circulation of cinchophen may occur. By weight sodium cinchophen increases the volume output of bile more than sodium dehydrocholate, which is an excellent hydrocholeretic. Cinchophen in large doses orally or intravenously decreases cholic acid output. But, it cannot be concluded from our results on "chronic" bile fistula dogs that cinchophen specifically interferes with cholic acid synthesis.

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Roentgen-Pigmentation in the Gold Fish.*

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One of the outstanding biologic effects of roentgen rays is the pigmentation of the skin. Roentgen pigmentation has been observed not only in human beings but in many mammals and in fish. Most characteristic is its persistence for weeks, months and years. The investigations of Miescher[1] and Peck[2] revealed the importance of chromatophores in this phenomenon. With respect to the rôle which chorial chromatophores play in the roentgen pigmentation of mammals, the eruption of chorial melanophores in the goldfish *(Carassius auratus)* after exposure to roentgen rays as described by Smith,[3, 4] is of interest.

Smith used a radiation of 100 kV, 5 MA, no filter and exposed in some instances only a portion, in other instances, the entire goldfish. Depending upon the dose, after a latent period of 5-6 days eruption of melanophores on the exposed side was observed, a general cutaneous melanosis was brought about in some cases, and some fish finally died. The eruption of melanophores usually however is a transient affair according to Smith. By a process of degeneration these melanophores disappear after 2-4 weeks and the cutaneous regions once more assume a normal color.

* Aided by a grant from the Committee in Aid of Displaced Foreign Physicians.

1 Miescher, G., *Arch. f. Derm.*, 1922, **39**, 313.

2 Peck, S. M., *Arch. Derm.*, 1930, **21**, 916.

3 Smith, G. M., *Am. J. Cancer*, 1932, **16**, 863.

4 Smith, G. M., *Biol. Bull.*, 1932, **43**, 484.

During studies concerning the suitability of goldfish for problems of experimental radiation therapy[5] some observations concerning the roentgen pigmentation have been made. The technic has been described previously.[5] In addition a radiation of 200 KV, 25 MA, 0.5 mm Cu and 3.0 mm Al Filter, HVL 0.9 mm Cu has been used. The results, based on the observation of more than 2000 goldfish, may be summarized as follows:

(1) The minimum dose to produce pigmentation with roentgen rays of HVL 0.233 mm to 1.0 mm Cu has been found at 800 r (air) under our experimental conditions. (2) In many instances considerably higher doses failed to produce pigmentation. This is in agreement with the results of Smith. (3) The pigmentation started on the head, spread to both sides of the trunk and was pronounced at the lateral lines, in spite of the fact that irradiation always took place in the dorso-ventral position. (4) Pigmentation was more marked when high doses were applied, where the fish's dorsal fin showed some black pigment prior to irradiation, and during spring. (5) Black pigmentation after irradiation extended into the "silver spots" which prior to treatment lacked the red pigment. It has also been observed in the albinotic variety of Carassius, the so-called silver-fish. Twenty-one days after exposure to roentgen rays, the fish appeared light grey. Pigmentation in the albinotic variety of the goldfish produced by mechanical means has been described by Osterhage.[6] These observations show that in the albinotic goldfish, radiation and trauma act in the same manner, as described by Smith[3, 4] for the red variety.

The observation of roentgen pigmentation in albinotic goldfish is especially interesting because of the mechanism of this process: In mammals this phenomenon is explained on the assumption of a photochemical process. In fish this explanation does not seem to hold true. Contrary to albinotic mammals, albinotic fish develop roentgen pigmentation. This directs attention to the fact that the chromatophores of fish are controlled by the nervous system. It is generally known that chromatophores of fish have a double innervation through sympathetic fibres (chromatodilatatores and chromatoconstrictores), and that there exists a chromatomotor nerve center in the medulla oblongata.[7]

Some brains of irradiated goldfish were studied in coöperation with Dr. Charles Davison of the Neuropathological Division. Depending

[5] Ellinger, F., PROC. SOC. EXP. BIOL. AND MED., 1939, **41**, 527.

[6] Osterhage, K. H., *Z. mikr. anat. Forsch.*, 1932, **30**, 551.

[7] Literature, see Parker, G. H., *Cold Spring Harbor Symposia on Quantitative Biology*, 1936, Vol. 4.

on the dose, there were observed in the region of the medulla oblongata a more or less definite area of gliosis as evidenced by formation of glia fibers. A fuller account of the neurologic changes after roentgen irradiation in the goldfish brain will be given elsewhere.

The destruction of the medullary region by roentgen rays may explain the roentgen pigmentation of the goldfish:

Schaefer[8] was able to demonstrate in Pleuronectes that only cuts into or below the medulla oblongata effected darkening of the caudal segments (expansion of chromatophores because of lack of chromato-constrictor impulses). The conclusion may, therefore, be drawn that the destruction of the medulla oblongata by roentgen rays acts in the same manner.

If a central disturbance is assumed in the pigment-motor nervous system, this would explain: (1) the start of pigmentation on the head of the fish; (2) the spread of pigmentation on the trunk especially there, where the lateral sense organ is located, whose relation to the nervous-system is known (Smith,[9] Sand[10]); (3) the pigmentation outside of the direction of the incident beam; (4) the pigmentation of albinos; (5) the latent period, slowly developing changes are most characteristic for the effects of roentgen rays on the central nervous system; (6) finally this would explain why in most of our experiments no restoration of the normal color within 28 days has been observed. An injury of the chromato-motor nerve center in the brain can most likely not be repaired; this regeneration or repair may occur, if only the peripheral part has been injured.

Summary. Roentgen pigmentation in mammals and fish have to be considered as different phenomena. While the former is influenced directly by a photochemical process and therefore generally limited to the site of action of roentgen rays, the latter seems to depend on a disturbance of the chromato-motoric nervous system and, therefore, may extend over the total innervated area.

8 Schaefer, J. G., *Arch. f. ges. Physiol.*, 1921, **188**, 25.

9 Smith, G. M., *Biol. Bull.*, 1930, **58**, 313.

10 Sand, A., *Proc. Roy. Soc. B*, 1937, **123**, 472.