

Variation in the Vertebral Number of the Milkfish *Chanos chanos*, Collected from Various Localities

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A total of 2497 milkfish fry were collected in 1976 from nine localities in six countries, viz. India, Thailand, Indonesia, Philippines, Taiwan, and Tahiti. Vertebral counts ranged from 40 to 45. The general trend of geographical gradient in vertebral counts in the milkfish was observed to be lower in the west (or otherwise, along continents) and higher in the east (or around oceanic islands). Extremes in the means of vertebral counts by localities were seen in the samples from India with 43.08 and from Tahiti with 43.82. It was suggested that there may be at least four subpopulations among the milkfish throughout the tropical Indo-Pacific waters.

Study on the existence of subpopulations in the milkfish *Chanos chanos* (Forsskål) is a prerequisite to the study of the population dynamics of the fish. A study of variation in vertebral number of the milkfish has been undertaken in an effort to determine whether several races or subpopulations exist in this valuable and widely distributed fish.

A portion of the present data was presented to the International Milkfish Workshop-Conference held at Tigbauan, Iloilo, Philippines on May 19~22, 1976, in an attempt to stimulate the conference group to organize a network study on this important aspect of the milkfish (Senta and Kumagai, 1976). Specimens from various localities throughout the tropical Indo-Pacific waters, ranging from India in the west to Tahiti in the east, have been collected during the year 1976. Variation in the vertebral number of the specimens, thus collected, suggest the existence of at least four subpopulations among them.

Materials and Methods

As a preparatory step, study was made on the progress of vertebral ossification in milkfish larvae and it was observed that in larvae larger than about 11 mm in total length, all the vertebrae were dyed well with alizarin-red, enabling accurate counting of the vertebral number. This means that the milkfish larvae being caught by fry collectors in the beach, usually ranging from 10 to 15 mm in total length, are old enough for the study of vertebral number.

A total of 2497 milkfish fry collected from nine localities in six countries were used for the study (Fig. 1 and Table 1). In Tigbauan near Iloilo specimens were collected during two main fry seasons, April and October, and a preliminary study was made to determine the extent of seasonal variation in the vertebral count in the fry of the same locality. The specimens were dyed with alizarin-red

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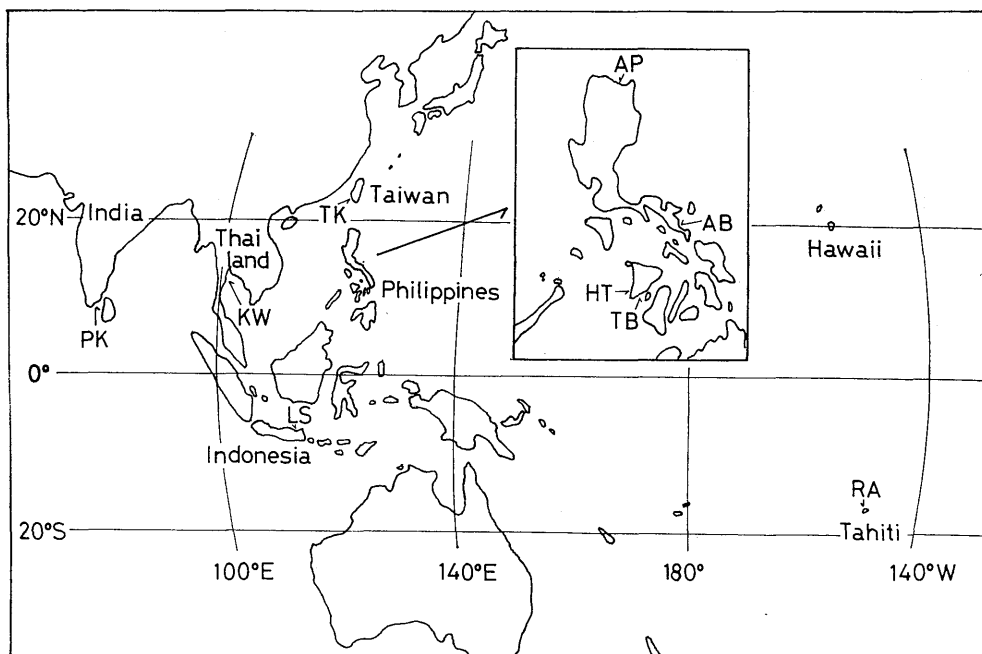


Fig. 1. A chart showing the localities where the specimens were collected. AB, Albay; Ap, Aparri; HT, Hamtik; KW, Kulong Wan Bay; LS, Lassem; PK, Punnaikkayal; RA, Rangiroa Atoll; TB, Tigbauan; TK, Tungkang.

beforehand. The hypural bone was included in the counting, while the basioccipital which precedes the atlas (first vertebra) and is shaped like an elongated horn at fry stage was excluded (Fig. 2).

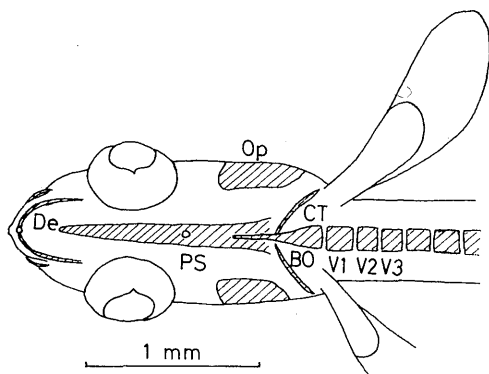


Fig. 2. Ventral view of anterior part of an alizarin treated milkfish fry, 13.5 mm in total length. Bones which absorbed alizarin are shadowed. BO, basioccipital; CT, cleithrum; De, dentary; Op, opercle; PS, parasphenoid; V1-V3, 1st to 3rd vertebrae.

Results

Table 1 summarizes the results of the

study. Vertebral counts ranged mostly either from 42 to 45 (in five samples) or from 42 to 44 (in four samples). In the sample from Hamtik, in the west coast of Panay Island however, showed a much wider range of vertebral counts, that is, from 40 to 45. In all the samples, except one from Rangiroa Atoll, Tahiti, the mode of vertebral counts was at 43. Fish with 43 vertebrae accounted for 73% of total individuals in the samples from Punnaikkayal of India and Kulong Wan Bay of Thailand, and from 53 to 62% in the samples from other localities, except Rangiroa Atoll. In contrast to this, in the sample from Rangiroa Atoll fish with 44 vertebrae accounted for 72%.

Extremes in the means of vertebral counts by localities were seen in the samples from Punnaikkayal with 43.08 and from Rangiroa Atoll with 43.82. Fig. 3 illustrates the mean and its 95% confidence limits of vertebral counts in the milkfish

Table 1. Vertebral counts in milkfish from various localities collected in 1976. Means and other statistics are also shown.

Country	India	Thailand	Taiwan	Indonesia	Philippines					Tahiti
Place	Punnaikkayal*	Kulong Wan**	Tungkang	Lassem***	Tigbauan (1)	Tigbauan (2)	Hamtik	Aparri	Albay	Rangiroa Atoll
Date of collection	Apr 4	June 24	Mar 25, May 16	May 15	Apr 21	Oct 26	Mar 29-May 6	June 3	June 6	Sep 1
Number of fish with counts of vert. no.										
40							1			
41							5			
42	19	8	6	5	2	8	9	9	4	1
43	143	139	72	77	100	199	235	131	146	95
44	35	44	45	51	86	112	169	86	119	300
45			1	1			8	2	3	21
Total	197	191	124	134	188	319	427	228	272	417
Mean vert. no.	43.081	43.189	43.331	43.358	43.447	43.326	43.382	43.355	43.455	43.818
Variance	0.2675	0.2367	0.3342	0.3195	0.2685	0.2699	0.4140	0.3255	0.2984	0.2546
Stand. dev.	0.517	0.487	0.578	0.565	0.518	0.520	0.643	0.571	0.546	0.505
Stand. err.	0.0369	0.0352	0.0519	0.0488	0.0378	0.0291	0.0311	0.0378	0.0331	0.0247
Coeff. var.	1.20	1.13	1.33	1.30	1.19	1.20	1.48	1.32	1.26	1.15

*Tuticorin, **Prachuab Kirikhan, ***Central Java.

from each of the surveyed localities. The mean was remarkably high in the Rangiroa Atoll specimens, distinguishing themselves from all the fish of other origins. On the contrary, the sample from Punnaikkayal had a mean considerably lower than the samples from Tungkang of Taiwan, Lassem of Central Java, and Philippine

fry grounds.

Table 2 shows the results of t-test to compare the means for every combination of two samples. In Fig. 3 the 95% confidence limits of the mean of Kulong Wan Bay sample and those of the Punnaikkayal and Tungkang samples are partly overlapping. From the table however, we know that the mean vertebral number of the Kulong Wan Bay sample is significantly different at the 5% level both from those of the latter two samples. A significant difference in means at the 5% level is also seen between the April and October samples of Tigbauan and also between the latter and the sample from Albay which is on the Pacific Coast of Luzon Island.

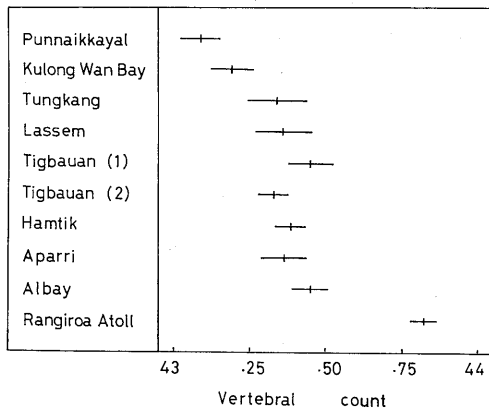


Fig. 3. The mean vertebral counts and their 95% confidence limits in the milkfish fry from various localities. Tigbauan (1) and (2) represent specimens collected in April and October, respectively.

Discussion and Conclusion

As far as the present data are concerned, the general trend of geographical gradient in vertebral counts in the milkfish

Table 2. Showing t-values for the purpose of testing the differences in mean vertebral counts of milkfish fry from various localities collected in 1976.

	Punnaikkayal	Kulong Wan	Tungkang	Lassem	Tigbauan (1)	Tigbauan (2)	Hamtik	Cagayan	Albay	Rangiroa Atoll
Punnaikkayal		2.103*	4.019**	4.605**	6.927**	5.209**	X	5.156**	7.276**	16.75 **
Kulong Wan			2.351**	2.894**	5.004**	2.962**	X	3.185**	5.198**	14.43 **
Tungkang				0.386	1.849	0.083	0.794	0.385	1.896	9.119**
Lassem					1.456	0.586	0.379	0.047	1.487	8.903**
Tigbauan (1)						2.531*	X	1.696	0.037	8.301**
Tigbauan (2)							X	0.624	2.708*	12.94 **
Hamtik								0.520	X	X
Cagayan									1.790	10.62 **
Albay										9.176**
Rangiroa At.										

(X shows variance ratio is highly significantly large ($F > F_{0.01}$).

is lower in the west and higher in the east. However, we need much more data to reach a definite conclusion. It may also be possible that the trend will turn out to be lower along continents and higher around oceanic islands when more data are accumulated.

Table 1 clearly shows that the milkfish fry occurring in Hamtik waters had a much wider range of vertebral counts than those from any other waters. The factor(s) affecting the variability in vertebral number of the milkfish is yet to be studied.

It is, however, almost certain that the milkfish around Punnaikkayal and those around Rangiroa Atoll belong to two separate subpopulations*. Further, Fig. 3 and Table 2 suggest, at least until any negative evidence is obtained, that there are at least four subpopulations (local races) in all: Punnaikkayal, Kulong Wan, Indonesian-Philippine (including Taiwan), and Rangiroa subpopulations. Still further, the comparison of the mean vertebral numbers in the October sample of Tigbauan and the Albay sample indicates the possibility that an extensive study in the

future may prove the existence of local races within a narrower area.

For complete understanding of the subpopulations in the milkfish, we need a knowledge on the migration of the fish. Based on the seasonal fluctuation in abundance of the milkfish fry occurring along the Vietnamese coast, Kuronuma and Yamashita (1962) proposed a theory that the milkfish spawners migrate either northwards or southwards with the change of the oceanography in the regional seas. Almost nothing else is known about the migration of the fish (Schuster, 1960), and no mark-and-recapture experiments have yet been carried out (Tampi and Davy, 1976). Both methods, mark-and-recapture experiments as a direct approach and subpopulation studies analyzing meristic character as an indirect approach, can be complementary measures in studying migration and population movement for each other.

Rabor (1938) in his studies on the skeletal system of Philippine milkfish found that 16 specimens out of 19 possessed 43 vertebrae while the remaining three had 44. Other stray references

* Frequency distributions of vertebral count of these two samples were compared by means of the chi-square test, giving a chi-square value as high as 203.85.

available on the vertebral count in the milkfish are cited in Table 3.

Table 3. Number of vertebrae in milkfish reported from several localities by various authors.

Locality	Author	Vertebral count
India?	Günther, 1868	45
Indonesia	Sunier, 1922*	44-45
Indonesia	Delsman, 1923	43
Philippines	Herre & Mendoza, 1929	44
Hawaii	Jordan & Evermann, 1905	45

* not consulted by us but cited from Schuster (1960).

Since most of these countings were made on museum specimens, the specimens studied were few in number. It is expected from Table 1 as well as from the result of Rabor's studies that a fish with 43 vertebrae has more chances to occur in the waters from India to Philippines, and a fish with 44 vertebrae in Hawaiian waters. It is not certain if it occurred only by chance that the vertebral counts reported by all the above cited authors, except for Delsman (1923), are 44 and 45.

Two samples from Tigbauan, one collected in April and another in October, had mean vertebral counts significantly different at the 5% level from each other. This indicates the existence of a seasonal as well as an annual fluctuation in mean vertebral counts of the milkfish occurring in the same locality. To confirm this finding, samples are being collected from several fry grounds in the Philippines which will be published by the present authors in the future.

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サバヒー脊椎骨数の地方的変異

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サバヒーはインド・太平洋区の熱帯・亜熱帯域各国で広く養殖されている魚で、草食性であることから世界的な蛋白政策の面から近年益々重視されるに到った。養殖は海岸で採捕される天然種苗に依存しているが、天然のサバヒーに関する研究は極めて少ない。本種の分布はアフリカ東岸からカリフォルニア沿岸に及び、当然その中に幾つかの系統群があることが予想される。1976年に、インド、タイ、インドネシア、フィリピン、台湾、タヒチ6ヶ国の9つの地方から集めた合計2,497尾のサバヒー仔魚について脊椎骨数を数えた。脊椎骨数の範囲は40乃至45個で、一般的傾向として、西（もしくは大陸沿岸）では脊椎骨数の平均値が低く、東（もしくは海洋性島嶼の周辺）で平均値が高かった。平均値の差を検定した結果、今回集め得た資料は次の4つのグループに分けられる。即ち1)インド（ツチコン市近傍プナイカヤル。平均43.08）、2)タイ（プラチュアブキリカン市クロンワン湾。平均43.19）、3)台湾（東港）・インドネシア（ラッセム）及びフィリピン各地（平均43.33~43.45）、4)タヒチ（ランギロア環礁。平均43.82）。将来より多くの資料が集積されれば、地理的により狭い範囲内（例えばフィリピン国内）や、或は同一地域において季節的に、系統群の存在が実証される可能性が予測された。

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