THE EFFECT OF NUTRITION AND SCIATIC NERVE SECTION ON REGENERATION OF THE MUCOUS MEMBRANE OF THE SMALL INTESTINE IN THE CRESTED NEWT

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Physiological regeneration of the epithelium of the small intestine has been studied chiefly in mammals [1, 3, 4, 5, 6]. Seasonal changes in the frog intestine have been studied only by A. M. Vasyutochkin [2], who found that in the mucous membrane of the frog intestine, disintegrative processes predominate over repair processes in the winter while the contrary is the case in the spring. In order to find whether the results obtained on mammals are general, or whether they apply only to the one class, it has been necessary to carry out similar experiments on representatives of other classes including the amphibia.

The aim of the present investigation has been to find whether those factors such as hunger, diet, and section of the sciatic nerve which have a decided effect in the case of mammals are also effective in the amphibia.

EXPERIMENTAL METHODS

The experiments were carried out on the crested newt (Triturus cristatus) in summer and winter. In the summer, the animals were caught in the reservoirs near Moscow shortly before the experiment was begun, while in winter the animals were used which had been kept for a considerable time in the laboratory. They were fed twice per week. Before the beginning of the experiment, the newts were starved for 5 days. Two experiments to find the effect of food, and one to find the effect of sciatic nerve section on the number of mitoses in the mucous membrane of the small intestine were carried out. The animals were killed by decapitation. The small intestine was removed intact. Part of the intestine (the caudal portion of the anterior half of the whole intestine) was fixed in Carnoy's solution. Paraffin sections 7μ thick were cut and stained in hematoxylineosin. A count was made of the different phases of the mitoses in the subepithelial outgrowths of the mucous membrane of the small intestine. The mitotic activity was expressed in each case as the number of mitoses per 1,000 cells.

The first experiment was carried out on 42 newts. Eight animals were killed in the fasting condition, and the remainder were fed at 10 a.m., after which 9 were killed after 2 hours, 8 after 6 hours, 9 after 10 hours, and 8 after 20 hours (from the time of feeding). In each animal 2,000 cells were examined.

EXPERIMENTAL RESULTS

It can be seen from Table 1 that 2 hours after feeding there is no difference in the number of mitoses between fasting and fed animals. Six hours after feeding there is an increase in the number of mitoses. This difference is statistically significant. The probability of such a difference arising by chance is less than 0.01. Ten hours after feeding the number of mitoses in the subepithelial outgrowths was reduced to the same level as in fasting animals, and was still the same after 20 hours.

TABLE 1

The Effect of Feeding on Mitotic Rate in the Mucous Membrane of the Small Intestine (First experiment)

No. of Mitoses Per 1,000 Cells					
	in fasting newts	after feeding			
		after 2 hrs.	after 6 hrs.	after 20 hrs.	after 20 hrs.
	20	12	17	30	24
	15	8	19	7	8
	9	21	22	10	18
	13	14	21	27	14
	20	19	31	12	21
	21	18	14	6	5
	11	12	29	23	11
	27	20	32	15	12
		23		10	
On average	17	16.3	23.1	15.5	14.1

As the newts were killed at various times of day, the question arose as to whether the observed changes in the number of mitoses were due to diurnal variation and not to time after feeding.

To decide this question, we carried out an experiment in the winter on 24 newts. All the animals were killed at 4 p.m.: 9 – fasting, 8 – after 3 hours, and 7 – after 6 hours from the time of feeding. The last time interval was chosen because in the previous experiment an increase in the number of mitoses was observed 6 hours after feeding. The killing after 3 hours was carried out to determine an inner limit to the time for the increase in mitoses. In this experiment 4,000 cells were examined in each newt.

The results of the counts are shown in Table 2.

In the second experiment, the number of mitoses in the subepithelial outgrowth of the small intestine in fasting newts was 10.6 per 1,000 cells. After 3 hours, the number of mitoses showed a sharp increase to 23.1 per 1,000. After 6 hours, the number was 20.3 per 1,000.

There was no change in the relative numbers of the different phases.

The results of the second experiment show that the increase in the number of mitoses 3 and 6 hours after feeding are due to feeding, and are not the result of a diurnal variation of mitotic activity, because the newts were killed at the same time of day. Thus, in amphibia as in mammals, feeding causes an increase in the rate of mitosis in the mucous membrane of the intestine and the increases occur at the same time.

TABLE 2

The Effect of Feeding on the Mitotic Rate in the Mucous Membrane of the Small Intestine (Second experiment) (Number of mitoses per 1,000 cells)

In Fasting Newts	After feeding	
	after 3 hrs.	After 6 hrs
11	26	20
14	23	29
9	31	20
9	30	25
11	19	16
10	22	23
6	14	19
12	20	
14		
On average 10.6	23.1	20.3

TABLE 3

Effect of Sciatic Nerve Section on Mitotic Rate in the Mucous Membrane of the Small Intestine. Number of Mitoses per 1,000 Cells (Third experiment)

Control	After Section of Sciatic Nerve	
	after 40 min	after 3 hrs
7	21	29
19	19	12
11	25	12
19	22	25
16	21	20
7	25	18
7	9	
Average 12.2	20	19.3

The third experiment was carried out to find how mitotic activity is affected by stimuli unrelated to digestion. As stimulus we used sciatic nerve section, which is known to cause a considerable increase in mitoses in the epithelium of the crypts of Lieberkuhn in mammals.

The experiments were carried out in the summer on 20 newts, 7 of which were controls, and 13 of which had the sciatic nerve cut (6—3 hours, and 7—forty minutes before killing). All the animals were killed at the same time (at 4 pm). Two thousand cells were examined in each animal. The results are shown in Table 3.

It can be seen from Table 3 that a sharp increase in the number of mitoses occurs 40 minutes after section of the sciatic nerve, and this increase is statistically significant. Three hours after the nerve section there is still a significant increase.

The results of all the experiments failed to show any seasonal effect. This is perhaps because in winter the newts were kept in the warmth and were fed.

From these results we may conclude that the effect of adequate and inadequate stimuli on the mitotic activity of the epithelium of the crypts of Lieberkuhn in mammals, and on the homologous but structurally distinct subepithelial outgrowths in the amphibian intestine is substantially the same. The fact that in both amphibia and mammals, representatives of widely separated groups, adequate and inadequate stimuli increase the number of mitoses in the small intestine, suggests that the effect is also general for other species.

SUMMARY

The physiological regeneration of the epithelium of the mucous membrane of the small intestine was studied in newts in summer and in winter. The number of mitoses was increased in the subepithelial intestinal outgrowth in 3-6 hours after feeding. In 10 hours after the food intake the number of mitoses decreased to the level, which is characteristic of hungry animals. In 20 hours the mitotic activity was almost the same. The number of mitoses in the epithelium of the mucous membrane of the small intestine of newts shows pronounced increase in 40 minutes and in 3 hours after the resection of sciatic nerve. These data coincide with those which were found in the study of physiological regeneration of small intestine in mammals.

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