ON THE ANALYSIS OF THE POPULATION STRUCTURE OF SKIPJACK (KATSUWONUS PELAMIS L.) FROM THE EASTERN PART OF THE TROPICAL ATLANTIC OCEAN *

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SUMMARY

Spatial variability of the frequency of gene "B" of "slow" esterases in the samples of skipjack tuna from the eastern tropical Atlantic is analyzed. Regarding this characteristic, the samples have been classified into three groups: (1) Sherbro area - 0.824; (2) Angola region - 0.693; and (3) Pagalou area - 0.735. Reliable differences between samples of the first and the second types by the frequency of the gene "B", differences in tuna size and spawning period suggest that skipjack tuna from the eastern tropical Atlantic are represented by two independent groups, in the northern (regions 71, 72, 76, 77) and southern (regions 72, 73, 74, 79) hemispheres. The habitats of the two groups overlap in the equatorial area (regions 72, 73, 77).

RESUME

La variabilité spatiale de la fréquence de gênes "B" de "lentes" estérases dans les échantillons de listao de l'Atlantique tropical est a été étudiée. Les échantillons ont été classifiés en trois groupes en suivant cette caractéristique: (1) zone Sherbro - 0.824, (2) région Angola - 0.693, (3) zone Pagalou - 0.735. Les différences fiables entre les échantillons du premier et second types sur la fréquence de gênes "B", les différences sur la taille des thonidés et la période de ponte, suggèrent que les listaos de l'Atlantique tropical est forment deux groupes distincts - dans l'hémisphère nord (régions 71, 72, 76, 77) et dans l'hémisphère sud (régions 72, 73, 74, 79). L'habitat de ces deux groupes se chevauchent dans la zone équatoriale (régions 72, 73, 77).

*Not to be cited without reference to the author.

RESUMEN

Se analiza la variabilidad espacial de la frecuencia del gene "B" de estearasas "lentas" en las muestras de listado del Atlántico tropical oriental. Con relación a estas características, las muestras se han clasificado en tres grupos: (1) área de Sherbro - 0.824, (2) zona de Angola - 0.693, (3) área de Pagalou - 0.735. La existencia de diferencias ciertas entre las muestras del primer y segundo tipo respecto a frecuencia del gene "B", y en cuanto a talla y período de desove, sugiere que el listado del Atlántico tropical oriental está representado por dos grupos independientes - en el hemisferio norte (regiones 71, 72, 76, 77) y en el hemisferio sur (regiones 72, 73, 74, 79). Los hábitats de los dos grupos se solapan en la zona ecuatorial (regiones 72, 73 y 77).

The skipjack Katsuwonus pelamis L. from the eastern tropical Atlantic is characterised by the complex intraspecific structure. According to the ICCAT data (1980, ICCAT, Madrid, p. 1-6), the question of the number of the stock units and migration pattern of each population has not received due attention. Meanwhile, there is every reason to believe that in the considered area there exist at least two populations of the skipjack - the groupings to the north (regions 71, 72, 76, 77) and to the south(regions 72, 73, 74, 79) of the equator. The tunas of the two groupings differ in four morphometric features (22 features altogether), growth rate, dates of spawning, and peculiarities of feeding (Alekseev, Alekseeva, 1981; Ovchinnikov, Leontjev, Tcsheglov, 1984).

In the present report an attempt is made to estimate the degree of intraspecific heterogeneity for the skipjack from the eastern tropical Atlantic from the frequency of alleles of the esterase locus.

MATERIALS AND METHODS

The material for the genetic and biochemical studies was collected over a considerable part of the species distribution range (fig. 1) from 11°S to 9°N and 9°E to 21°W in April, September and October 1978, in September 1979, in February 1980, and in January, March and April 1984. The frozen samples of the muscles were used to extract the water soluble protein. Electrophoretic fractioning of muscle protein was made in 12% PAAG in tris-EDTA-borate buffer, pH-8.6. The activity of esterases in gel blocks was revealed from reaction with a-naphthilacetate and the subsequent dying with fast red TR. The genetic homogeneity of the samples was estimated from X^2, the reliability of differences from the Fischer criterion and similarity of groupings by the phenotype ratio from the Zhivotovsky index (Zhivotovsky, 1979). The maturity stages of tunas were determined from the 6-grade scale (Instruction for..., 1980).

RESULTS AND DISCUSSION

The synthesis of electrophoretic versions of "slow" esterases in the skipjack tunas is controlled by four (A, B, C, D) alleles of one autosomal locus (fig. 2), and the empiric distribution of phenotypes (AB, AC, BB, CC, BC, CD, BD) agrees with the expected distribution according to the adopted hypothesis of 4-allele system of genetic control (table 1).

The frequency of gene "B" of the Est-IV-locus was used as a genetic marker in comparison of tuna samples from various regions of the distribution area. Three types of samples have been distinguished from this feature. Their characteristics are presented in table 2.

Three types of tuna samples were from the following areas of the tropical Atlantic (fig. 1):

1 - Sherbro area (77)
2 - Angola region (79) and one sample from Sherbro area (77)
3 - Pagalou area (73)

The first type sample (northern grouping of tunas) involved three subsamples with the frequency range q"B" from 0.800 to 0.869. In January, sexually mature tunas (IV, VI-IV) of the prevalent size group of 48-50 cm were captured; as early as March (one sample), the active spawning (IV-V, V) of tunas was under way in the coastal waters of Sierra Leone.

In March-April, the second type sample (southern tuna grouping) was represented by the tunas with immature gonads (VI, VI-II, II) with the gene "B" frequency of 0.689 and two size groups (32-36 cm, 40-46 cm). One sample with a close frequency of q"B" (0.700) for the tunas of similar sizes (40-46 cm) was recorded in February in the Sherbro area (77). The ovaries of this group of tunas were mainly in maturity stages IV, IV-V.

It can be assumed that "... during the spawning of the southern grouping in the pre-equatorial waters of the western part of the Gulf of Guinea (September-December) the reproductive contingent of the northern grouping occurs to the north of 10°N. During the migration of the specimens of the northern grouping to the pre-equatorial waters (January-April) the mature tunas

of the southern grouping complete their spawning in the area to the south of 5°N (February) and migrate southwards for feeding. Thus both groupings can be considered as independent reproductive units (Alekseev, Alekseeva, 1981).

There is a close agreement between the above-stated and the results of the statistical processing of genetic parameters: a comparison of samples of the first and second types for genetic homogeneity from the frequency of gene "B" yields X^2 - 12.106 at d_f - 1, $P < 0.001$; differences between the samples from the main phenotype "BB" is statistically reliable according to the second threshold of probability prognoses of the Fischer criterion (F_f"BB" - 11.07 $< F_{st}$0.95);
the indices of the phenotypic similarity (Zhivotovsky, 1979) - frequency of common phenotypes in two sample types - show reliable differences between the northern and southern groupings (r - 0.9650 ± 0.0113, X^2 - 18.191 at 4 degrees of freedom).

In April, September and October the tuna grouping in the Pagalou area was represented by the specimens with immature (VI-II), maturing (III, VI-III) and mature (IV, VI-IV, V) gonads, and with the characteristics (predominant size group and the frequency of gene "B") common for the northern and southern groupings (fig.3). The third type sample involved six subsamples however none of them showed the frequency q"B" with the values 0.8 and 0.6 (table 1). The absence of the given frequences can be related to a high degree of mixing of tunas from the northern and southern groupings in the Pagalou area, which has resulted in an averaged frequency of gene "B" (0.735) for the third sample type and thus appears to be genetically homogenous as to this feature (X^2 - 5.906, d_f - 3, $P \geq 0.05$) (Titova, 1983. The above-stated assumptions are corroborated by the preliminary results of the skipjack tagging obtained by the Japanese investigators in 1980-1981, according to which the tunas migrate during the warm period from the area 73 to the southern parts of the areas 75 and 74 (fig. 1) (Ovchinnikov, Leontjev, Shcheglov, 1984).

SUMMARY

Reliable differences between the first and second sample types by the frequency of gene "B" and the differences between the sizes and spawning terms of the tunas suggest that the skipjack from the eastern part of the tropical Atlantic are represented by two independent groupings (populations) in the northern (areas 71, 72, 76, 77) and southern hemispheres.

The distribution areas of the two groupings overlap in the equatorial area (areas 72, 73, 77).

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Table 1

Distribution of phenotypes and gene frequences of polymorphous locus (Est-IV) of muscle esterases in skipjack samples

Areas	No. of samples	No. of sp.	Phenotypes AB	AC	BB	CC	BC	BД	CД	Gene frequency p^A	q^B	r^C	c^D	X^2	d_f	P
I	2	3	4	5	6	7	8	9	I0	II	I2	I3	I4	I5	I6	I7
72	I	I00	0.0	0.0	66 67.2	2* 3.0	3I 28.7	I 0.8	- 0.2	.0000	.8200	.I750	.0050	0.75	2	>0.50
	2	23	I 0.8	0.I	I7 I7.3	- 0.2	4 3.4	I 0.8	- 0.I	.02I7	.8696	.0869	.02I8	0,53	3	>0.90
	3	25	0.0	0.0	I6 I6.0	I I.0	8 8.0	- 0.0	- 0.0	.0000	.8000	.2000	.0000	0.00	I	
	≤I-3	I48	I 0.8	0.2	99 I00.5	3 4.0	43 40.3	2 I.6	- 0.32	.0034	.8244	.I655	.0067	I.08	3	>0.75
77,79	I	66	3 2,0	0.8	29 3I.3	4 5.4	30 26.2	- 0.0	- 0.0	.0227	.6894	.2878	.0000	2.43	2	>0.25
	2	50	0.0	0.0	25 24.5	5 4.5	20 2I.0	- 0.0	- 0.0	.0000	.7000	.3000	.0000	0.I0	I	>0.70
	≤I-2	II6	3 2.I	- 0.8	54 55.8	9 9.9	50 47.2	- 0.0	- 0.0	.0I29	.6939	.2932	.0000	I.55	2	>0.25

* In numerator - observed phenotypes, in denominator - theoretically expected

Table 1 (continued)

I	2	3	4	5	6	7	8	9	I0	II	I2	I3	I4	I5	I6	I7
73	I	I00	- 0,7	I 0.2	57 58.5	3 5.2	39 35.2	- 0.0	- 0.0	.0050	.7650	.2300	.0000	5.34	2	>0.05
	2	59	- 0.7	I 0.3	33 3I.3	5 4.0	20 22.6	- 0.0	- 0.0	.0085	.7288	.2627	.0000	2.99	2	>0.20
	3	29	- 0.0	- 0.0	I8 I7.4	2 I.4	9 I0.0	- 0.0	- 0.0	.0000	.7759	.224I	.0000	0.39	I	>0.50
	4	28	- 0.0	- 0.0	I7 I7.2	I 2.5	I0 9.4	- 0.0	- 0.0	.0000	.7857	.2I43	.0000	0.94	I	>0.25
	5	I00	I 0.7	- 0.2	52 5I.8	8 7.3	38 38.8	I 0.7	- 0.27	.0050	.7200	.2700	.0050	0,86	3	>0.80
	6	200	I 0.7	- 0.2	I05 I02.9	I6 I5.I	76 78.9	- I.4	2 0.5	.0025	.7I75	.2750	.0050	6,48	3	>0.05
	≤I-6	5I6	2 2.8	2 I.0	282 279.I	35 34.3	I92 I95.6	I 2.2	2 0.8	.0038	.7355	.2578	.0029	3.27	3	>0.25

Table 2

Frequency of gene "B" Est-IV-locus in three samples of skipjack from tropical Atlantic

Types of samples	q "B"	No. of sp.	No. of samples
1	0.824 (0.800-0.869)	148	3
2	0.693 (0.689-0.700)	116	2
3	0.736 (0.717-0.786)	516	6

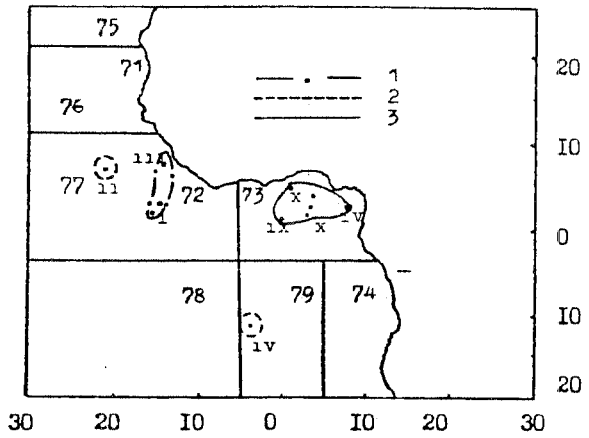

Fig. 1. Distribution of the skipjack samples in space.
1 - northern grouping, 2 - southern grouping,
3 - Pagalou area grouping.
Roman numerals denote the sampling months.

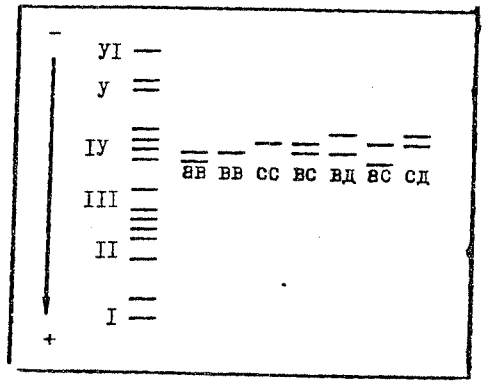

Fig. 2. Scheme of electrophoretic spectrum of muscle esterases of the skipjack.
IV - phenotypes of polymorphous zone of "slow" esterases.

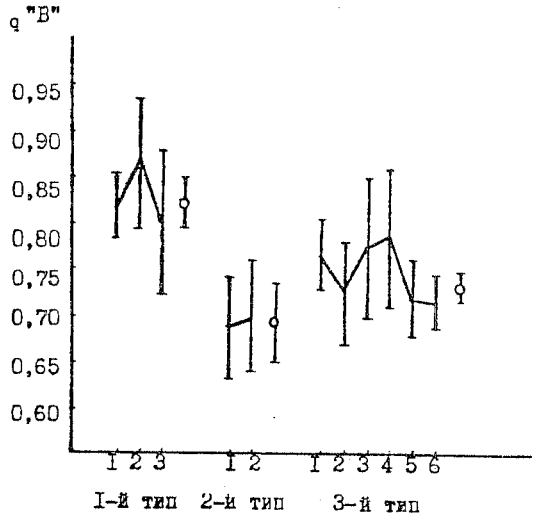

Fig. 3. Variability of frequency of gene "B" in three types of samples of the tropical Atlantic skipjack. Lines with confidence intervals - gene frequences in separate samples, light circles - mean frequency of a gene in samples.
X-axis - the number of samples and types of samples.