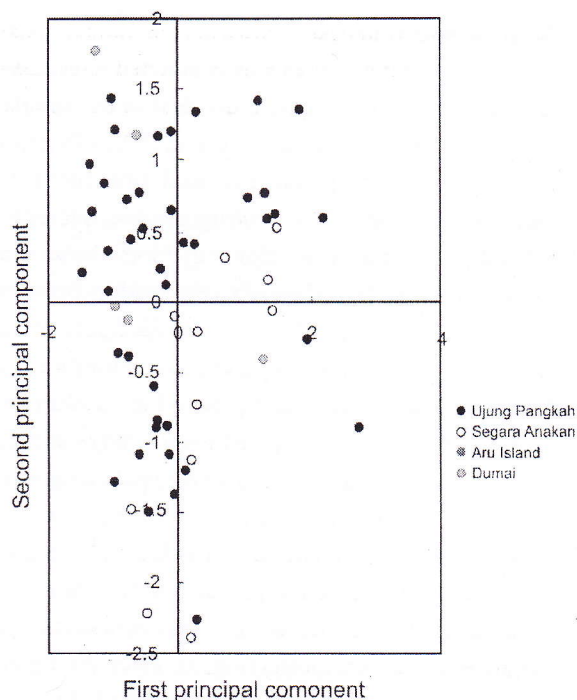


Figure 4. Principal component analysis based on morphometric data of the individual specimens of *Sillago sihama*.

predorsal length 32-35 and caudal peduncle depth 7-8. The *Sillago sihama* observed were 12.8-20.1, 23.9-32.2, 27.0-36.3, and 6.2-9.0 for body depth, head length, predorsal length and caudal peduncle depth respectively. Based on those data, *S. sihama* in this observation had a wide variance may be it was caused by number of specimens varied from small to longer size (92-260 mm). Therefore, the peak number of the characters were in the interval of the previous study.

Using ANOVA, they were some characters that had significant among those samples such as: body depth, caudal peduncle depth, predorsal length, length of dorsal fin base 1, length of pectoral fin, length of pelvic fin, head length, head width, snout length suborbital width and orbit to pre opercle angle. This parameters were significant at least in two locations using one character. For more than one characters, multivariate analysis was used such as cluster analyses and principle component analyses. In present study using principal component analysis, it showed two main group of those population in Indonesia which were Arafuru sea group and others

with taxonomic distance around 0.25. This data also supported by a principal component analysis which was two group. Some key characters were estimated using compare between principal component analysis and loading vector results, which were length of ventral fin, snout length, length of pectoral fin and body depth in a little longer size in Arafuru Sea than others. Based on the data, it can be stated that population of *Sillago sihama* in Indonesia seem to be two group which were Arafuru Sea (Eastern Indonesia) and others (Western Indonesia).

CONCLUSION

The meristic characters (number of: pectoral rays, scale at lateral line and scale at caudal peduncle) and morphometric characters (consisted of body depth, caudal peduncle length, predorsal length, length of dorsal base 1st, length of pectoral fin, length of pelvic fin, head length, head width, snout length, sub orbital width, orbit to pre opercle angle and eye diameter comparing with total length) were important tools to signify a variation in *Sillago shima*.

Using multivariate analysis, they could not show a significations among local population of *S. sihama*, therefore it seems a signification in the local population of Arafuru Sea group and others.

REFERENCES

- McKay, R.J. 1985. A revision of the fishes of the family Sillaginidae. *Mem. Qd. Mus.* 22(1):1-73
- McKay, R.J. 1992. Sillaginid Fishes of the World, FAO-UN, Rome, p. 87.
- Fischer, W. and P.J.P. Whitehead. 1974. FAO Species Identification Sheets for Fishery Purposes. Eastern Indian Ocean (Fishing area 57) and Western Central Pacific (Fishing area 71). Vol 4. FAO, Rome.
- Kawamura, G, S. Mori and S. Toya. 1992. Catching process in encircling gillnet as inferred from catch, *Nippon Suisan Gakkaishi*, 58(2), 249-254.
- Cailliet, G.M., M. S. Love, and A. W. Ebeling. 1986. *Fishes. A field and laboratory manual on their structure, identification and natural history*. Wadsworth Publishing Company. Belmont, California. p. 194.
- Gunn, J.S. and N.E. Milward. 1985. The food, feeding habits and feeding structure of the whiting species *Sillago sihama* (Forsskal) and *Sillago analis* Whitley from Townsville, North Queensland, Australia, *J. Fish Biol.*, (26), 411-427.
- Kakuda, S. 1970. Studies on the ecology and fishing stock of *Sillago sihama* (Forsk.) through the analysis of its bottom drift-net fishery. *J. Faculty of Fisheries and Animal Husbandry, Hiroshima University*, 9, 11-55.
- Mio, S. 1965. The determination of the age and growth of *Sillago sihama* Forskal. *Bull. of The Japan Sea Reg. Fish. Lab.*, 14, 1-18.
- Palekar, V.C. and D.V. Bal. 1959. Studies on the food and feeding habits of the Indian Whiting (*Sillago sihama* Forskal) from Karwar Waters. *Journal of University of Bombay*, (NS), 27 B(5):1-18.
- Radhakrishnan, N. 1957. A contribution to the biology of Indian sand whiting- *Sillago sihama*, Forskal. *Indian J. Fish.*, 4, 254-283.
- Weber, M and F. de Beaufort. 1931. *The Fishes of the Indo-Australian Archipelago*. VI. Leiden. E.J. Brill Ltd.