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Induction of Water Drive in *Triturus viridescens* With Anterior Pituitary Extract.*

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In certain well established localities the American newt, *Triturus viridescens,* shows two well-defined habitats in its life cycle. The larval and adult phases live in water while the immature phase, representing some 3 to 5 years of the cycle, lives on land. In this interesting life-cycle 2 migrations occur, that from water to land following metamorphosis and that from land to water as maturity is reached. In an attempt to determine whether or not these migrations—particularly that from land to water—are brought about by the endocrine glands Reinke and Chadwick[1] were able to induce the land phases to assume a water habitat, long before they would do so normally, by giving them intramuscular implants of pituitaries from the adults. By appropriate tests the water drive-inducing factor was shown to be a product of the anterior lobe of the pituitary. They were able to show later that this action of the pituitary occurs in the absence of both the thyroids and gonads.[2]

Is the factor which induces the water drive peculiar to Triturus, or is it a hormone distributed widely among the vertebrates but with a specific effect in Triturus? If generally present in the vertebrates, with what known pituitary principles is it to be identified? The nature of its effect in Triturus is such that one is led to believe that the same pituitary principle which is responsible for growth in the body generally also induces migration to water as maturity is reached. In order to test the presence of the water drive factor in at least one other vertebrate class and at the same time to test the growth hormone as possibly being the cause of it, an attempt has been made to induce the water drive with a commercial extract of sheep pituitary which contains the growth-promoting factor (Antuitrin G). A total of 49 land phases (red efts) of Triturus were injected and set up for observation according to procedures previously described.[2]

* Antuitrin G, Parke Davis.

1 Reinke, E. E., and Chadwick, C. S., PROC. SOC. EXP. BIOL. AND MED., 1939, **40**, 691.

2 Reinke, E. E., and Chadwick, C. S., *J. Exp. Zool.*, 1940, **83**, 223.

A preliminary test was made on 18 efts. Six, ranging from 60 to 90 mm in length and given 3 injections of 1 RU each at 48-hour intervals, all entered water within 122 hours. Six, ranging from 83 to 95 mm in length and given 3 injections of 1 RU each at 24-hour intervals, entered water within 92 hours. Six 78 to 93 mm efts, each given 4 RU in 2 equal amounts 24 hours apart, entered water in 72 to 100 hours. All 18 efts molted by the 3rd day following the initial injection and all had entered water by the 5th day. Their adaptation to water was apparently complete and by the 10th day their color had undergone a profound change from the red of the land phase to the green and yellow of the adult water stage. Controls, either uninjected or injected with tap water or Antuitrin S† did not enter water nor did they molt nor show any change in color.

In an attempt to determine the threshold dosage of the extract necessary to induce the water drive, 12 efts ranging from 50 to 90 mm in length, were each given single injections varying from 0.3 to 2 RU. Eleven of the 12 entered water at intervals of 3 to 10 days. Only 2, each receiving 2 RU doses, remained permanently adapted. The others were in and out of water rather indifferently and, when it appeared that there could be no correlation between dosage and time required to enter water to stay, each eft was given enough additional extract to make a total dosage of 3 units. All of these efts molted and, with the exception of the one 50 mm eft, were well adapted to water when killed 2 to 3 weeks after the initial injection. These observations indicate that 2 to 3 RU of Antuitrin G are necessary to induce the water drive, providing the injected animals are above 50 mm in length.

In order to check further the failure of the extract to induce small efts to go to water, 7 efts, ranging from 46 to 55 mm in length, were each given 6 half-unit injections at 12-hour intervals. Although all molted on the 2nd and 3rd days and entered water by the 6th day, none of them remained consistently in water during the 3-week period of observation. Additional injections of the extract failed to make them become completely adapted to water.

Since Antuitrin G contains both the gonadotropic and thyrotropic anterior pituitary factors, it was considered of interest to see if the extract would induce the water drive in efts deprived of their gonads and thyroids. Six gonadectomized efts ranging from 75 to 90 mm in length and given 3 RU in 3 days, responded identically with the animals in the preliminary test. Only 1 of 6 thyroidectomized efts

† Parke Davis Co. This extract contains the anterior-pituitary like factor and had been shown previously not to be effective in inducing the water drive.

of similar size and given the same treatment entered water and none molted.

To summarize briefly, 35 large efts ranging from 60 to 95 mm in length, either normal or gonadectomized, were driven to water within 5 days by injections of 2 to 3 RU of mammalian pituitary extract. Similar quantities failed to cause 8 efts less than 55 mm in length and 5 of 6 large thyroidectomized efts to enter water.

While mammalian pituitary extract does not consistently induce the water drive in small efts nor in efts deprived of their thyroids, the fact that it invariably causes large normal or gonadectomized efts to migrate to water is proof that the water-drive factor is not restricted to Triturus alone. Although the return of Triturus to water is necessary for reproduction, the gonads seem not to be concerned in any way with the initiation of the water-drive. The failure to induce the water drive consistently in thyroidectomized efts by injection of mammalian extracts when implants of adult Triturus pituitary readily do so[2] indicates either a species difference or that some qualitative change has been brought about in the mammalian factor due to the manner of extraction. The failure to induce the drive in small efts is also quite interesting but before any conclusions can be drawn as to these failures a greater series of thyroidectomized and small efts must be injected. The acceleration of the acquisition of adult characteristics along with the water drive in large efts by injection and in efts of any size by implantation of adult Triturus pituitary together with the fact that the water drive is induced by a recognized growth hormone-containing extract, indicates that the growth hormone is also the water-drive hormone.