Differential Modification of Embryonic Development of Organs in Twins and Double Monsters of Salt-Water Minnows

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This paper is supplementary to one which recently appeared in *Physiological Zoology* (Vol. XI, 2), and is the fourth in a series of studies with ultraviolet radiation and fertilized Fundulus eggs. The radiation source was a Cooper-Hewitt quartz mercury-vapor arc. Eggs were exposed for varying periods of time at intervals shortly after fertilization.

In singly developing axes, the most frequent modification appeared in regions of the body, which at the time of exposure were physiologically more active in relation to other regions. In this way varying degrees of reduction in the developmental potency of the anterior median region appeared.[1]

Similar effects may be obtained when early exposures made just prior to the first cleavage result in the development of two axes with consequent production of twins and double monsters. Each member of such a pair may be independent of the other, or the two may be united posteriorly and show varying degrees of normality of development. In the above instances, each member usually has its own circulatory system with a heart whose rate of beat seems to be a function of its relative normality, i. e., two hearts may beat at different rhythms on the same yolk sac.[2]

Such embryos may be antipodean in their positions on the yolk sac, and be entirely unconnected anatomically and appear not to influence each other's growth. Microscopic examination of such embryos reveals complete mirror imaging of parts.[3]

On the other hand, where developing axes are anatomically connected, and one seems to have a developmental advantage at the outset, they appear to influence each other physiologically, and within a short time it becomes evident that one embryo is growing at the expense of the other. The result is that one embryo may be completely normal and its smaller partner be differentially inhibited. The inhibition of development manifests itself in the same way as the inhibition which appears in single axes, but since the inhibiting agent (in this case the other member of the pair) is continually present, the degree of inhibition is definitely more marked and its effect continuous and uncomplicated by differential recovery.

When these embryos are sectioned and studied microscopically certain facts are evident, namely, the central nervous system is most frequently inhibited particularly in the region of the developing forebrain. In some instances, differentiation seems not to have kept pace with proliferation, with the result that a large amount of brain tissue develops without any characteristic brain structure. In such an embryo the rest of the organs appear to develop normally in most instances. A similar condition has been previously reported in chick embryos.[4]

In some double monsters the development of both embryos is inhibited. Microscopic study of these forms reveals the same selective inhibition along developmental axes. In some extreme cases, namely, in the autosite-parasite type only a small protoplasmic mass appears in place of a second embryo. Study of sections of such an inhibited member may show little more than a heterogeneous mass of commingled tissues which can scarcely be distinguished from each other and in which a directional developmental force is obviously lacking. Such a form may or may not have its own yolk sac circulation. A hormonal influence on development appears to be ruled out in the former instance. Furthermore, the inhibitory effect is obviously already active at the time of early development of the nervous system, i. e., before the circulatory system becomes active.

In many instances, in the development of closely adjacent parallel axes, a mid-line fusion is obvious in the central nervous system and frequently the only evidence of duplication appears in the single posterior axis, as a ventral bifurcation of the neural canal, and a double notochord.

In conclusion it may be stated that where developmental inhibition of embryonic axes is produced by early exposure to ultraviolet radiation, the developing nervous system, in most instances, shows the greatest degree of modification.

REFERENCES

1. Hinrichs, Marie A., and Genther, C., Ultraviolet radiation and the production of twins and double monsters, *Physiol. Zool.*, Vol. IV, 3, 1931.
2. Hinrichs, Marie A., Temperature effects on the heart rate of double embryos of Fundulus, *Manuscript*, 1933.
3. Hinrichs, Marie A., The microscopic anatomy of twins and double monsters of Fundulus Heteroclitus, *Physiol. Zool.*, Vol. XI, 2, 1938.
4. Hinrichs, Marie A., Axial duplications produced in lower vertebrates by early exposure to ultra-violet radiation, *Illinois Acad. Sci. Trans.*, Vol. XXII, 1930.