writer to point out the possibilities of the recently discovered pitchblende deposits at La Bine point in the Echo Bay region of Great Bear Lake in the Northwest Territories, Canada.

The former compared the rates of occurrence of sex-linked lethal mutations in *Drosophila* in a street-car tunnel in San Francisco, where the natural ionizing radiation was fully twice as great as the radiation in their laboratory at Berkeley. The difference in the rate of occurrence of lethal mutations in the tunnel and in their laboratory, which was 2.5 times the probable error, although probably not statistically significant, is indicative.

The latter, working independently of Babcock and Collins, arrived at a somewhat similar conclusion. After unsuccessfully searching with an electroscope in the Ozark caves and lead mines in Missouri for a location with sufficient increase of ionization over that of the laboratory, they finally utilized an abandoned Carnotite mine in Colorado. The radiation in this mine was 0.39 times as intense as that from one mg of radium when the rays were passed through a 0.156 inch lead filter. Male *Drosophila* flies were exposed for 40 hours in this mine. It was found that the difference in the occurrence of gene mutations between tests and controls was 2.09 times the probable error. Although the results of these two independent experiments are probably not statistically significant, they would seem to suggest that more definite results might be obtained from more strongly ionizing radiations.

From electroscopic tests of eight samples of pitchblende from La Bine Point, Echo Bay, Great Bear Lake, N.W.T., Spence,[3] mineral technologist, Department of Mines, Ottawa, found that the uranium oxide content ranged from 27.88 to 83.90 per cent.; the equivalent range of radium content would thus be approximately from 70.79 to 213 milligrams per ton. Complete chemical analysis of two samples are also given in tabular form. The intensity of radiation from these outcrops[4] of pitchblende would undoubtedly be much greater than the intensity of radiation in either an abandoned Carnotite mine in Colorado or a street-car tunnel in San Francisco.

Considering the work mentioned, it has occurred to me that biologists might profitably investigate the Great Bear Lake pitchblende deposits from the viewpoint of observing gene mutations produced under conditions there. Evidence of this in the flora and fauna indigenous to the district, which includes species of Picea, Betula, Alnus, Ericads, mosses, liverworts and lichens, as well as numerous insects, might be observed in addition to exposing introduced biological entities, such as insects, mosses, fungi and other plants of known genetic constitution, to the action of these natural radiations.

The inaccessibility of the field, some 700 miles north of Edmonton, practically only accessible by airplane, and the lack of the necessary funds and material for this type of investigation has practically placed this very interesting possibility beyond the scope of the writer. No doubt this field would yield some very interesting data in regard to the rôle of natural radiations as a factor in the evolution of species by furnishing hereditable variations upon which the forces of nature could act.

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[3] Hugh S. Spence, "Radium-bearing Minerals from Great Bear Lake, North West Territories," Mines Branch, Dept. of Mines, Ottawa Memorandum Series No. 48: 1–4, 1931.

[4] Hugh S. Spence, "Occurrences of Pitchblende and Silver Ores at Great Bear Lake, N.W.T.," Mines Branch, Dept. of Mines, Ottawa Memorandum Series No. 51: 1–6, 1931.

POSSIBILITIES OF SECONDARY POISONING OF BIRDS AND MAMMALS

IN the winter of 1915, during jack-rabbit poisoning work in Lake County, Oregon, a coyote in the characteristic position of strychnine poisoning was found dead at a haystack. Portions of mutilated carcasses of rabbits that had been poisoned were lying near-by. In most cases the stomach and intestines were the only parts of the rabbit left untouched, but occasionally these also had disappeared. The stomach contents of the coyote found dead were examined and found to contain the stomach of a rabbit together with the contents. It is not common for a coyote to eat the viscera of rabbits. This was a case of direct poisoning from swallowing the poisoned bait in the rabbit stomach rather than secondary poisoning from eating strychnine in the flesh.

The lean meat of several rabbits that had been poisoned with strychnine was fed a dog and some chickens without producing any ill effects.

Hawks have often been observed to eat ground squirrels and prairie dogs so poisoned, without apparent ill effects.

Indians on some of the Indian reservations have been reported to have eaten ground squirrels poisoned with strychnine, without any unpleasant after effects.

Reports have been received that occasionally a dog has died suddenly after eating the bones of a poisoned rabbit that had been exposed for months to the

weather. Laboratory analysis of such bones has shown minute quantities of strychnine present in them. Before being killed, however, very few rabbits ingest sufficient strychnine that enough would be deposited in the bones to kill a dog.

After eating ground squirrels affected with bait materials poisoned with thallium sulphate, a number of coyotes have been found dead or having the symptoms of thallium poisoning. A small percentage of the squirrels when affected with thallium will sit at the entrance of their burrows in a stupor, and the coyotes easily catch them and eat the whole carcass. If they happen to catch one that has eaten a large quantity of grain within twelve hours, they may obtain some of the thallium on the grain. This would greatly reduce the number of squirrels they would have to eat to obtain a lethal dose. The number of squirrels in this condition, or of squirrels that die on the surface when thallium is used, is small in comparison with the original number of squirrels. Rarely skunks have been found dead that were suspected of having been killed by secondary poisoning on areas treated for ground squirrels with thallium-poisoned grain. That so few carnivores are affected by thallium in rodent control operations is probably due to the large number of poisoned rodents they would have to eat to obtain a lethal dose, and the difficulty in securing the number that would be required.

Very seldom has a bird of prey been found dead on or in the vicinity of areas from which the squirrels had been removed with thallium. On the Peckham Ranch, Santa Cruz County, California, on March 13, 1927, an eagle was observed that showed symptoms of thallium poisoning. Of several eagles that were feeding on the same area it was the only one affected and was found dead on the 21st.

To obtain some definite information under controlled conditions on the secondary poisoning of hawks with strychnine and thallium, a study of their resistance to these poisons was made at the Control Methods Research Laboratory, at Denver, Colorado. Early in July of 1928 a young Swainson's hawk was obtained and held in a large cage until December, 1928. Observations of the hawk's habits of feeding revealed the fact that it would readily take two medium-sized wild rats at a feeding, but that any number in excess of two would usually be killed and saved for future use. Thirteen small rats were consumed, however, in a two-day period. Medium-sized rats were considered those weighing 150 to 300 grams; small rats 40 to 125 grams.

In the period from December 12 to 17, this hawk was continually fed wild rats that had been killed with thallium iodide. Ten rats were eaten, and these ten rats contained 42.70 mg of thallium as the iodide. As the hawk weighed 1.24 kg this represents a dose of 34.43 mg/Kg. No symptoms of poisoning were noted.

Then on the successive days of February 13 and 14, 1929, the hawk was fed a total of 13 rats, which contained 153.37 mg thallium as the sulphate. The bird weighed 1.36 kg, so this dose was 113.00 mg/Kg. This showed no symptoms of poison.

On May 27, a rat was injected with 100.00 mg of arsenic as the trioxide and fed to the hawk. For two days after this dose of 73.70 mg/Kg the bird was somewhat listless and had no appetite, but by the 30th of the month normal appearances had returned. So on June 13 a rat carrying 200.00 mg of arsenic was given to the hawk. This dose of 147.40 mg/Kg failed to produce any toxic response at all.

On June 19 a rat was injected with 500.00 mg of strychnine as the sulphate, and fed to the hawk. It was taken rather slowly, but all was gone on the morning of the 20th. This was a dose of 368.00 mg/Kg of strychnine, and the hawk was in evident distress most of the day. The symptoms manifested, however, were confined to difficult breathing, stiff legs and extreme nervousness.

Regardless of this condition, the hawk's appetite was still good on the 20th, and it ate a rat that had been killed by an injection of 300.00 mg. of thallium as the sulphate. This was a dose of 220.00 mg/Kg, since the hawk had been practically stationary in weight for some time. On the morning of the 21st, the bird's appearance was entirely normal. On the 22d, it took a rat readily. The first signs of illness appeared on the 23d. On the 24th the bird was almost comatose with eyes closed and the wing drooped.

On the 25th, the hawk's condition was improved, and ate a new-born wild rat. A relapse occurred on the 26th, but the appetite was still good and three infant rats were eaten. By the 27th the bird was unable to stand. Posterior paralysis was well developed. No appetite. Condition was unchanged during the day of the 28th. Hawk died in asphyxial spasm at 9:15 A. M. on the 29th.

During its experimental career, this hawk survived 34.43 mg/Kg and 113.00 mg/Kg thallium; 73.70 mg/Kg and 147.40 mg/Kg arsenic; 368.00 mg/Kg strychnine. And finally lived for 9 days after a dose of 220.00 mg/Kg of thallium.

These figures indicate how extremely unlikely it would be to kill a hawk of this kind by secondary poisoning under field conditions. An ordinary small mammal, such as a ground squirrel, weighing from 1/4 to 1/3 Kg is killed by 3 to 10 mg of Strychnine; 10 to 25 mg arsenic; or 8 to 15 mg of thallium. As-

suming then that the mammal had eaten the larger quantity of poison listed, a hawk like the one tested could eat more than 50 squirrels that had been killed with strychnine; more than 8 that had been killed with arsenic, and about 20 that had died from the effects of thallium, providing it did not obtain any of the ingested poisoned grain.

With this resistance to strychnine the hawk would be practically immune to danger from secondary poisoning from such a toxic agent.

These experiments indicate that the bird would be forced to live entirely for about three weeks on mammals dying from thallium to obtain a lethal dose. This estimate is made disregarding the rate of elimination of poison that would be made by the mammal, which factor should double the number of animals needed to provide a lethal dose for the bird.

These results in laboratory experiments lead to the following conclusions:

Arsenic has no great secondary poisoning hazard, and is too erratic in its results to be a good rodent poison, consequently it is not used in large field-control operations.

Strychnine presents no danger of secondary poisoning to hawks.

Thallium is apparently more hazardous, but even this cumulative poison can kill hawks only in extraordinarily large doses, unlikely to be obtained under field conditions.

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SPREAD OF BROAD FISH TAPEWORM OF MAN

THE finding of *Diphyllobothrium latum* (Linn., 1758), the broad fish tapeworm of man, in Oklahoma should be of interest to parasitologists. It is known that this species was brought to the United States by the Swedes and Finns who settled in Minnesota and North Dakota, where the proper intermediate hosts for its development abound. Hegner, Root and Augustine[1] write: "In the United States *Diphyllobothrium latum* has been considered a rare parasite occurring only in emigrants from European endemic centers. However, a number of indigenous infections have been reported recently from Minnesota, Illinois, Indiana, Michigan and Massachusetts." The above-mentioned states are all in the northern tier of states. The occurrence of this tapeworm in Oklahoma shows a wider distribution for the species.

Recently a thirty-one-year-old laborer called at the Oklahoma Medical School Hospital clinic for treatment. He stated that he believed he had a tapeworm because he recognized the signs and that he knew people got them from eating dried fish in the old country, as he had done. He stated that he was a native of Finland and has been in America fifteen years, coming to Oklahoma three months ago from Louisiana. This is interesting, because the tapeworms taken from him must have had a length of life of over fifteen years, provided of course that he became infected in his native land. Riley[2] stated a Swedish woman was definitely known to carry the infection for thirteen years.

Upon examination he was found to have numerous ova in the stool, to have bloody diarrhea, to be very anemic and weak, with attendant colicy pains. These pains he claimed doubled him up and kept him from work. Dr. A. D. Danielson treated him with oleoresin of aspidium and salts. At the first treatment twelve feet of proglottids was obtained. Later fifteen to twenty feet was obtained. All the segments showed the characteristic grayfish color and coiled brown uterus centrally located. By careful search two heads were found. These were unarmed and had two bothria or slit-like suckers. Upon the patient's release, "feeling much better," he was told to come back in two months to be checked.

As this host came from Finland not more than fifteen years ago, it is evident that carriers are still actively transporting this parasite across the ocean and spreading it farther in the United States, and that the migration of Finns, and perhaps Swedes, in search of work in new areas is a large factor in its spread.

The danger of this species becoming indigenous to the southern states seems remote, due to the absence of cold water lakes and proper intermediate fish hosts. The possibility remains, however, that *D. latum* may adapt itself to different intermediate hosts from those now known for it and hence become endemic in new areas.

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DISCOVERY OF CONODONTS IN THE PHOSPHORIA PERMIAN OF WYOMING

DURING the summer of 1931, the Phosphoria formation along the east front of the Wind River Mountains, Wyoming, was examined for microfossils. The Phosphoria is Pennsylvanian and Permian in age, the boundary coming below the Pustula member. This member contains a bed of low-grade rock phosphate

[1] R. W. Hegner, F. M. Root and D. L. Augustine, "Animal Parasitology," 731 pp. New York, 1929.

[2] Wm. A. Riley, "The Longevity of the Fish Tapeworm of Man, *D. latus*," *Jour. Parasitol.*, 5: 193, 1919.