Influence of Local X-ray Treatment on Development of Jaws in Young Axolotl (*Siredon mexicanum*)* (19393)

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The number and age of the experimental animals (Fig. 1) and the dosages of x-radiation are indicated in Table I.

Methods. During irradiation of the lower jaw, the upper jaw and skull were protected by a small lead plate (about 1 mm thick) which was inserted into the mouth of the anesthetized animal. The bodies of the experimental animals were protected by a lead plate 4 mm thick. Irradiations were made from the ventral aspect. During irradiation of the upper jaw, the lower jaw was similarly protected, and irradiations were made from the dorsal aspect. The conditions of irradiation were as follows: 55 kv., 3 ma. max., no filter. Some of the animals of the first group and all animals of the second group were fixed at the end of experiments. But the other animals of the first group and all of the third group were fixed at various times following irradiation. In the first group, the animals were fixed at 10, 24, 34, 43, 52, 71, and 92 days after treatment. In the third group, animals were fixed at 7, 13, 23, 33, and 54 days after treatment. The heads of animals were fixed in a saturated solution of bichloride of mercury with 5% acetic acid; embedded in paraffin; sectioned at 10 μ and stained with Böhmer's hematoxylin and eosin.

Results. In the first group, a slight retardation of growth of the treated jaw was observed 71 days after irradiation. In group III, a suppression of growth of treated jaws was observed 33 days after treatment. The difference in sensitivity to x-ray irradiation of animals of various ages was more evident long after irradiation. For example, a comparison of Group I animals 312 days after treatment with 3000 r and Group II animals 176 days after irradiation with 2000 r showed that in the latter younger group, in spite of the smaller dosage, the jaws showed a much greater suppression of growth than did the Group I animals. Moreover, the suppression of growth in the latter group became evident much sooner. In some cases, the suppression of growth of the treated jaw was so great that the animal was unable to eat and had to be fed by hand (Fig. 3 and 4). In a few animals, the upper jaws were irradiated. In these experiments, similar results were obtained, but the suppression of growth here was not as great as in the irradiated lower jaws (Fig. 2).

In accordance with our previous observations, the appearance of treated tissues in jaws fixed long after irradiation was normal (Brunst(1-3), and Brunst, Barnett, and Figge(4)). Examination of jaws of animals fixed on the day of treatment shows that they had small teeth even at this time, but these teeth disappeared completely in the treated jaws while they developed normally in the control (shielded) jaws (Fig. 6 and 7). The irradiated jaws lack teeth, but are otherwise miniature copies of normal jaws having all of their component parts.

In the animals of the third group, the tissues appeared normal 7 days after treatment. In spite of this, the growth of teeth in the treated jaw was arrested. Thirteen days after treatment, some parts of the irradiated epithelium

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TABLE I. Arrangement of Animals According to Age and Dosage Groups.

Group	No. of animals	Age in days after hatching	Size in cm (approx.)	Dosage in r
I	22	60	5	3000
II	5	20	3	2000
III	9	22	3–3½	4000

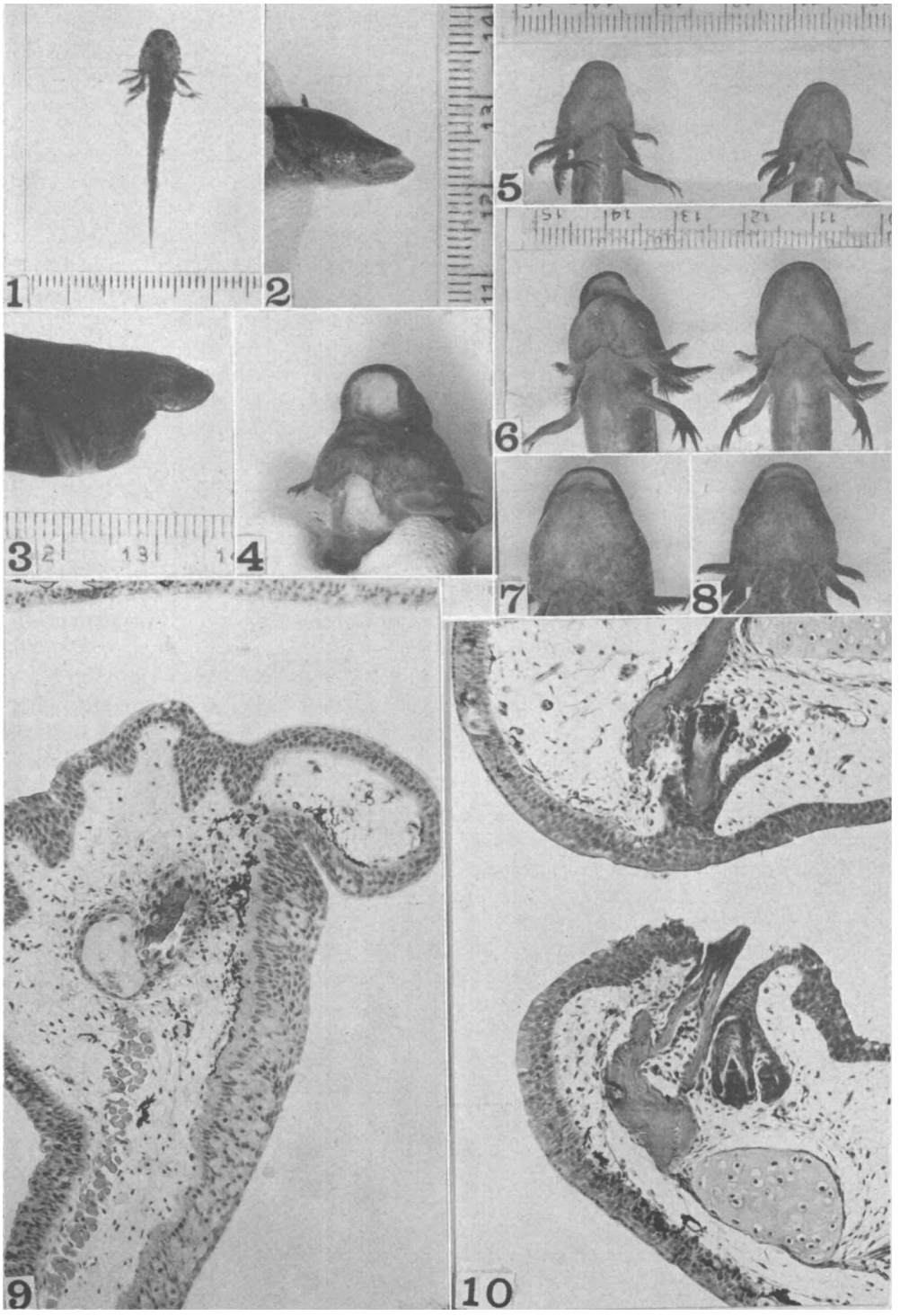

FIG. I. Animal on day of irradiation 20 days after hatching (second group).
FIG. 2. 250 days after irradiation of upper jaw (lateral view) with 2000 r (irradiation 20 days after hatching, second group).

FIG. 3. 176 days after irradiation of lower jaw with 2000 r (lateral view, second group, irradiation 20 days after hatching).

FIG. 4. Same animal as in Fig. 3 (ventral view).

FIG. 5. Left: Third group (irradiation 22 days after hatching) 34 days after irradiation of lower jaw with 4000 r. Right: Untreated (control) animal from same spawning.

FIG. 6. Left: Third group (irradiation 22 days after hatching) 58 days after irradiation of lower jaw with 4000 r. Right: Untreated (control) animal from same spawning.

FIG. 7 and 8. First group (irradiation 2 months after hatching) 53 days after irradiation of lower jaw with 3000 r.

FIG. 9. A sagittal section through treated jaw 120 days after irradiation with 2000 r (second group, irradiation 90 days after hatching) (× 60).

FIG. 10. A sagittal section through both jaws of a control animal of same age as in Fig. 9 (× 60).

were not normal in appearance. The mitotic activity in the treated tissues had been completely suppressed and, therefore, the formation of new enamel organs did not occur. The tissue-reaction of the irradiated jaw was especially clear 23 days after treatment. In the treated jaw at this time, there was observed a degenerating giant cell epithelium: a feature which is very typical of the primary acute reaction to irradiation (Brunst(1-3), and Brunst, Barnett, and Figge(4)). By this time, the enamel epithelium had disappeared and the resorption of teeth was in progress. There is some evidence that macrophages take an active part in the destruction of the teeth.

Animals of Group III, fixed 34 days after irradiation, still had small remnants of the teeth in some places of the treated jaws (Fig. 5). It is important to note that at this time, when the resorption of teeth is almost complete, only a small retardation of growth of the irradiated jaw is observed. The degenerating giant cell epithelium has disappeared and is now replaced with epithelium of normal appearance. In spite of great mitotic activity, this epithelium is unable to produce new enamel organs. Fig. 6 shows treated and control animals 58 days after irradiation. The retardation of growth of treated jaws is clearly evident and is much more noticeable than in the first group (Fig. 7 and 8). All remnants of teeth in the treated jaws have completely disappeared; accordingly, the histological picture of such a jaw (Fig. 9) contrasts greatly with the normal histological picture of jaws of the control animals (Fig. 10). The formation of new teeth was never observed up to approximately one year after x-ray irradiation.

Summary. Lower or upper jaws of young axolotls (age 20 to 60 days) were locally irradiated with 2000-4000 r. Suppression of growth of treated jaws was observed in all cases. The irradiated jaw is a miniature copy of the normal jaw. Tissue reaction of irradiated jaw was evident 23 days after treatment with 4000 r (primary acute reaction). The treated jaw at this time showed a typical degenerating giant cell epithelium. The enamel epithelium disappeared and resorption of teeth was in progress. Thirty-four days after irradiation there remained small remnants of teeth in parts of treated jaws. At this time, when the resorption of teeth is almost completed, only a small retardation of growth of the irradiated jaw was observed. The degenerating giant cell epithelium has disappeared and been replaced with normal-appearing epithelium, but this epithelium was unable to produce new enamel organs. Fifty-eight days after treatment the retardation of growth of the treated jaws was clearly evident, and all remnants of teeth in them completely disappeared. In the control (shielded) jaws of the same animals, the development of teeth proceeds normally. The mechanisms of tooth formation and tooth maintenance are permanently destroyed by x-ray irradiation.

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