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# Dinitrophenol and Regeneration in Tubularia.

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Recent studies of the effects of alphadinitrophenol on the higher vertebrates and man[1] have shown its powerful influence on the metabolic rate. The fact that it resembles thyroxin in this respect has led to an examination of its influence on the regenerative development of certain lower invertebrates of relatively simple structure, some of whose responses to thyroxin are already known. It will be recalled that thyroxin retards the division rate of animal cells, the early development of sea urchin and ascidian[2] and regeneration of the hydranth in the hydroid *Pennaria*.[3]

During the past summer the effect of alphadinitrophenol in various concentrations on the regeneration of the hydroid *Tubularia crocea* has been observed. A single experiment will be considered at this time.

Four dishes were prepared, each with 100 cc. of sea water. One served as a control. The others contained, in addition to the sea water, alphadinitrophenol in concentrations of 1:100,000, 1:200,000 and 1:400,000 respectively. In each dish were placed 30-32 segments, 15-20 mm. long, from the distal ends of an equal number of

TABLE I.

| Dishes | I | | II | | III | | IV | |
|---|---|---|---|---|---|---|---|---|
| Hour 0 | 32 segments in 1:100,000 DNP | | 32 segments in 1:200,000 DNP | | 30 segments in 1:400,000 DNP | | 30 segments in sea water | |
| 18 | To sea water; no hydranths | | To sea water; no hydranths | | To sea water; no hydranths | | To sea water; no hydranths | |
| | Regen. | Het | Regen. | Het | Regen. | Het | Regen. | Het |
| 40 | 12 | 3 | 13 | 0 | 25 | 0 | 26 | 0 |
| 46 | 20 | 3 | 25 | 0 | 28 | 0 | 29 | 0 |
| 48 | 26 | 6 | 27 | 4 | 28 | 1 | 29 | 0 |
| 64 | 32 | 16 | 32 | 19 | 30 | 7 | 30 | 4 |
| 73 | 32 | 21 | 32 | 21 | 30 | 7 | 30 | 5 |

[1] Tainter, M. L., and Cutting, W. C., *J. Pharm. Exp. Ther.*, 1933, **49**, 410; Cutting, W. C., Mehrtens, H. G., and Tainter, M. L., *J. Am. Med. Assn.*, 1933, **101**, 193.

[2] Torrey, H. B., Riddle, M. C., and Brodie, J. L., *J. Gen. Physiol.*, 1925, **7**, 449; Torrey, H. B., *Carneg. Inst. Year Book*, 1927, **26**, 228; *Endocrinology*, 1928, **12**, 65.

[3] Torrey, H. B., *Carneg. Inst. Year Book*, 1928, **27**, 286.

*Tubularia* stems that were similar in size and general condition. Eighteen hours later, and before any hydranths had appeared, they were all transferred to sea water. Subsequent events that bear especially on the present report are recorded in Table I.

This table shows not only an initial *lag* in the appearance of hydranths on the pieces exposed to the higher concentrations of alphadinitrophenol but an equally marked *acceleration* in the appearance of hydranths heteromorphically. During the next 24 hours, all stems had produced hydranths at one end at least. Those in dishes I and II had overhauled the others in this respect while retaining their earlier advantage in number of heteromorphic hydranths, even increasing it.

To what shall we refer these curiously contrasting results?

When heteromorphosis occurs in *Tubularia,* the distal hydranth appears, typically, in advance of the proximal; also, in the presence of a well developed distal hydranth the regeneration of the proximal hydranth is materially retarded. There is an initial distal-proximal polarity that is much less pronounced when the primary hydranth is removed, and may be nullified or even reversed by one of several experimental procedures. When, for instance, the distal ends are exposed to deoxygenated water, the proximal ends to well aerated water, the proximal hydranths now develop not only more rapidly than the distal, but more rapidly than would have been the case had not the development of the distal hydranth been inhibited by lack of oxygen.[4]

It seems possible to regard the immediate effect of alphadinitrophenol as depressing to development at both ends of each piece sufficiently not only to slow down during exposure the development of the distal hydranth but by so doing to lessen the influence of the latter on proximal regeneration. This would explain the fact that on the return of the pieces to sea water development proceeded on somewhat more even terms.

Like thyroxin, then, alphadinitrophenol depresses developmental processes in such lower organisms as *Tubularia,* processes which are relatively independent of the exceptional oxidation which it has been shown to promote in mammals.

[4] Torrey, H. B., *Univ. Calif. Publ. Zool.*, 1912, **9**, 249.