(165) R. Ghys and A. Reuter
Radiobiology Laboratory,
Department of Biochemistry,
Faculty of Medicine, Laval University, Québec, P.Q.

Presented at the 6th Ann Meeting of Canadian Fed of Biol Soc. London, ont. June

PROGRESSIVE ALTERATION OF SERUM PROTEINS IN RATS SEVERAL MONTHS AFTER AN ACUTE OR PROTRACTED IRRADIATION

Conf-

CONF-294-1 (2, C)

Alterations of serum proteins after an acute X irradiation have been described by several authors. In 1954, Fisher et al (1) observed a fall of the albumin and γ globulin fractions and a rise in the percentage of β and α globulins in rats during a 14 day period after the irradiation; Winkler and Pashke (1956) (2) confirmed these results. Goranson (3) et al, using the starch electrophorese technique, noticed an abnormal α 2 globulin which appears in mice 72 hours after irradiation and lasts for at least 10 months. Ditzel (4), in hamsters kept under observation for 45 days after the irradiation, saw alterations of the serum protein pattern similar to those previously described in rats. We are presently studying delayed changes of the serum proteins in male Sprague Dawley rats which survived the acute irradiation syndrome. The present report deals with animals given ^{60}Co irradiation at 6 to 8 weeks of age, and the same observed for about a 12 month period.

Doses of irradiations ranging from the LDo to the LD50 were given either at 0.2 rads or 16 rads per minute. Some of the

Canadian Federation of
Biological Societies
6th Annual Meeting
London, Ontario, CANADA
June 17-19, 1963

animals receiving the low dose rate irradiation were kept at 6°C for one month prior to irradiation, which enabled them to survive total body doses of radiation up to 1800 rads (5).

Paper electrophoreses and microdosage of proteins by the biuret method have been done so far on the plasma proteins of 146 irradiated rats (29 had an acute irradiation, 73 chronic irradiation and 44 chronic irradiation following cold acclimatization). The same analyses were performed on 60 normal animals, 2 to 12 months of age, to see the effects of aging on serum proteins.

No significant variations in the total serum proteins have been observed in any one group; the average in all series being around 7 gr %, with practically no individual value lower then 6 g % nor higher than 8 g %.

The shaded areas of fig. 1 show the limits of variation of the mean (95% confidence level) for proteins of normal rats.

Aging produces a decrease in the percentage of the albumin fraction and an increase in the α globulin fractions, while β and γ globulins remain at fairly constant levels. In irradiated animals, albumin content begins to fall below normal levels approximately 5 months after the irradiation. In the most extreme cases, albumin content can fall to less than 30% of the normal for animals of the same age.

The percentage of α globulins tends to be slightly above normal in some rats. Those elevated values might correspond to the modifications, observed by other authors, in the days following irradiation. (1) (2) (3) (4).

There is no significant variation of the β globulin fraction.

The most striking changes are seen in the γ globulin fraction, which increases markedly and consistently following irradiation. In some cases, the quantity of γ globulins in the circulating blood is more than doubled.

Alterations of the serum protein pattern in irradiated rats, made more radioresistant by cold acclimatization, are similar to those just described (fig 2).

So far, we have not observed any relationship between the magnitude of the irradiation dose and the protein changes, but it should be remembered that all our series consist of animals which survived a radiation dose in the lethal or near sublethal range.

Accordingly, the results of all the electrophoreses done between the 5th and 10th month after the irradiation have been grouped in table 1. The decrease of the albumin and increase of the γ globulins in most animals can readily be seen in this table.

As far as we know, this striking increase of the γ globulins has never been described in the litterature. We do not know yet if this is due to the release in the serum of abnormal proteins or merely to an increase of normal components of this group of proteins: this question is presently under investigation.

In our opinion, the importance of these alterations of the serum proteins of irradiated rats, appearing in otherwise seemingly normal animals, lies in the fact that they might be a link between the early irradiation syndrome and the "late effects" (accelerated aging and tumour production) of irradiation.

A. Reuter* and Roger Ghys
Laboratoire de radiobiologie
Département de Biochimie
Faculté de Médecine
Université Laval
Québec

1. Fisher, M.A., Magee, M.Z., and Coulter, E.P., Arch. Biochem. 56, 66 (1955).

2. Winkler, C., and Paschke, G., Rad. Res. 5, 196 (1956).

3. Goranson, E.S., Mc Culloch, E.A., and Cinits, E.A., Rad. Res. 12, 560 (1960).

4. Ditzel, Y., Rad. Res. 17, 694, (1962).

5. Ghys, R., Nature 198, 603, (1963)

* Visiting scientist from Department of Isotopes C.E.N. Mol, Belgium.

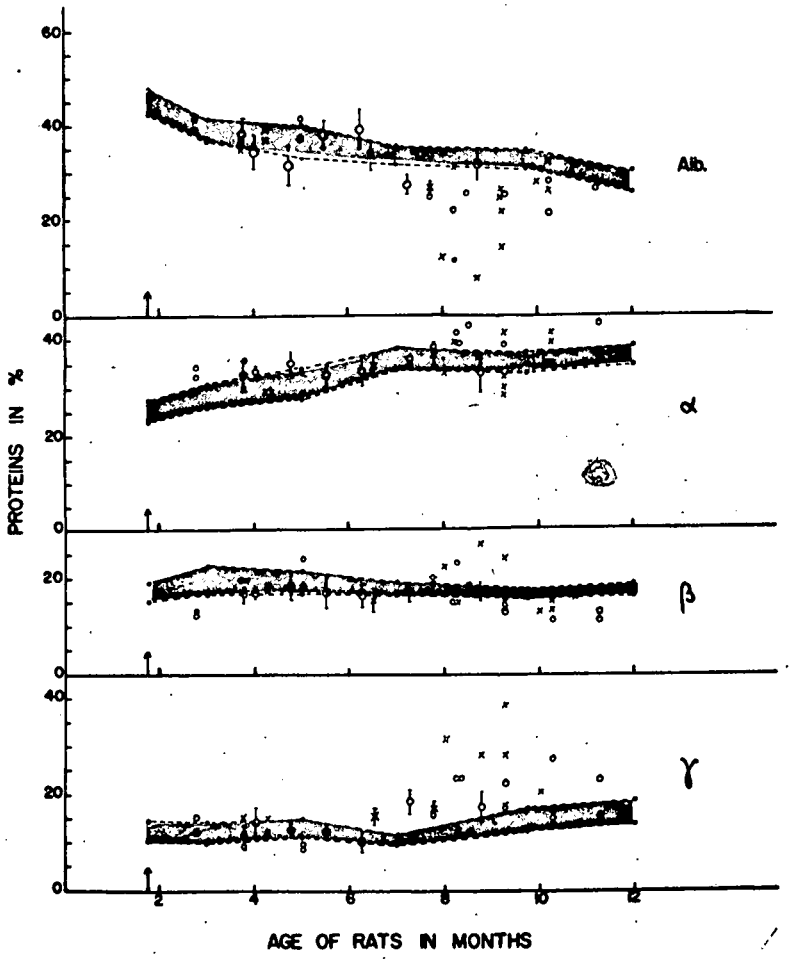
TABLE I

VARIATIONS OF PROTEIN FRACTIONS IN RATS IRRADIATED 5 to 10 MONTHS BEFORE*

	% of the total number of animals with protein values		
	lower than the mean	within the limits of the true mean°	higher than the mean
Albumins	78.6	19.8	1.6
α globulins	19.8	43.9	36.3
β globulins	43.9	31.8	24.3
γ globulins	0.	26.0	74.0

*) based on a total of 66 animals

o) the limits of the "true mean" for the various protein groups are those within which the mean has a 95% probability to occur for normal animals of the same age.


PROTEINS IN %
60
40
20
0
Alb.
α
β
γ
2
4
6
8
10
12
AGE OF RATS IN MONTHS

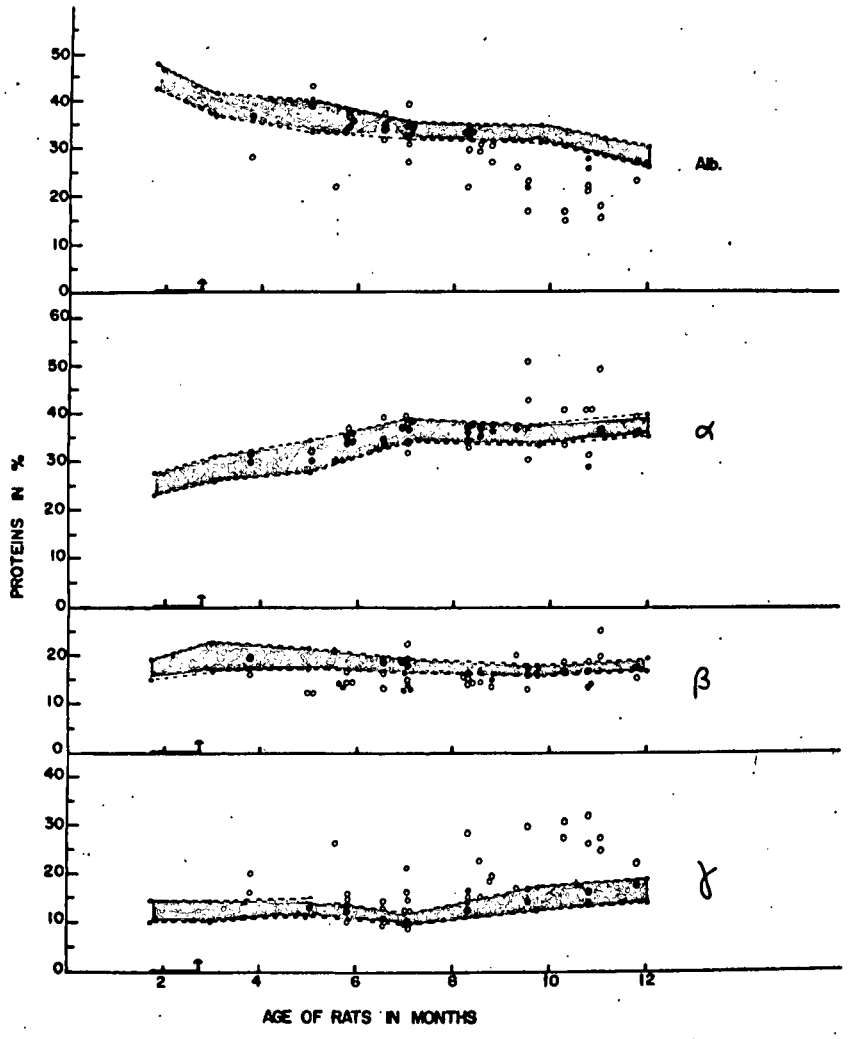

Alb.
α
β
γ
PROTEINS IN %
AGE OF RATS IN MONTHS

Fig. 1. Variations of the serum protein pattern in irradiated rats x: animals irradiated at 16 rads/min; o: animals irradiated at 0,2 rads/min; I: variation of the mean in series of at least 7 rats; ↑ : time of the irradiation.

Fig. 2. Variation of the serum protein pattern in rats irradiated after cold acclimatization (1 month at 6°C), o: animals irradiated at 0,2 rads/min ; ↑: time of the irradiation.