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Rausch, Babero, Rausch & Schiller in Journal of Parasitology (June 1956) 42(3).

STUDIES ON THE HELMINTH FAUNA OF ALASKA. XXVII. THE OCCURRENCE OF LARVAE OF *TRICHINELLA SPIRALIS* IN ALASKAN MAMMALS

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In 1948 much interest in trichinosis in arctic regions was aroused, particularly by the findings of Thorborg *et al.* (1948), who investigated serious outbreaks occurring among the Eskimo of West Greenland during 1947. Consequently, with the founding of the Arctic Health Research Center in the autumn of 1948, a study of trichinosis in Alaska was the first project to be initiated by the Zoonotic Disease Section (formerly Animal-borne Disease Section) of this Center.

Field work was begun in January, 1949, and a preliminary note on trichinosis in Alaskan mammals was published by Brandly and Rausch (1950). The subject of trichinosis in arctic regions was reviewed by Connell (1949).

The survey to determine the prevalence of *T. spiralis* in mammals in Alaska was terminated in the spring of 1953; this paper reports the results of this work.

MATERIALS AND METHODS

An effort was made to obtain a series of each species of mammal occurring in Alaska, with exception of the ungulates. Such specimens were collected over the entire Territory, but most originated above the Arctic Circle. Many mammals were secured through the cooperation of Eskimo and Indian trappers, who held the frozen carcasses of animals taken for their fur until they could be brought to the laboratory in Anchorage. In some instances, only muscle tissue of animals, with collecting data, was preserved. The personnel of the Zoonotic Disease Section also collected large numbers of mammals. Dogs were generally obtained when those no longer serviceable were destroyed, but some were purchased for this study. Although some autopsies were performed in the field, most of the animals were brought entire to the laboratory. For the purposes of this work, several grams of striated muscle were taken, routinely from the diaphragm, at the autopsy of each animal. These samples were frozen and stored for later processing. The larvae were usually dead when isolated.

The presence of *Trichinella* larvae was determined through the artificial digestion of tissue samples. For this purpose, the tissue was chopped with a knife into small pieces, placed in a solution of pepsin and hydrochloric acid, and incubated at 37° C. with constant agitation for 24 hours. The resulting fluid was poured through a fine-mesh screen to remove any undigested material and was allowed to stand in graduated cylinders until any larvae present settled out. The supernatant fluid was siphoned off, the residue placed in watch glasses with a few drops of 10 percent

Received for publication, November 14, 1955.

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potassium hydroxide solution, and any larvae present were counted under the dissecting microscope.

The tissue samples were processed at the Arctic Health Research Center during the summer of 1949 by Dr. J. D. Tiner, now at the Microbiological Institute, Rutgers University. From the spring of 1950 to the time the survey was discontinued, this work was performed by Mr. B. B. Babero. This report is based upon the data recorded by these workers.

RESULTS

Tissue samples from 2433 mammals, representing 42 species, were processed. Larvae of *Trichinella spiralis* were found in 23 species. Two hundred eighty-five animals (11.7 percent of the total) harbored larvae.

The findings are discussed below, by host-species. Mammalian names are according to Miller and Kellogg (1955) and Rausch (1953).

Soricidae.

No larvae were found in 18 shrews of 3 species; viz., *Sorex obscurus* Merriam, *S. cinereus* Kerr, and *S. tundrensis* Merriam. Shrews feed readily upon carrion, and in Alaska they are found often in buildings or caches where meat is stored.

Beliaeva (1954) examined a total of 126 shrews from the Belovezha Forest, on the eastern border of Poland. One of 39 specimens of *S. araneus* Linnaeus, and one of 38 specimens of *S. macropygmaeus* Miller (= *S. caecutiens* Laxmann) were infected. Forty-nine specimens of *S. minutus* Linnaeus were negative.[3] Beliaeva concluded that these animals became infected through feeding on carcasses of carnivorous mammals.

Ursidae.

Three species of bears occur in Alaska, and small series of each were obtained.

Of 20 grizzly (brown) bears, *Ursus arctos* Linnaeus, 10 (50 percent) harbored *Trichinella* larvae. These ranged in number from 0.1 to 45.6 larvae per gram of tissue (av. 12.4 per gram). The bears were from localities scattered widely over the Territory, and infected animals were taken as far north as the Alaktak River, near the Arctic Coast, and as far south as the lower Alaska Peninsula.

These bears feed upon carrion whenever it is available, including carcasses of other bears killed and left in the field by hunters. They are mainly herbivorous, however. Farther south (Kodiak Island and Alaska Peninsula), salmon (*Oncho-rhynchus* spp.) comprise an important part of the summer diet.

Five black bears, *Ursus americanus* Pallas, of 23 examined, were infected (21.7 percent). Numbers of larvae ranged from 0.5 to 400 per gram of tissue (av. 81 per gram). Most of the bears examined, and all of those infected, were killed in southern Alaska. Black bears feed largely upon vegetation, but also consume available carrion. They are numerous near settlements and farms, where they sometimes feed upon refuse.

Nine of 17 (52.9 percent) polar bears, *Thalarctos maritimus* Phipps, harbored *Trichinella* larvae. Infections were very light, ranging from 0.4 to only 4.0 larvae per gram of tissue (av. 1.6 per gram). Excepting 3 animals from St. Lawrence

[3] Beliaeva gave only common names for mammals examined; the scientific names of the insectivores were obtained from Bobrinskii, B., A. Kuznetsov, and A. P. Kuziakin, "Opredelitel' mlekopitaiushchikh SSSR." Moscow, 1944.

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Island, all were killed on the Arctic Coast near Barrow or Wainwright.

Leiper (1938) reported 4 of 6 polar bears dying in the London Zoological Garden to be infected with *Trichinella* larvae, and he believed these to have been acquired before the animals were captured. There have been several reports of infected bears from zoological gardens on the Eurasian continent. Parnell (1934) reported having found infected polar bears in the Canadian Arctic. Thorborg *et al.* (1948) observed larvae in 2 of 3 polar bears from the Thule region, and in 4 of 13 from East Greenland. Roth (1949) found larvae in 6 of 19 bears from West Greenland. Brown *et al.* (1949) observed larvae in 2 of 3 bears from the Canadian Northwest Territories. Roth (1950) summarized the work in Greenland, and reported infections in 31 of a total of 112 polar bears examined. He also reviewed the unpublished data of other workers, and mentioned the finding of infected bears in Spitzbergen.

Outbreaks of trichinosis in man have been traced frequently to their origin in the flesh of polar bears (see Connell, 1949; Roth, 1950).

In contrast with the aforementioned species, the polar bear is almost entirely carnivorous, although some vegetation may be consumed during the summer months. Seals (*Phoca* spp.) are an important part of its diet. Polar bears sometimes enter Arctic Coast villages, where they feed on carrion, including carcasses of dogs and other animals.

Canidae.

A total of 225 dogs was examined from various localities. Of these, 102 animals (45.3 percent) harbored *Trichinella* larvae. These figures, however, are misleading, since place of origin is important. Sixty dogs, all negative, were obtained in Anchorage and its environs—the one city in Alaska most nearly comparable to small cities in the United States. Excluding these, 61.8 percent of the remaining 165 dogs were infected.

More specifically, 40 of 47 dogs (85.1 percent) from St. Lawrence Island harbored larvae, and 38 of 41 dogs (92.6 percent) from the village of Barrow were infected. In the dogs of these 2 villages, the number of larvae per gram ranged from 0.5 to 65, with an average of 9.7 per gram.

Included in this series of 225 dogs were 13 from the Aleutian Island of Adak; of these one animal was infected, having 4 larvae per gram of tissue. Rats, *Rattus norvegicus* Berkenhout, are extremely abundant on Adak, and are frequently infected (12 percent of 224 rats; Schiller, 1952). The dogs examined were strays, but it appears that they did not often feed upon rats. Sixty-four dogs not mentioned specifically, were collected from numerous localities, mostly in northern Alaska.

It is evident that conditions in arctic villages favor the infection of sledge dogs. Although only a few species of land mammals occur on St. Lawrence Island, the arctic fox is trapped there annually in large numbers (the population has been high during the last 10 years) and the discarded carcasses of these animals are often consumed by dogs. The dogs are also fed waste parts of those marine mammals that provide the main source of food for the Eskimo. Conditions are somewhat comparable at Barrow, where foxes were abundant in 1949–50, and again in 1953–54. At both places, discarded carcasses of dogs are eaten by other dogs,

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especially in the summer, when the animals are not worked and are consequently fed little.

From previous work in arctic regions it is known that the prevalence of *Trichinella* larvae in dogs may be high. Thorborg *et al.* (1948), in an addendum, reported 41 of 54 dogs from West Greenland infected. According to Roth (1949), 46 of 66 dogs from the same region were infected; in a later report (1950) summarizing all of the work in Greenland, larvae were reported in 151 (66.5 percent) of 227 dogs examined. Kuitunen-Ekbaum and Fleming (1949) found 2 of 4 dogs infected in northern Canada.

Of 8 coyotes, *Canis latrans* Say, examined from southern Alaska, one (12.5 percent) had 45.0 larvae per gram of tissue. Since coyotes feed essentially upon small mammals and carrion, examination of a large series would probably disclose a high prevalence of infection.

Tissues were processed from 154 wolves, *Canis lupus* Linnaeus, most of which were killed by Eskimo in the central Brooks Range, arctic Alaska. Fifty-one wolves (33.1 percent) harbored larvae. These ranged in number from 0.1 to 20 per gram of tissue (av. 3.3 per gram).

From these findings, one might conclude that wolves feed upon smaller mammals to an extent greater than ordinarily supposed. Certainly they rarely, if ever, become infected through the eating of ungulates. According to the observations of one of us (RR), little carrion besides that of large hoofed animals is available in the nearly uninhabited region of interior Alaska where most of these wolves were taken.

Roth (1950) demonstrated *Trichinella* larvae in fragments of tissue adhering to skins of 2 wolves taken in Greenland and deposited in the Zoological Museum of Copenhagen. In the Belovezha Forest, Beliaeva (1954) found larvae in 8 of 21 wolves examined.

In Alaska, the red fox, *Vulpes vulpes alascensis* Merriam, is also an important host of *T. spiralis*. Of 76 animals examined, 31 (40.8 percent) were infected. The number of larvae ranged from 0.3 to 41 per gram (av. 8.4 per gram). Fifty-four of the red foxes (71 percent of the total) were collected in the Brooks Range, and the remainder from various localities to the south. Of these 54 foxes, 25 (80.6 percent of the total number of infected animals) harbored larvae. Forty-four foxes were taken around Anaktuvuk Pass, central Brooks Range; of these, 20 (45.5 percent) were infected. Farther to the east in the vicinity of Arctic Village, 10 foxes were taken, 5 (50 percent) containing larvae. Although the series are small, it is of interest to compare with the above the findings in 13 foxes killed in the Copper River valley south of the Alaska Range; here, only 2 animals (15.4 percent) harbored larvae. The remaining 9 infected red foxes were taken from widely separated localities.

To our knowledge, nothing has been published previously on the occurrence of *T. spiralis* in the red fox in arctic America. This species is known to be an important host of this nematode in Europe. Roth (1950) summarized data on *Trichinella* larvae in the red fox there, and additional work has been done by Söntgen (1939) and by Beliaeva (1954), who found larvae in 5 of 6 red foxes from the Belovezha Forest, in eastern Poland.

Only 16 (7.2 percent) of 222 arctic foxes, *Alopex lagopus* Linnaeus, were in-

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fected. Larvae ranged in number from 0.1 to 84.5 per gram (av. 22 per gram). Of 117 foxes from the Arctic Coast, 12 (10.3 percent) were infected. Of 94 arctic foxes from St. Lawrence Island, 3 (3.1 percent) were infected. The other infected fox was collected on Adak Island, in the Aleutians.

Parnell (1934) observed infected arctic foxes in northern Canada. Leiper (1938) reported trichinosis in 2 arctic foxes which died in the London Zoological Gardens. Roth (1949) found 3 of 101 foxes from West Greenland infected (2.8 percent), and in a later report (1950) had found no more after examining 264 animals. In the latter paper, Roth reviewed other work done in Greenland and elsewhere.

On the Arctic Coast and St. Lawrence Island, the arctic fox is dependent essentially upon mouse-like rodents for food. The availability of food varies according to population fluctuations among the small rodents. During the last 10 years, the brown lemming reached high population densities 3 different times on the Arctic Coast. The tundra vole on St. Lawrence Island has been abundant since 1949, attaining greatest numbers in fall, 1954. Other food items are invertebrates cast in by the sea, young birds, and carrion (see Braestrup, 1941). Remains of marine mammals are consumed, including those of seals left by polar bears.

Mustelidae.

A high prevalence of *T. spiralis* larvae was recorded in the ermine, *Mustela erminea arctica* (Merriam). Of 51 animals examined, 18 (35.3 percent) were infected. The larvae ranged in number from 0.1 to 436 per gram of tissue (av. 16.4 per gram). Of 40 animals collected in the Brooks Range, 17 (42.5 percent) were infected. The remaining ermines, including the other infected animal, were collected in the Copper River valley. Roth (1950) examined 3 ermines with negative results.

Since the ermine feeds upon mouse-like rodents, the high prevalence of *T. spiralis* is not explained by present knowledge. Mouse-like rodents and hares may harbor *Trichinella* larvae more frequently than recognized. The large number of small mammals consumed by the ermine and other small carnivores might compensate for a low rate of infection. This principle holds true for certain other species of helminths in Alaska; i.e., the larval form may seem very rare, but a high proportion of the final hosts may harbor the adult.

Two least weasels, *Mustela rixosa eskimo* (Stone), harbored larvae, one having only 0.8 larvae per gram of tissue, and the other more than 1400 per gram. Both were collected in the central Brooks Range. These small weasels prey upon lemmings and other small rodents, and may become numerous when the prey-species reach a high density.

Nineteen of 38 wolverines (*Gulo gulo* Linnaeus) (50 percent) studied contained larvae of *T. spiralis*. The number of larvae ranged from 0.2 to 18 per gram of tissue (av. 3.5 per gram). Rates of infection in this series of wolverines did not differ with the locality from which they were taken.

In addition to feeding upon small mammals, the wolverine consumes carrion.

The following mustelids were examined with negative results: Marten, *Martes americana actuosa* (Osgood), 18; Mink, *Mustela vison* Schreber, 43; Otter, *Lutra canadensis* (Schreber), 7; Sea otter, *Enhydra lutris* (Linnaeus), 20. An exami-

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nation of larger series of mink and marten is planned. Many mink are trapped by the Eskimo of the lower Kuskokwim region, and the carcasses of these animals are eaten during the winter months.

Felidae.

Four of 17 lynx, *Felis lynx canadensis* Kerr, harbored larvae (23.5 percent), ranging from 0.6 to 14 larvae per gram of tissue (av. 7.2 per gram). Two of the infected animals were taken in the central Brooks Range, and 2 in the Copper River valley, southern Alaska.

Beliaeva (1954) observed larvae in one of 3 lynx examined from the Belovezha Forest.

Lynx feed upon small mammals, mainly hares.

Leporidae.

Larvae were recorded from 2 (3.8 percent) of 53 snowshoe hares, *Lepus americanus dalli* Merriam; these 2 animals contained 0.5 and 3.0 larvae per gram of tissue. Forty hares, including those infected, were collected in the Brooks Range; the remaining 13 were taken in southern Alaska, near Anchorage.

The presence of the larvae in hares, ordinarily herbivorous animals, may possibly be the result of their feeding upon carrion, as they reportedly do when their population is at a high density.

Ochotonidae.

Thirteen pikas, *Ochotona collaris* (Nelson), were collected in the Talkeetna Mountains in southern Alaska; tissues processed were negative.

Sciuridae.

One ground squirrel, *Citellus undulatus* (Pallas), of 129 examined (0.8 percent) was infected. This animal, from St. Lawrence Island, had 0.3 larvae per gram of tissue.

Although primarily herbivorous, *Citellus undulatus* also consumes mammalian flesh when available (Geist, 1933; Cade, 1951). We have observed this behavior in northeastern Alaska and in the Talkeetna Mountains, where remains of voles were found in stomachs and cheek pouches of these squirrels. Such animals feeding upon carcasses of dogs or arctic foxes would of course be exposed to infection.

Four (4.3 percent) of 94 red squirrels, *Tamiasciurus hudsonicus* (Erxleben), were infected. Larvae ranged in number from 0.1 to 1.2 (av. 0.7) per gram of tissue. Three of the infected red squirrels were taken in the Brooks Range, and one in the Copper River valley.

The red squirrel in omnivorous. We have observed red squirrels feeding upon the flesh of the snowshoe hare (carrion), and mammalian bones are often found among food items stored by these animals for winter use. They no doubt eat any warm-blooded animal they are able to capture and kill. Red squirrels scavenge around settled areas, as well.

In addition, the following sciurids were examined with negative results: Marmot, *Marmota m. caligata* (Eschscholtz), 9; Flying squirrel, *Glaucomys sabrinus* (Shaw), 1.

Cricetidae.

Of 18 brown lemmings, *Lemmus sibiricus trimucronatus* Merriam, examined,

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one (0.8 percent) from the Brooks Range was infected, with 0.1 larvae per gram of tissue.

The brown lemming is herbivorous, but may eat mammalian tissue under some conditions. This was not seen during the mass die-off occurring along the Arctic Coast in 1949 (Rausch, 1950), but Thompson (1955) observed the consumption of dead lemmings by others during the lemming emigration near Barrow in 1953.

Of 49 red-backed voles, *Clethrionomys rutilus dawsoni* (Merriam), 2 (4 percent) animals from the upper Kenai Peninsula harbored larvae. The numbers of larvae present were 0.5 and 0.7 per gram of tissue.

This vole has a varied diet, and may consume mammalian tissue. In Alaska, it is often found, especially in winter, in and around buildings, where it feeds on stored foodstuffs.

One (1.8 percent) of 57 narrow-skulled voles, *Microtus miurus muriei* Nelson, taken in the Brooks Range, was infected. Little is known of the diet of this vole, beyond the fact that it feeds upon vegetation and stores quantities of leaves and rhizomes for winter use.

Another microtine rodent, the muskrat, *Ondatra zibethica* Linnaeus, was found infected. One (0.9 percent) of 113 animals harbored 1.3 larvae per gram of tissue. This animal was taken in the Copper River valley. The muskrat is seasonally very important as human food in some parts of Alaska.

In addition to the above, the following rodents were examined with negative results: Collared lemming, *Dicrostonyx torquatus rubricatus* (Richardson), 7; Field vole, *Microtus pennsylvanicus* Ord, 10; Tundra vole, *M. oeconomus* Pallas, 234. Roth (1950) examined 4 specimens of *Dicrostonyx* with negative results.

Castoridae.

Twenty-nine beavers, *Castor canadensis* Kuhl, were examined. One of these, taken on Kalgin Island, Cook Inlet, (3.4 percent) harbored 3.0 larvae per gram of tissue.

Erethizontidae.

No larvae were found in 3 porcupines, *Erethizon dorsatum myops* Merriam.

Monodontidae.

Tissues from 49 white whales, *Delphinapterus leucas* (Pallas), were processed, and one animal (2 percent) killed at Wainwright was found infected. Only 17 larvae were obtained in 25 grams of tissue (0.6 per gram).

Thorborg *et al.* (1948) pointed out that the history of an outbreak of trichinosis in 1947 at Kekertak, West Greenland, suggested the source of infection to have been a white whale. Roth (1949) found no larvae in 27 white whales. Brown *et al.* (1949) examined 9 white whales from the Canadian Northwest Territories and found all negative for *Trichinella* larvae. In his summary of the work in Greenland, Roth (1950) reported negative results from a total of 91 white whales.

The white whale feeds largely upon fishes (Vibe, 1950; Vladykov, 1944). It is difficult to understand how this animal might be infected unless it be through the consumption of fishes or invertebrates which have recently ingested mammalian flesh, as postulated by Vibe to explain infection of seals.

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Balaenidae.

Samples of striated muscle were obtained from 15 baleen whales killed at Barrow and Wainwright. Although designated as "bowhead" whales by the Eskimo, the identifications were not confirmed. As expected in baleen whales, all were negative. Roth (1950) examined several whales of various species, with negative results.

Odobaenidae.

Fifty-one walrus, *Odobenus rosmarus divergens* (Illiger), from St. Lawrence Island and the Arctic Coast, were examined. No larvae were found.

Thorborg *et al.* (1948) concluded that the flesh of walrus was the probable source of infection in certain outbreaks occurring among Eskimo in West Greenland in 1947. These writers stated (p. 789), "It is generally accepted that this sea mammal lives only on shells, fishes etc. However, it must be mentioned in this connection that remnants of seals have been found in the stomachs of walrus. It is possible that a voracious animal such as the walrus will eat any kind of meat or carrion." Several reports in the literature make it clear that seals are frequently eaten by walrus. A thorough investigation of the feeding habits of the walrus in Greenland has been reported by Vibe (1950).

Roth (1949) reported on the examination of 133 walrus from West Greenland, in which no larvae were found; in a later report, however, (1950) he observed 2 infected animals in 207 (0.9 percent). Brown *et al.* (1949) examined 7 walrus from the Canadian Northwest Territories; all were negative. Kuitunen (1954) reported finding 17 infected walrus among 394 collected in arctic Canada. Fifteen of the infected animals were taken off Southampton Island, and the other 2 at Cape Dorset.

Phocidae.

Samples of tissue from 310 seals, from the Arctic Coast and St. Lawrence Island, of the genus *Phoca* were processed. These are considered as a group, since specific identifications in some cases were not made. The majority was comprised of 2 species, the ringed seal, *P. hispida* Schreber, and the harbor seal, *P. vitulina* Linnaeus. A few ribbon seals, *P. fasciata* Zimmermann, were also included.

Trichinella larvae were recorded from 2 seals (0.6 percent of the total). The animals were from St. Lawrence Island and Point Lay and contained 75.0 and 1.2 larvae per gram of tissue, respectively.

Since *Phoca* spp. feed largely upon invertebrates, the mechanism by which they are infected is not easily understood. Vibe (1950) concluded that seals may consume amphipods feeding around mammalian carcasses which find their way into the sea, and are thus infected either through accidental ingestion of the tissue itself or through mechanical transfer via the amphipods.

One of 52 ringed seals (1.9 percent) was found infected in West Greenland by Roth (1950). Seals of other species, some not occurring in Alaskan waters, gave negative results. No larvae were found in several seals from northern Canada examined by Brown *et al.* (1949).

Of 126 bearded seals, *Erignathus barbatus* Erxleben, one (0.8 percent) was infected. Most of these animals were killed on the Arctic Coast; the infected specimen was taken at Point Lay.

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Thorborg *et al.* (1948) first reported trichinosis in a bearded seal. Brown *et al.* (1949) examined a few bearded seals, but none was infected. Roth (1949) found larvae in one of 28 bearded seals from West Greenland; in 1950, he reported no additional larvae after examining 56 animals.

According to Vibe (1950), the bearded seal is relatively omnivorous, feeding upon many species of invertebrates and upon fishes.

Otariidae.

Muscle tissue from 4 sea lions, *Eumetopias jubata* (Schreber), taken on St. Lawrence Island, were examined with negative results. This animal is piscivorous.

Dr. Carlton M. Herman, Patuxent Research Refuge, Laurel, Maryland, examined 101 fur seals, *Callorhinus ursinus cyanocephalus* (Walbaum), from St. Paul Island, Pribilofs, for *Trichinella* larvae, and kindly granted permission for inclusion of his data here. With the exception of one 10-year old bull, all of these animals were young males, 2-4 years old. No larvae were found, using both direct examination and digestion methods.

Fur seals are piscivorous.

Ungulates, Introduced Commensals, and Birds.

In addition to the 2433 mammals discussed above, a few ungulates were also examined: Moose, *Alces alces gigas* Miller, 2; Caribou, *Rangifer tarandus stonei* Allen, 8; Goat, *Oreamnos americanus* (Blainville), 2; Bison, *Bison bison* (Linnaeus), 6. All were negative for *Trichinella* larvae.

The brown rat, *Rattus norvegicus* Berkenhout, is abundant in a few Alaskan towns and generally throughout the Aleutian Islands. It is not known to be feral except in the Aleutian Islands and on some of the smaller islands around Kodiak. A total of 261 rats from Nome, Fairbanks, Kodiak, and Adak Island was processed; of these, 28 (10.7 percent) were infected. Rats of all ages, except young in the nest, were included; a higher prevalence rate would be evident on the basis of adult animals only.

The following flesh-eating birds were also processed: Herring gull, *Larus argentatus* Pontopiddan, 2; Glaucous-winged gull, *L. glaucescens* Naumann, 2; Short-billed gull, *L. canus brachyrhynchos* Richardson, 3; Glaucous gull, *L. hyperboreus* Gunnerus, 6; Pomarine jaeger, *Stercorarius pomarinus* (Temminck), 10; Long-tailed jaeger, *S. longicaudus* (Vieillot), 2; Short-eared owl, *Asio flammeus* (Pontoppidan), 1; Hawk owl, *Surnia ulula caparoch* (Müller), 4; Great horned owl, *Bubo virginianus* (Gmelin), 2; Snowy owl, *Nyctea scandiaca* (Linnaeus), 6; Goshawk, *Accipiter gentilis* (Linnaeus), 3; Sparrow hawk, *Falco sparverius* Linnaeus, 1; Golden eagle, *Aquila chrysaetos* (Linnaeus), 3; Bald eagle, *Haliaetus leucocephalus* Linnaeus, 6; Raven, *Corvus corax principalis* Ridgway, 47; Canada jay, *Perisoreus canadensis* Linnaeus, 3; Magpie, *Pica pica hudsonia* (Sabine), 1. Of these, a few larvae were recorded only from a Pomarine jaeger, collected at Barrow. Until confirmed experimentally, however, this finding is regarded as an error.

TRICHINOSIS IN MAN IN ALASKA

When this work was begun, it was believed by some that undiagnosed disorders reported in arctic villages might be attributable to *Trichinella* infections. There

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was no tangible evidence to support this view, however. Lack of medical records in Alaska and limited medical facilities in remote regions made it difficult to obtain information on the prevalence of specific diseases. This situation has been greatly remedied in recent years, and the importance of *T. spiralis* as a parasite of man can best be assessed sometime in the future.

Williams (1946) reported 2 outbreaks of trichinosis. The first of these involved 3 white men, and resulted from their eating the poorly cooked flesh of a brown bear, *U. arctos,* at Yakataga, Southeastern Alaska. In the second, a young Eskimo died at Selawik in February, 1946, after consuming the flesh of either a brown or a polar bear. In view of the time of the year, it is probable that the latter was involved. Further details on this case have not been available.

Three outbreaks of trichinosis are known to have occurred during the period of nearly 7 years covered by the present work.

In the summer of 1950, 2 white women became infected following the consumption of the flesh of a black bear, *U. americanus,* at Nenana, Alaska. Diagnosis was made from clinical evidence and on the basis of the history. The patients were treated by a private physician, and recovery was uneventful.

In the winter of 1954, an Eskimo from the lower Kuskokwim region was treated for trichinosis at the 5005th Air Force Hospital at Anchorage. A high eosinophilia was present, and muscle tissue obtained by biopsy contained numerous, still unencysted larvae. The patient stated that he had eaten only the flesh of moose during the few weeks preceding his illness. This information was kindly provided by Dr. James G. Bridgens, formerly pathologist at the hospital, now at the Independence Sanitarium and Hospital, Independence, Missouri.

In only one instance were several people involved. In May, 1954, a young Eskimo shot a brown bear near Solomon, on the Seward Peninsula. Eight persons in his family, including himself, and a guest consumed the slightly cooked flesh of this animal. Except for the father of the family who died during the interim, all became seriously ill between 2 to 3 weeks following consumption of the flesh. All were treated by Dr. Fred M. Langsam, Maynard-MacDougall Memorial Hospital, Nome, Alaska, to whom we are indebted for this information. Typical symptoms of trichinosis were present in all 7 cases. The hunter himself was the most seriously ill of the group, and was also the last to become ill. An eosinophilia of 26 percent was present, and on June 30 he demonstrated a strong reaction to intradermally-injected *Trichinella* antigen. There were no deaths.

Although the objective of the work reported herein was to determine the prevalence of *T. spiralis* in mammals other than man, intradermal tests were performed on a small number of Eskimo, as follows:

Locality	*Total Number*	*Number Positive*	*Percent Positive*
St. Lawrence Island	232	21	9
Wainwright	71	20	28
Anaktuvuk Pass	17	1	5.8

The people tested at Wainwright ranged in age from 16 to 79 years (average age: 37). Using the same antigen (Trichinella Extract Lederle), Brown *et al.* (1949b) observed positive reactions in 91 (46 percent) of 195 persons tested on Southampton Island. Of 98 persons tested further, 39 (39 percent) gave a positive precipitin test, while 25 of these showed a positive reaction with the intradermal test. At Igloolik, N. W. T., using the same commercially-prepared antigen, Brown

Rausch, Babero, Rausch & Schiller in Journal of Parasitology (June 1956) 42(3).

et al. (1950) obtained 22 positive reactions among 100 persons tested. In view of the findings among Canadian Eskimo, the rate of infection at Wainwright, as suggested by the intradermal test, is not remarkably high.

Hitchcock (1950) observed positive intradermal reactions in only 6.6 percent of 150 Eskimo tested in the lower Kuskokwim region. Later work at Kotzebue revealed only 1.6 percent positive reactors among 300 Eskimo (Hitchcock, 1951).

Viable larvae must be frequently ingested by the Eskimo, although present-day methods of food preparation generally preclude extensive outbreaks such as have occurred in Eskimo of Greenland.

DISCUSSION

Conditions in arctic regions are particularly favorable for the transmission of *Trichinella* larvae among wild mammals. Mammals are abundant, although the number of species represented is relatively small. A large proportion of the species present is comprised of those which are entirely or occasionally carnivorous, and predator-prey relationships are in general well defined.

The question of when and how *T. spiralis* became established in mammals in arctic regions has been the subject of some discussion (see Connell, 1949; Roth, 1950). The view that this nematode may have been introduced by man in recent times must be altogether untenable. As pointed out by Cameron (1950), ". . . it is a parasite of carnivores and this development cycle has tended to confine its natural distribution to holarctic boreal regions where carnivores habitually eat carnivores." And further, ". . . animal husbandry has enabled it to become an important parasite of man and pigs in temperate regions." The occurrence of this nematode in man, in some of his domesticated animals, and in his commensals seems now to be entirely independent of the natural cycle occurring in wild mammals, and the latter exists independent of man's influence.

In Alaska, the risk of infection to the aboriginal peoples is correlated with local practices regarding preparation of food. Bears probably constitute the greatest potential source of human infection, but the flesh of these animals is customarily well cooked. Dogs are no longer used as human food in Alaska, nor are foxes or wolves under ordinary conditions. However, such animals as wolverines and minks are still eaten in remote regions, where larger mammals are rare. Large species of marine mammals are potential sources of more extensive outbreaks, since one infected carcass may be divided and consumed by several families. Presently, however, the Eskimo and Indians appear to be no more frequently infected than is the white man who may, through ignorance or carelessness, fail to cook adequately the flesh of bears and other animals.

The mechanism of transmission of *T. spiralis* larvae in wild mammalian populations is not well understood. Eaters of carrion may often become infected, but the place of important prey species—i.e., microtine rodents, sciurids, etc., is not clear. In attempting to learn how the larvae are transmitted to red foxes in Germany, Söntgen (1939) had 40 microscopic examinations performed on each of a total of 521 field voles (*Microtus*) killed in a region where infected foxes were frequently taken. His results were negative. He also reviewed the work of others who had found no larvae in these animals, and concluded that foxes become infected through consumption of the carcasses of other foxes.

Rausch, Babero, Rausch & Schiller in Journal of Parasitology (June 1956) 42(3).

Beliaeva (1954) examined more than 700 mouse-like rodents, 126 shrews, and 20 moles from the Belovezha Forest in eastern Poland. Among the small rodents were species of *Clethrionomys, Microtus, Arvicola, Micromys,* and *Apodemus,* as well as house mice (*Mus musculus* Linnaeus).[4] Two shrews (see above) were infected. Larvae were found in 4 of 41 specimens of *Apodemus flavicollis* Melchior, taken around settled areas. An additional 194 of these rodents, taken in forested areas, were negative. Eight of 16 moles, *Talpa europaea* Linnaeus, taken in populated areas, were infected, and the identity of the nematode was confirmed by experimental infection of white mice. Beliaeva found carcasses of carnivores in areas where the infected animals were trapped, and believed that such carcasses, brought by hunters to populated areas and discarded, serve as the source of infection for small mammals as well as for swine.

The occurrence of *T. spiralis* in small rodents and insectivores may depend largely upon the availability of the infected tissue of carnivorous mammals in the form of carrion. In settlements in or near wilderness areas, carcasses left by hunters may have importance, as suggested by Beliaeva. Where the mammalian fauna is abundant, as in Alaska, small mammals may become infected in nature. In Alaska at the present time, it appears that carnivores most frequently become infected through feeding on the carcasses of other carnivores. The investigation of this problem to determine what place the small mammals may have in the transmission of *T. spiralis* in Alaska is being continued.

ACKNOWLEDGMENTS

This opportunity is taken to express appreciation to those who have extended valuable assistance in the course of this work: Personnel of the U. S. Fish and Wildlife Service in Alaska provided numerous specimens and assistance; laboratory facilities and logistic support were provided by the Arctic Research Laboratory, Office of Naval Research, at Point Barrow in the years 1949–53; Dr. Vilhjalmur Stefansson encouraged this work and assisted by making available his correspondence with other investigators in arctic regions on the subject of trichinosis; the late Dr. Hans Roth, Royal Veterinary and Agricultural College, Copenhagen, gave valuable information and suggestions during the early years of this investigation; Mr. Ralph B. Williams, Director of Laboratories, Alaska Department of Health, Juneau, permitted use of data from his records; many of the Eskimo and Indians of arctic Alaska assisted in the collection of mammals, and particular thanks are expressed to the people of Anaktuvuk Pass for their whole-hearted cooperation over a period of several years.

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[4] Only common names were used by Beliaeva. Technical names for the rodents were obtained from Vinogradov, B. S., and I. M. Gromov, "Gryzuny fauny SSSR." Moscow-Leningrad. 1952.

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