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18

MECHANISMS OF BIOCHEMICAL ADAPTATION OF SEA ORGANISMS TO ENVIRONMENTAL STRESSES

MECANISMES D'ADAPTATION BIOCHIMIQUE DES ORGANISMES MARINS A DES FACTEURS EXTREMES DU MILIEU

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Steadiness of sea organisms to the effect of abiotic and anthropogenous factors is observed at all levels of biological organization (Polikarpov, Matskivsky, 1982 ; Hocacka, Somero, 1977). The basis for the molecular level consists in the macromolecular interaction ensuring normal functioning of an organism, as well as population and biosystem at large. In this connection, composition and properties of proteins are the most informative and sensitive indicators required for estimation and prediction of hydrobionts' state under conditions of the growing effect of anthropogenous factors with ionizing radiation representing these and being a model of a number of factors. Ionizing radiations produce uniformly distributed and simultaneous effect on an organism and appear a suitable means for investigation of processes occurring in the course of adaptation evolution securing general (nonspecific) resistance of natural populations (Scott, Butcher, 1971).

Therefore the purpose of the present work is based on the study of changes' character is blood metalloproteids of marine fishes during their adaptation to irradiation.

MATERIALS AND METHODS

The objects of investigation were males and females of the Black Sea fish *Neogobius melanostomus*. Experimental groups consisted of 10 males an 7-10 females. To examine the effect of the external 2 Gy γ - irradiation (^{137}Cs, dose rate 0.04 $Gy.s^{-1}$) of fish using electrophoretic technique in a 7 % polyacrylamide gel (Davis, 1964), we were determining the composition of blood serum metalloproteids and hemoglobin in experimental and intact animals following 1, 3, 5, 7, 10, 20, and 30 days after exposure. Ferriferous and cupriferous components were detected according to F.T. Clark (1964) and F.A. Owen, A. Smith (1961) respectively, hemoglobin was detected using the method suggested by O. V. Troitskaya (1977). Metalloproteid fractions' distribution was established by the relative electrophorectic mobility factor (K_{eph}). On the basis of K_{eph} values of (M±) fractions constituting over 60 per cent in statistical mean samples, we were plotting "standard" electrophoretic spectra further used in comparative analysis. The values obtained from experimental groups were correlated with the respective values of intact fishes taken as 100 per cent.

RESULTATS AND DISCUSSION

The analysis of experimental data has down that a common property of serum metalloproteids of fishes appears with the growth of the EPh-spectra heterogeneity within the first 5-7 days following the exposure. Later on, the number of fractions of these proteins is decreasing and reaching, after 20-30 days, the values registered in intact animals.

Responses of fishes' blood metalloproteids to γ -irradiation take place according to a certain sequence.

Dynamics of ferriferous components in the irradiated fishes' blood serum has a marked two-phase character (Fig.1). We have established a significant (by 50-80 per cent) fraction number increase on the first and the seventh days following the exposure to the γ - irradiation ; after that their number was decreasing to the value registered in intact female fishes on the 10th and male fishes on the 30th days following the exposure.

On the third day after irradiation, blood serum of fishes showed a 100 per cent growth of the cupriferous component number. Such trend was observed until the 7th day when the indicators attained their maximum values (Fig.2). On the 20th and 30th days following the exposure, females and males, respectively, showed resumption of the fraction number of cupriferous proteins in h-spectra of the blood serum.

The number of hemoglobin fractions in fishes' blood after γ-irradiation is changing to a lesser extent than serum metalloproteids. Here, the growth of the hemoglobin fractions' number by 33-67 per cent occurs within the 1st-7th day period ; then these values dropped down the level characteristic to non-irradiated fishes (Fig.3).

The first 10 days following the exposure were remarkable for the trend of a 30-40 per cent reduction of "rare" metal-containing proteins. Here, the dynamics of the "rare" components' number had an antipodal characteristic with regard to metalloproteids and hemoglobin fractions' changes in "standard" EPh-spectra. Thus, the ferriferous proteins showed a sharp reduction of the "rare" fractions not later than one day following irradiation, while that of cupriferous proteins and hemoglobin was observed not earlier than after 3-5 days. Hence, we may assume that heterogeneity growth of serous metalloproteids and hemoglobin in fishes is explained by "rare" components whose occurrence, due to metabolic disorders caused by γ -irradiation, reaches 60 per cent and more, giving them the status of "standard" s-spectra.

The character of the determined changes in metalloproteids is stipulated by a high chemical activity of iron, copper, and their protein complexes which catalyze the major redox reactions in an organism. It has been found that serum metalloproteids are characterized by hypersensitivity to radiation as compared to hemoglobin.It may also be assumed that the adaptative response of an organism is directed to ensuring the normal functioning of hemoglobin which plays a cardinal role in vital activity (Sukhomlinov, Kashenko, 1974). The hemoglobin exchange is know, to depend on and be defined by the metabolic status of serum ferri- and cupriferous proteins characterized by oxydase activity and capacity to utilize and transport iron (Frieden, 1981 ; Aisen, Listowsky, 1980). In this connection, we emphasize a fast non-specific reaction of ferriferous proteins whose number of fractions, well after 24 hours following the exposure, grows by 1.5-2 times due to predominating of the reserved "rate" components; 5-7 days later, a more complex and differentiated organism response follows which is proved by the formation of new fractions of cupri- and ferriferous proteins.

The continuity of the reactions considered leads to the reduction of electrophoretic composition of fish blood hemoglobin after 10 days, while the "adjustment" sytem, to which serum metalloproteids may be related, is reduced over a longer period: 20-30 days following the irradiation. It was also found that all composition changes of serum metalloproteids and blood hemoglobin induced by irradiation in females are traced earlier and normalized faster as compared to the respective characteristics in males. This fact proves greater adaptive flexibility of females in contrast to males.

The regular character of composition changes in fishes' blood metalloproteids may reflect the effect of common molecular mechanisms intented for providing the stability of an organism and implementation of its rehabilitative capabilities under conditions of the extreme effect of anthropogenous factors.

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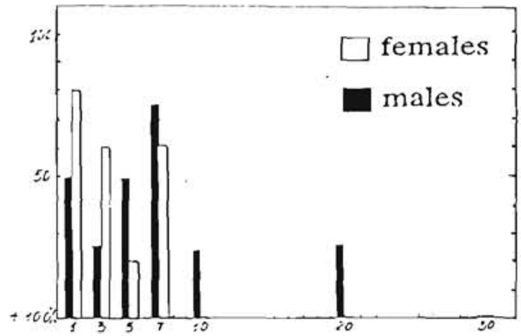

Figure 1 - Changes of ferriferous proteins fraction number in blood serum of fishes exposed to γ-irradiation. Abscissa shows days following the exposure, ordinate gives percentage of values compared to intact fishes taken as 100 per cent.

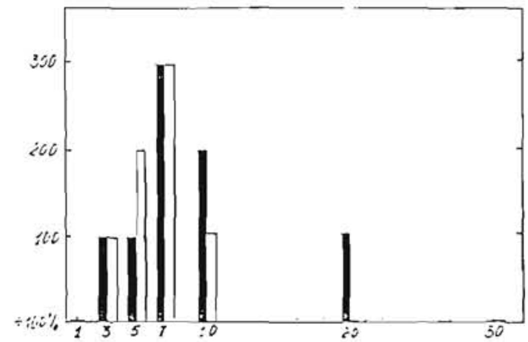

Figure 2 - Changes of cupriferous proteins number in blood serum of fishes exposed to γ-irradiation. Designation is similar to figure 1.

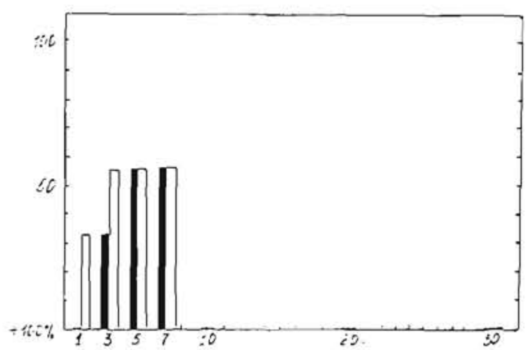

Figure 3 - Changes of hemoglobin fraction number in fishes' blood following exposure to γ-irradiation. Designation is similar to figure 1.