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Analysis of Experimental Production of Bifid Tails by Ultraviolet Irradiation.

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The embryological basis of spina bifida and the associated double-tailed condition has received a number of explanations. Hertwig¹ advanced the basic theory that the bifid condition results from inhibition of gastrulation which retards closure of the blastopore and thereby prevents fusion of the anlagen of the axial organs located on either side of the blastopore. Bergel² followed Hertwig, attributing bifid tails to a persisting blastopore which mechanically blocks the tail anlagen. Baldwin,³ studying the effects of ultraviolet irradiation upon frogs' eggs, concluded that the essential factor was injury to the highly susceptible yolk material (endoderm), which serves as a barrier to the approximation of the blastoporal lips. Bellamy⁴ suggested inhibition of the *dorsal* blastoporal lip, which is a region of high susceptibility to a variety of noxious conditions.

This study is a preliminary report of attempts to determine whether injury to one or more specific regions of the egg is responsible for the bifid condition of the lower back and tail, or whether it is produced by general injury to the egg. Localized sublethal injuries were produced easily by means of ultraviolet irradiation.

A cold quartz burner* was used whose spectrograph shows a high proportion of rays at 2537 A. U. The intensity was such that after irradiating early gastrulae for 13 minutes there was no trace of a neural plate within 24 hours. Most of the egg-jelly was removed with scalpels. The eggs were placed in a chamber the bottom of which was a quartz plate 1.65 mm thick. Irradiation was from below, with the ultraviolet burner 2.5 mm from the lower surface of the quartz plate. Shields cut from tinfoil were applied closely to the surface of the egg to protect all except the irradiated region. Eggs irradiated in the proper regions (*vide infra*) consistently developed 2 tail buds which were on opposite sides of the egg or in contact with

¹ Hertwig, O., *Arch. f. mikr. Anat.*, 1892, **39**, 353.

² Bergel, A., *Arch. f. Entw.-mech.*, 1927, **109**, 253.

³ Baldwin, W. M., *Anat. Rec.*, 1915, **9**, 365.

⁴ Bellamy, A. W., *Biol. Bull.*, 1919, **37**, 312.

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one another in the dorsal midline. The embryos and their bifid tails developed well; some were raised to the early tadpole stage.

The results of irradiating early gastrulae of *Hyla regilla*, the tree frog, are shown in Table I.

TABLE I.

Irradiated region of egg	No. of eggs	No. developing bifid tails
Entire lower surface (mesoderm and endoderm)	19	19
Endoderm only	3	0
Mesoderm "	4	4
Dorsal lip "	7	0
Ventral lip "	2	0
Both lateral lips only	3	3
Ventral lip and both lateral lips	2	2
Dorsal lip and both lateral lips	2	2
Dorsal and ventral lips	3	0

Note that irradiation of the endoderm (yolk), or of the dorsal or ventral blastoporal lips alone or together does *not* produce the bifid condition, although the resulting tail is shorter than that of controls. The movements of gastrulation were delayed in all irradiated eggs, irrespective of the region irradiated. A persisting blastopore with protruding yolk plug was common after irradiation of endoderm alone, of dorsal lip or ventral lip each alone or together; but this did *not* prevent the formation of a single tail.

The significant point in which all these experiments agree is that *only by irradiation of the lateral blastoporal lips, whether alone or together with other regions of the egg, could the bifid condition be induced.* The lateral blastoporal lips of the early gastrula of *Hyla regilla* contain essentially all of the tail anlagen.⁵ The bifid condition of the tail is therefore a direct effect of the ultraviolet irradiation upon the tail-forming materials of the egg. In these experiments the bifid condition was *not* induced by a general inhibition of gastrulation movements, by persistence of the blastopore, nor by inhibition of the dorsal or ventral blastoporal lips.

⁵ Schechtman, A. M., to be published.