

TRANSFORMING AND INHIBITORY ACTION OF X-RAYS ON DEVELOPMENT OF SPUR ANLAGEN IN CHICK EMBRYOS

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The development of spurs in chick embryos was studied after a single exposure to wholebody x irradiation in a dose of 600 R. Two well marked radiosensitive periods were found during the development of spur anlagen. Irradiation during these periods has different results: transformation of the spur anlage into a scale (irradiation on the 8th-9th day of incubation) or total inhibition of spur development (irradiation on the 10th day of incubation).

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X rays have a powerful injurious action causing various types of disturbance of embryonic development. Usually the anomalies produced are characterized either by complete inhibition of development of the anlagen as a whole or by defects of individual parts of the embryo. In experiments to investigate the radiosensitivity of anlagen of skin derivatives (feathers, scales, spurs) it was found that, besides their usual inhibitory action, x rays also have a transforming action, as a result of which the spur anlage is transformed into a typical imbricate scale.

EXPERIMENTAL METHOD

The investigation was carried out on hen embryos of the Russian White breed. Eggs were incubated at 38.2°C and 60% relative humidity. Total irradiation was given by the RUM-11 apparatus between the 7th

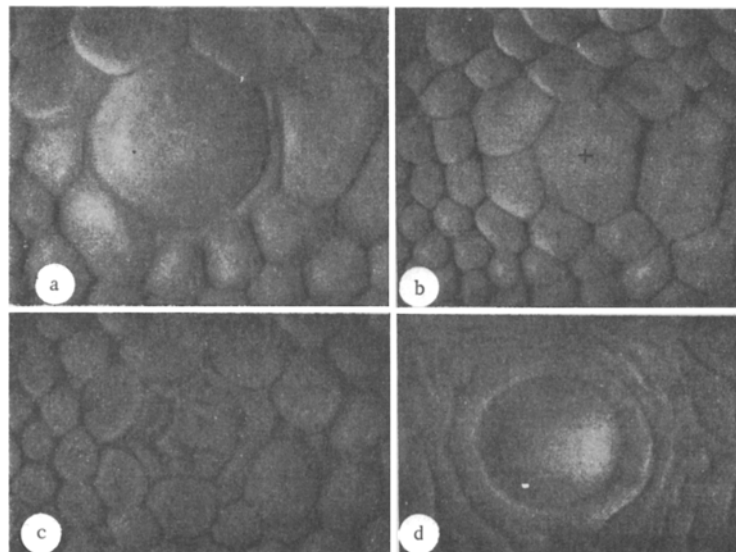


Fig. 1. Spurs and scales on the tarso-metatarsus of 16th day embryos. a) Control; b) imbricate scale (shown by cross) developing from spur anlage after irradiation on 8th day of incubation; c) complete inhibition of spur development following irradiation on 9th-10th day of incubation; d) complete inhibition of scale development after irradiation on 11th day of incubation. 25 \times .

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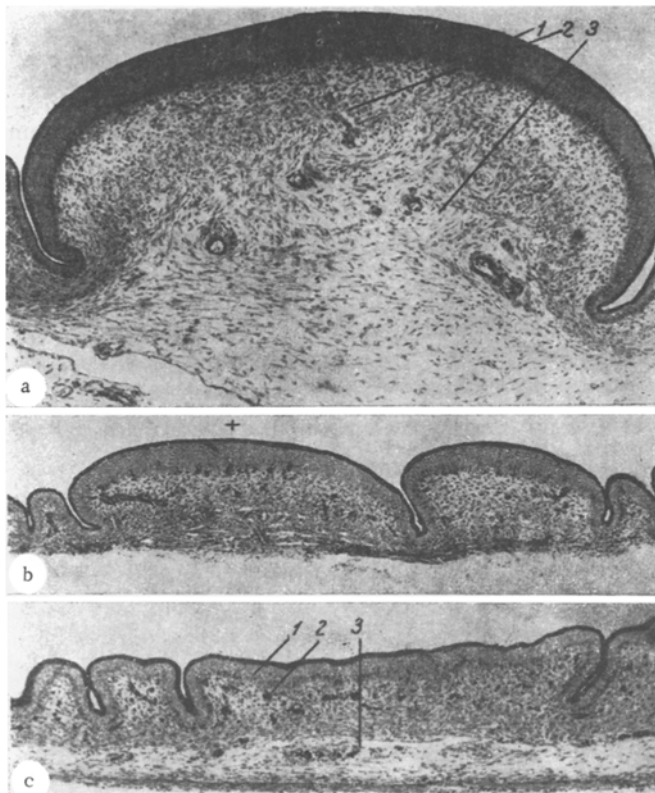


Fig. 2. Transverse sections through control spur (a), imbricate scale (b) developing from spur anlage (marked by a cross), and spur completely inhibited by irradiation (c) in 16-day embryos. 1) Horny scale of spur; 2) body of spur; 3) fibrovascular cushion. Fixation by Bouin's method, stained with azan. Magnification: a, c) 90 \times ; b) 80 \times .

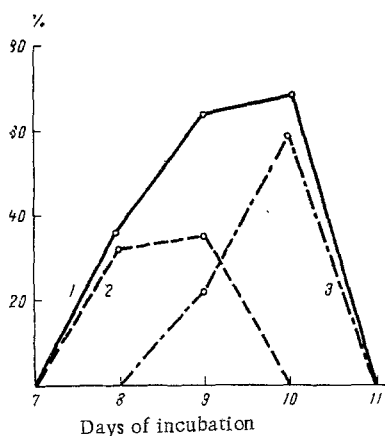


Fig. 3. Disturbances of spur development following irradiation at different times of incubation. Abscissa: days of incubation; ordinate: percentage of damaged spurs. 1) Total number of damaged spurs; 2) transformation of spur into imbricate scale; 3) complete inhibition of spur development.

and 14th days of incubation. All experimental and control eggs were examined on the 16th day of incubation. The limbs (right) were removed from the embryos and fixed in Bouin's fluid. Small pieces of skin with spurs were excised from the fixed material and mounted in water under a cover slip. The spurs were photographed under the MBS-1 microscope, and the state of their development was then studied from the photographs. Material for histological investigation was embedded in paraffin wax and sections cut to a thickness of 8-10 μ were stained with azan or hematoxylin-eosin.

EXPERIMENTAL RESULTS

The spur of an unirradiated 16-day embryo consists of a large, conical structure with a round base (Fig. 1a), surrounded by several satellite scales. The spur, like a horny scale, consists of three parts: epidermal, dermal, and vascular, but it differs from the scale in that all three parts of extremely hypertrophied. The well developed vascular plexus, together with the connective-tissue cells, collagen and argyrophilic fibers, constitute the fibrovascular cushion on which rests the growing dermal part of the spur, forming the actual body of the spur, covered by a thick (horny) cap (Fig. 2a).

X rays had a well marked injurious action on spur development (Fig. 3). After irradiation on the 8th day of incubation, instead of a spur, 35% of embryos developed typical imbricate scales (Fig. 1b). On section, the scale developing from the spur anlage was quite indistinguishable from the imbricate scales situated alongside it (Fig. 2b). After irradiation of 9-day embryos, 63% of them developed an abnormal spur, and the actual character of injury itself was sharply modified. Besides disturbances such as transformation of spurs into scales about 35%, cases were observed in which the spurs were rudimentary (about 10%), or even failed completely to develop (21%). The rudimentary spur still had its typical shape — a small conical structure with a round base; if development was completely inhibited, only a small area of wrinkled skin remained at the place where the spur should have been (Fig. 1c) and on the 19th-21st day of incubation this area was completely covered by the edges of the adjacent scales. All three parts of the spur were injured: the epidermal cap was comparable in thickness with the thin epidermis in the folds of skin between the scales, the dermal part was much thinner, and the fibrovascular cushion was poorly developed and its surface was either flat or slightly convex (Fig. 2c). When irradiation was carried out on the 10th day of incubation the spurs completely failed to develop (accounting for 59 of the total of 67% of all types of disturbances). Irradiation on or after the 11th day of incubation had no effect on spur development, but on the contrary, the surrounding scales were damaged (Fig. 1d).

The existence of two phases of spur injury undoubtedly reflects different states of development of their anlagen at the time of the injurious action of x rays: irradiation of the early spur anlage modified its development toward the imbricate scale, while irradiation at a later stage of the developing anlage leads to inhibition or complete suppression of spur formation. Two independent radiosensitive (critical in Svetlov's terminology [2]) periods thus exist in the morphogenesis of spur anlagen. Irradiation during these periods has different results: transformation of the spur anlage into a scale anlage (irradiation on the 8th-9th day of incubation) or inhibition of spur development (irradiation on the 10th day of incubation).

The possible reason for these different types of injury to the spur anlage may be a disturbance of different aspects of the mechanisms of its morphogenesis laid down in the course of evolution. Since spurs are derivatives of horny scales, the development of these scales from spur anlagen after irradiation must be regarded as an example of experimental organogenetic atavism [2]. Takhtadzhyan [3] distinguishes two groups of teratologic processes: atavisms, of importance in evolution, and anomalies, which are simple disturbances of the mechanism of development. According to Takhtadzhyan, when deviations occur in the normal course of ontogenesis of phylogenetically complex organs, it is the historically younger correlative connections which are disturbed first, and the older elements are not affected until later. The phenomena of the transforming and inhibitory action of x rays on spur development should probably be approached from this point of view.

LITERATURE CITED

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