GIANT MAST CELLS—A SPECIAL DEGENERATIVE FORM PRODUCED BY MICROWAVE RADIATION

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THE EFFECTS of microwave radiation on the biological system are for the most part still unknown. The biological effects of microwave energy can be divided into two general categories: thermal and non-thermal. The thermal effect can further be divided into volume heating and selective heating (specific thermal) effects [3, 7, 9, 10]. Most of the biological effects of microwave radiation are attributed to thermogenesis. The mechanism of thermal induction in biological tissue is probably the "dipolar ion effect", in which dipolar molecules increase their thermal motion [1, 4, 11].

Mast cells are extremely sensitive to environmental changes, irritation or actual injury. They respond to injury of any kind by liberating substances normally held in their protoplasm. Degranulation and disruption are the most common reactions of the mast cells against irritating stimuli [8, 12, 13, 14]. Mere changes in the shape or size of the mast cells due to external stimulus are relatively rare. However, by using some drugs which inhibit mitosis the mast cell morphology can be altered [5, 6].

In the present paper data are reported which show that after treatment with microwave radiation some of the mast cells located in the peritoneal fluid of the experimental animals were transformed into giant cells and that this phenomenon is possibly a non-thermal effect of the microwave radiation.

Materials and Methods.—Young adult white male rats (200–250 g) were treated with Radarmed-Tischgerät 12T200 (produced by Deutsche Elektronik GmbH, Berlin-Wilmersdorf), which is a microwave apparatus generating a beam of high frequency energy having a wavelength of about 12.4 cm and a frequency of 2425 ± 25 megacycles. A director hemispherical in shape and 17 cm in diameter was used. The animals were treated in a cardboard box which was placed immediately beneath the director. The irradiation time was 5 min and the power of the radiation was 80 W. In order to examine the effect of the mere heating the animals were anaesthetized with Nembutal (subcutaneously) and then heated in a thermostat chamber until their rectal temperature reached 42°C. This temperature was maintained for 2–3 min. The rats were then removed and they awakened in their usual cages. During the microwave treatment the temperature of the rats reached only about 41°C. The possible effect of the lack of the oxygen and cumulation of carbon dioxide was studied in the following way. Some rats were placed in a large glass container, which was closed tightly. After a short time the rats lost consciousness. 2 or 3 min later they were removed from the container; they recovered in some minutes.

The animals were examined 3 hr after the treatment. They were decapitated with scissors and the peritoneal cavity was opened by a short incision and a sample of the peritoneal fluid was drawn into a pipette. Smears were stained with May-Grünwald-Giemsa stain. The mast cells in the smears of the peritoneal fluid were examined

with a measuring ocular. The metachromatic material in the mast cells was shown by staining the smears with toluidine blue and the fluorescent amines were demonstrated according to Falk [2] by treating the smears with dry formaldehyde vapour for 1 hr at 80°C and examining the preparations under a fluorescence microscope.

Observations.—A peculiar form of the mast cell appeared in the peritoneal fluid of most of the experimental rats subjected to microwave radiation. These mast cells were gigantic in size when compared with the normal mast cells. The mean diameter (the mean of the longest diameter of the cell and the diameter at right angles) of the mast cells in the control material was about 12.7 μ on the average. The longest mean diameter found in the control cells was 24 μ. On the other hand, the irradiated material contained giant mast cells having a mean diameter up to 37 μ and the longest diameter up to 47 μ. The area of the largest giant cells was also about nine times that of the normal cells. The incidence of giant mast cells varied between 5 and 30 per cent. Not a single giant mast cell was found in the control animals.

The giant mast cells showed no signs of disruption, all holding their granules inside the cell membrane. The density of the giant cells was somewhat lower than that of the normal mast cells. The stainability was also slightly decreased and the cells seemed to be faded in comparison to the normal mast cells. However, the giant mast cells were stainable with toluidine blue and they also were fluorescent after treatment with formaldehyde vapour. In some of the giant mast cells the granules were so tightly packed together that their individual outlines could not be discerned. However, most of the giant mast cells seemed to be swollen and oedematous and their granules were clearly distinguishable. Also the nuclei of the giant mast cells could be seen very clearly in most instances.

Since the temperature of the animals rose during the microwave treatment, the effect of merely the temperature of the body was studied. The experiments showed that the size of the mast cells did not increase at all. An experiment on the effect of the lack of oxygen and the cumulation of carbon dioxide also gave negative results as far as the formation of giant mast cells was concerned. However, a slight increase in the size of the mast cells was noted.

The giant mast cells were obviously formed from the normal mast cells present in the peritoneal fluid, all the transitional stages from the normal mast cell to the giant form being found.

Discussion.—The response of the mast cells of the peritoneal fluid to the microwave radiation was somewhat surprising. The expected reaction was degranulation and disruption, which usually are the immediate occurrences when mast cells are subject to irritation of any kind. It seems obvious that the giant mast cells are not formed by fusion of two or more cells, they are not so-called quasi mast cells (macrophages containing mast cell granules), nor are they the product of some disorder in the mitosis. It seems rather that they are a result of some disorder in the internal

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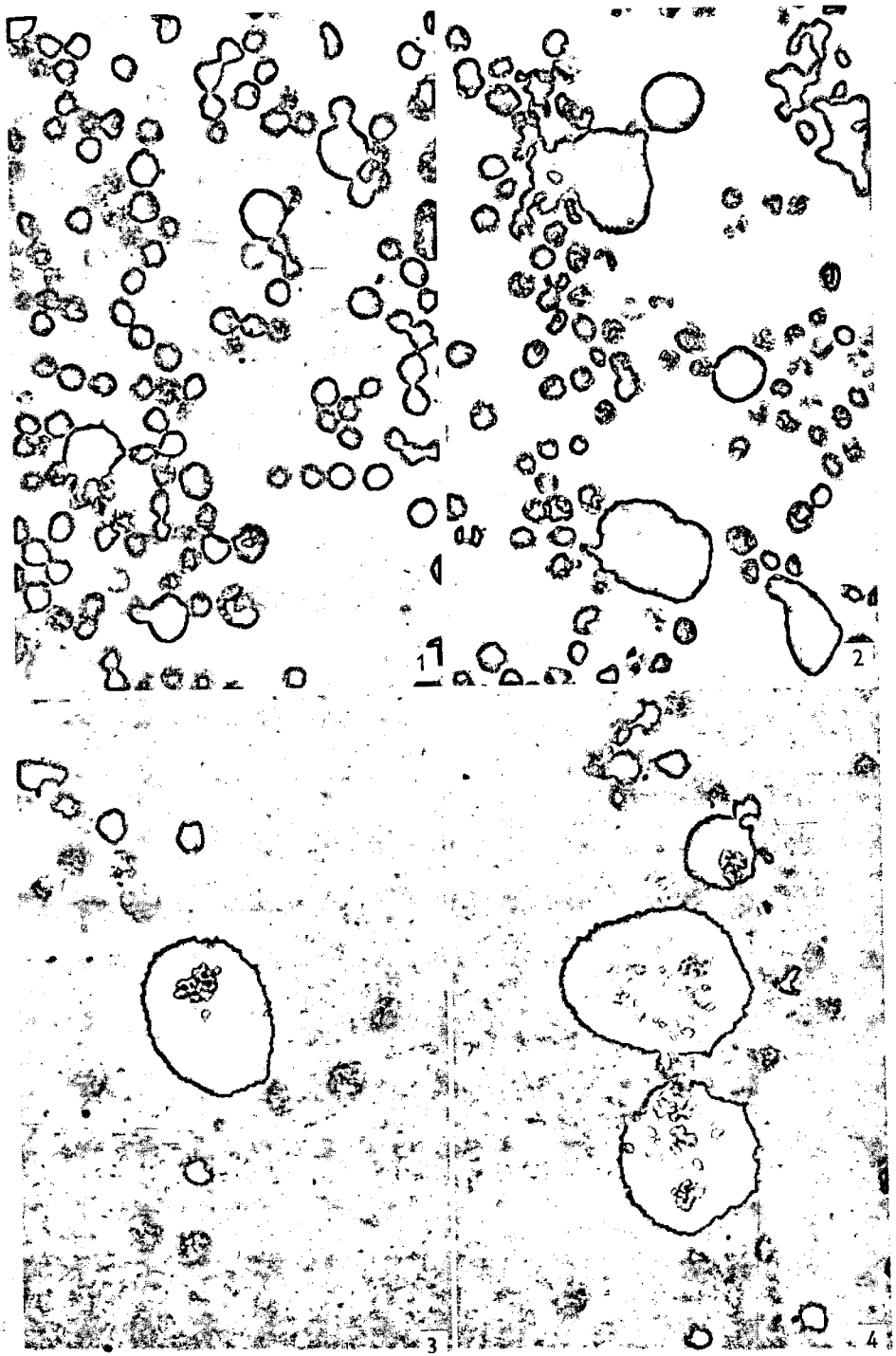
All smears are stained with May-Grünwald-Giemsa stain and photographed at a magnification of ×660.

Fig. 1.—Normal mast cells in the peritoneal smear of a control animal.

Fig. 2.—Two large dense mast cells.

Figs. 3–4.—Giant mast cells.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metabolism of the cells themselves. This process is probably degenerative by nature. The process is, however, not very grave, since the staining properties of the mast cell did not change but only became somewhat weaker. The fact that the other cell types in the peritoneal fluid showed no changes points to the probability that the mast cells are more sensitive than other cells or that they have a special reaction which the other cell types do not have. Since the mere heating of the tissues did not produce giant mast cells, their formation must be regarded as a non-thermal effect of the microwave radiation. Anoxia probably has some role in view of its known inhibitory action on mast cell degranulation due to phosphatidase A [12].

Summary.—The appearance of giant mast cells in the peritoneal fluid of the rat after microwave irradiation is reported. These giant cells are probably a special degenerative form of the mast cells. The formation of giant mast cells seems to be one of the non-thermal effects of microwave radiation.

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FINE STRUCTURE OF MEIOTIC CHROMOSOMES OF THE BASIDIOMYCETE *COPRINUS LAGOPUS*

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The fine structural organisation of the chromosomes of higher organisms at the synaptic stage of meiosis was first demonstrated by Moses [9] in spermatocytes of the crayfish. At this stage a tripartite structure is present within the nuclei which has been called the synaptinemal complex. This structure, Moses and Coleman [11] have pointed out, represents a longitudinal section through both of the homologues