about one-third the diameter from the margin. No information regarding the shape of the cross-section of the shell can be gathered from the specimen, except that at the few places where the external curvature is exposed no sign of flattening can be seen. The type specimen, herewith illustrated, is in the Peter Redpath Museum, McGill University.

This specimen is particularly remarkable because of the association of gerontic features. First, the siphuncle contracts anteriorly; secondly, the last nine septa are closely crowded together, indicative of an inability to move forward the accustomed amount; and lastly, the contracting of the conch towards the aperture and the thickening of its distal part. This is rather an unusual feature, for the contraction is ordinarily restricted to the living chamber alone, and is frequently effected by an internal thickening of the wall of the living chamber, the exterior showing no decrease in diameter. Our specimen not only shows such a decrease, but also a deposit round the interior of the distal end of the living chamber thickening the outer rim so that 2cm. from the edge it is 8mm. thick.

A. anticostiense (Billings), from the Richmond and Gamache of Anticosti, is fully as large as our specimen, but its ventral side is known to be strongly flattened and on that side the sutures are strongly recurved, whereas on the broadly convex dorsal side they are directly transverse. The thickness of the siphuncle in a dorso-ventral direction exceeds one-half the diameter of the conch, laterally it slightly exceeds one third. The septal necks are much longer than in our specimen. *A. (Armenoceras) sedgwicki* (Billings), from the Richmond and Gamache of Anticosti, is generically distinct from our specimen because of the lack of a septal neck, the segments of the siphuncle are adnate to the enclosing septa. *A. (Leurorthoceras) beloitense* (Whitfield), from the Black River of Wisconsin, Lake Huron, and Arctic America, is also generically distinct by being flattened ventrally with broad ventral lobes to the suture, and the siphuncular segments are only moderately inflated. Few other cephalopods of commensurate size and of the Actinoceras type are known.

THE FLUCTUATION IN THE POPULATION OF WILD MAMMALS, AND THE RELATIONSHIP OF THIS FLUCTUATION TO CONSERVATION

By R. M. ANDERSON

Chief of Division of Biology, National Museum of Canada

Read at Provincial-Dominion Game Conference, held at Ottawa, January 26, 1928.
Published with the permission of the Director, National Museum of Canada, Ottawa.

WHILE in a general way it is a matter of common knowledge among farmers, trappers, fur-dealers, and naturalists, that there are wide fluctuations in the numbers of various species of wild mammals from time to time, the extent of such variation and its periodicity are not so well understood. The mammals, being as a rule comparatively stationary in their habitats, or only slighly or imperfectly migratory, and distributed in some cases over immense areas, do not lend themselves readily to the methods of census-taking like the migratory wildfowl which congregate in masses on restricted areas in winter or on summer breeding grounds.

Statistics based on fur returns are apt to lead to misleading conclusions unless spread over a wide area for a term of years. While sudden rises in prices may temporarily lead to intensive production, or rather exploitation, in certain areas, swelling the statistical figures, this may lead to depression later, since the law of diminishing returns rapidly gets in its deadly work in the fur-trade. Regardless of commercial reasons, however, there is a normal and fairly periodic fluctuation in the numbers of certain species due to natural causes.

The records of the Hudson's Bay Company's fur returns for the past hundred years are particularly suitable for data on these fluctuations, as the Company was not accustomed to stimulate the production of any particular kind of fur, but took the whole fur produce in trade from the natives and sold all the furs at annual fur-sales in London, without holding fur from year to year for speculative purposes.

Records were also kept showing the periodic increase and decrease of other forms of wild

life, as these keenly affected the life of the Indians and other inhabitants of the North, directly affecting the output of furs and the amount of provisions and other credit supplied to the natives. In many districts the Indians starved during bad rabbit years, and were consequently unable to travel and trap during the fur season, while carnivorous mammals which fed on the rabbits diminished in proportion to the rabbits.

Dr. C. Gordon Hewitt[1] quotes the periods of maximum abundance of the snowshoe rabbit or varying hare, (*Lepus americanus*) according to the Hudson's Bay Company's returns: 1845, 1854, 1857, 1865, 1877, 1888, 1897, 1905; or in other words in cycles of 9, 3, 8, 12, 11, 9, and 8, giving an average periodic cycle of 8.5 years, which is not far from the popular belief in a seven-year cycle for this animal. For the lynx the average periodic cycle of 9.5 years is given, the lynx becoming more abundant from the year of rabbit abundance to three and four years later. Foxes show a periodic cycle of about 9.5 years, marten of 9.5 years, fisher and mink of 9.7 years each. Wolves and muskrats, which have a wider range of food supply, show slight and irregular periodic fluctuations in numbers.

The ultimate causes of the fluctuations of these fur-bearers are in many cases obscure or unknown. Some of the rodents, as mice, voles, lemmings, and rabbits, are very prolific, and when favoured by a combination of friendly circumstances, such as good climatic conditions, abundant food, and security from natural enemies, increase prodigiously until overcrowding brings in epidemic disease which reduces the numbers to a minimum. Vernon Bailey[2] has shown by experiments that a female meadow mouse can produce seventeen consecutive litters of young in captivity within a year, while one specimen, born on May 25, produced 33 families of young, totalling 78 in number, before she was a year old.

Many of the predatory mammals, as fox, lynx, and marten, subsist largely upon these smaller mammals, and the abundance of the carnivores depends more or less closely upon the presence of their favourite prey. Mammals which feed upon a mixed diet of insects, fish, and vegetable matter, do not show such extremes of variation in numbers. Whether the decrease in numbers of the predatory mammals is due to actual starvation, whether scarcity of food affects their fertility, and whether over-feeding in time of abundance has an adverse effect on reproduction are problems which have not been sufficiently studied.

Occasionally, when a disease from wild mammals, or carried by wild mammals, affects live stock or human beings, such as anthrax or Texas fever, interest is stirred up and investigations made. One of the latest cases of this nature was first noted in 1919, when the United States Public Health Service started an investigation of the so-called "deer-fly fever." They found the germ carried by the deer-fly to wild rabbits, proved that it could be carried from one rabbit to another by rabbit-lice, that an infected bedbug could give the infection to a mouse, and that a mouse could catch the disease by eating an infected bedbug. Frequent cases were found where market-men got so-called "rabbit fever" from handling dead rabbits, particularly rabbits from certain states, and others were infected by bites from ticks which feed on jackrabbits and snowshoe rabbits. Some cases were serious, a few fatal. Ultimately it was found that the trouble was caused by the same microbe found in 1911 in ground squirrels in Tulare County, California, and named *Bacterium tularense* McCoy. The name tularemia for the new disease, is derived from this.[3]

While decreases in the number of rabbits are immediately obvious in their effects, both upon human inhabitants and upon the larger carnivores, other influences may be at work which are not so readily detected. Other small mammals, apparently insignificant from the human standpoint, may have far-reaching influence upon the rest of the animal kingdom. Cabot has shown the importance of the native mice to the land mammals and birds of Labrador.[4] In periods of scarcity of small mammals the food supply of the carnivores is directly affected and in periods of extreme abundance of the former the vegetative growth may be adversely affected to the detriment of other forms of ife. We have seen this in various historical mouse plagues which have grievously affected agricultural interests. We also see that when animals, such as ground squirrels ("gophers"), or wolves and

[1] *The Conservation of the Wild Life of Canada*, Chapter IX, pp. 213-234, Charts I to V, Charles Scribner's Sons, New York, 1921.

Since writing the above, Mr. C. S. Elton, of Oxford University Museum, has called my attention to the fact that more recent revisions of this data, by a more scientific analysis of the peak figures, have shown that the periodic cycles of both rabbit and lynx average about 10 years. Muskrats are also shown to have a periodic cycle of about 10 years. See also Elton, C. S., "Periodic Fluctuations in the Numbers of Animals: Their Causes and Effects, *Brit. Journ. Exper. Biol.*, II, Oct., 1924, pp. 119-163.

[2] "Breeding, Feeding, and Other Life Habits of Meadow Mice (*Microtus*)", *Journal of Agriculture Research*, Vol. xxvii, No. 8, Feb. 23, 1924, p. 528.

[3] de Kruif, Dr. Paul, "When You Shoot a Rabbit, look out for Tularemia, a mysterious plague—It's easy to avoid," *The Country Gentleman*, Vol. xcii, No. 10, October, 1927, Philadelphia, pp. 13-15, and 43.

[4] Cabot, William B., In Northern Labrador, Boston, 1912, appendix, pp. 287-292.

coyotes, become a menace to agricultural or stock-raising interests, that something is very soon done about it, and investigations are instituted. The same could be done in regard to the game and fur-bearing mammals.

There are still deeper problems involved, which, unfortunately, have not received the attention they deserve. Pathologists have devoted most of their time to the study of diseases which affect mankind directly, and have discovered the relation of the yellow-fever and malarial mosquitoes, the hookworm, certain of the trypanosomes to sleeping sickness and other tropical diseases, and the rat and ground squirrel to other diseases, but the surface has only been touched. We have found that certain species of tape-worms have an injurious effect on the health of domestic and wild animals, but few of their life histories have been thoroughly worked out. Only last fall, Dr. Seymour Hadwen, my companion on a field trip, found numerous cysts of a probably unknown species of tapeworm in the liver of a wild muskrat in northern Alberta, but its secondary host is unknown, and we do not know to what extent this may affect muskrat life. The most lowly species of vole or shrew may be host to various internal and external parasites, or bear trypanosomes in their blood which may work havoc on themselves and on other species which eat them raw or feed on their range.

The problems of wild animal life are so varied and interlocking that the services and co-operative studies of zoologists, parasitologists, pathologists, and veterinarians, extending over a period of years, are essential to the beginning of a thorough elucidation of the questions involved. We have only made the barest beginnings in scientific study of most of these questions.

It is evident that over-hunting and trapping during periods of natural depression may be disastrous to the continuance of many species, particularly of such species as have a virtual bounty on their heads in the form of spectacular prices for furs. When we have more definite knowledge of the causes involved we may be able to do something towards alleviating or preventing some of the unfortunate results, and in the meantime, our game officials may be able to obtain data on the periods of low ebb of species, and make provision in time for special protection of such species at the initiation of such periods of depression, by legislation providing for temporary closed seasons without the necessity of special legislation covering each suspension of the open season, a method which is usually too slow to be effective in such cases.

NOTES ON BIRDS OF THE LABRADOR PENINSULA IN 1928

By HARRISON F. LEWIS

IN THIS YEAR the time that I spent on bird protection duties on the south shore of the Labrador Peninsula, between Shelter Bay and Blanc Sablon, extended from May 4 to September 14. From the observations of birds made during that period the following have been selected as suitable to offer for publication here.

1. *Alle alle.* DOVEKIE.—Dr. Arthur A. Allen and I saw two in spring plumage together in the middle of outer Coacoacho Bay on June 9.

2. *Larus kumlieni.* KUMLIEN'S GULL.—An adult of this species alighted on the water close beside the S.S. *Nayarit,* on which I was a passenger, while it was under way near Bay Johan Beetz on May 12. I identified it by careful observation, through X6 binoculars, of its characteristic markings.

3. *Sterna caspia imperator.* COUE'S CASPIAN TERN.—Audubon found this species, which he mistook for the Royal Tern, nesting near Little Mecattina Island, but of recent years it has been found nesting along the north shore of the Gulf of St. Lawrence only on Fog Island, about twenty miles west of Cape Whittle. However on July 23, when I visited a colony of Ring-billed Gulls (*Larus delawarensis*), in Mecattina Bird Sanctuary, about twelve miles east of Little Mecattina, I was greatly pleased to hear, amid the clamor of the Gulls, the harsh note of the Caspian Tern. One individual was soon seen, hovering among the Gulls, but no other Caspian Tern was observed at this place. As I was about to leave the colony I noticed one nest, a little apart from the others, which contained three eggs, two of which seemed to be typical eggs of the Ring-billed Gull, while the third was much more elongated and was apparently an egg of the Caspian Tern. This longer egg, when handled, was observed to be addled. I could not help wondering if I was observing, in what seemed to be an unmated bird and its infertile egg, the last descendant of the Caspian Tern reported here by Audubon.