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Parasites of Bears: A Review

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INTRODUCTION

This paper is an attempt to summarize the available information on parasites of bears. Knowledge of ursine parasites has expanded considerably since the subject was reviewed by Stiles and Baker in 1935; more than 90 additional reports on the subject have been published, and at least 43 additional parasites have been reported. In this paper, available information is summarized for each of 77 species of parasites, including (1) species of host, (2) pathological effects, (3) whether hosts were captive or wild, (4) the proportion of the bears from a given geographic location that were infected, and (5) sources of information. Parasites also are listed by host. Topics discussed include transmission of trichinosis and parasitism during hibernation.

PROTOZOA

Hair and Mahrt (1970) reported two new species of coccidia from wild black bears (*Ursus americanus*) in Alberta, Canada. They examined 52 fecal samples and found oocysts of *Eimeria albertensis* in four and oocysts of *E. borealis* in three of them. Coccidia also were reported from the USSR, where *E. ursi* was reported from the brown bear (*Ursus arctos*) (Yakimoff and Matschoulsky 1935) and *Isospora fonsecai* was reported from the red bear (*Ursus arctos isabellinus*) (Yakimoff and Matschoulsky 1940). Couturier (1954) thought Coccidia and Infusoria make bears slightly ill. Stiles and Baker (1935) reported a haemosporidean parasite (*Babesia* sp.) from an unidentified bear in a zoo at St. Petersburg, Florida. Marchionini (1967) claimed that bears (species not given) could act as intermediate hosts for *Leishmania* sp., which is the protozoan agent of dermal leishmaniasis, a disease of man in the Middle East.

TREMATODES AND ASSOCIATED RICKETTSIA

Flukes (*Dicrocoelium lanceatum*) were found in the bile ducts of 8 of 12 adult Himalayan bears (*Selenarctos thibetanus*) in southeastern USSR (Bromlei 1965). Worley *et al.* (1976) found flukes (*Echinostoma revolutum*) in 2 of 31 wild grizzly bears (*Ursus arctos horribilis*) in Montana. A third fluke, *Nanophyetus* (=*Troglotrema*) *salmincola*, was reported from a wild brown bear from eastern Siberia (Filimonova 1966) and from experimentally infected black bears from the north-western United States (Simms *et al.* 1931, Farrell 1968, Poelker and Hartwell 1973).

Farrell (1968) reported that metacercariae of *Nanophyetus salmincola* live in certain species of fish, including the salmonid species eaten by bears. The metacercariae carry two types of rickettsia-like organisms which they transmit to fish-eating mammals. One is *Neorickettsia helminthoeca,* to which the bear is refractory; the other has no generic name but is known to cause Elokomin fluke fever (EFF) in black bears. Farrell (1968) experimentally infected nine wild-caught black bears with metacercariae of *N. salmincola.* Eight of them exhibited diarrhea and refused to feed on the ninth to twelfth days following infection. Appearance of these animals varied from mild lethargy to lateral recumbancy from which they were aroused only with difficulty. The ninth bear was captured in an area where it probably already had been exposed to EFF, and it was immune to the disease. Six of the bears were sacrificed for further studies during the acute phase of illness. One of these had approximately 64, 000 flukes in the small intestine and showed bile blockage with necrosis of the gall bladder sufficient to have caused death. The two bears that were not sacrificed made uneventful recoveries without treatment.

CESTODES

Cyclophyllidean Tapeworms

Jonkel and Cowan (1971) found *Taenia saginata* in several droppings from wild black bears in northwestern Montana. Horstman (1949) reported *T. pisiformis* from a wild black bear in Colorado. Rausch (1954) and Rausch *et al.* (1956) reported *T. krabbei* and sterile specimens of *T. hydatigena* from captive black bears in Alaska. *Taenia krabbei* also was found in 2 of 21 wild grizzly bears (*Ursus arctos*) in northwestern Canada (Choquette *et al.* 1969). Taeniid cestodes (cf. *Multiceps serialis*) were found in a wild black bear in Minnesota during a population explosion of the snowshoe hare (*Lepus americanus*), which is the usual intermediate host of *M. serialis* in that state (Rogers 1975). *Taenia* was found in 7 of 12 wild black bears in central Alaska (Hatler 1967), in 2 of 30 wild black bears in Montana (Worley *et al.* 1976), in 14 of 66 wild grizzly bears in Montana (Worley *op. cit.*), and in a captive Himalayan bear in India (Stiles and Baker 1935). Other reports of adult cyclophyllidean tapeworms include *Pentorchis arkteios* in a sun bear (*Helarctos malayanus*) in Burma (Meggitt 1927), *Taenia ursi-maritimi* in captive polar bears (*Ursus maritimus*) in Europe (Rudolphi 1810; Linstow 1878), and *T. ursina* in a captive brown bear in Copenhagen (Linstow 1893). Wardle and McLeod (1952) listed *T. ursina* and *T. ursi-maritimi* as *nomina dubia.*

Horstman (1949) stated that he found two new species of tapeworms, *Mesocestoides krulli* and *Anacanthotaenia olseni,* in wild black bears in Colorado. However, as far as we could determine from the *Zoological Record* and from the *Nomenclator Zoologicus* by Edwards and Hopwood (1966), no descriptions of these cestodes have been published.

Bears also can serve as intermediate hosts for certain cyclophyllidean cestodes (Meggitt 1924). Batsch (1786) listed *Ursus* sp. as a host for hydatid cysts of *Echinococcus granulosus,* and Diesing (1851) reported cysticerci (*Cysticercus cellulosae*) from a brown bear, presumably from the Old World. Martin (1950) found numerous unidentified cysticerci in practically every skeletal muscle of a wild black bear in California. The bear weighed 85 kg (188 pounds), had little fat, and had a lusterless pelt when killed on 13 October.

Pseudophyllidean Tapeworms

The only pseudophyllidean tapeworms reported from bears from North America have been from the genus *Diphyllobothrium*. Bears acquire these parasites by eating fish that contain plerocercoids (Rausch 1954).

There has been disagreement concerning the specific identification of several of these cestodes (see review by Rausch 1954). *Diphyllobothrium* from wild black bears from Yellowstone National Park have been identified as *D. latum* (Skinker 1931; Rush 1932), *D. cordatum* (Scott 1932) and *D. cordiceps* (Rausch 1954). Specimens identified as *D. latum* by Rush (1932) later were identified as *D. cordatum* by Scott (1932).

Rausch (1954) provisionally described tapeworms from brown bears (*Ursus arctos middendorffi*) on Kodiak Island, Alaska, as a new species, *D. ursi*. Cestodes tentatively identified as the same species were found in 3 of 21 grizzly bears from northwestern Canada (Choquette *et al.* 1969). Skinker (1931) reported *D. latum* from an unidentified bear from Ketchikan, Alaska. *Diphyllobothrium* was found in 16 of 66 grizzly bears and in 2 of 30 black bears in Montana (Worley *et al.* 1975). *Diphyllobothrium* also was found in unidentified bears from the northwestern United States and Alaska (Ward 1927) and in wild black bears in southern Alaska (Rausch 1961) and Minnesota (Vergeer 1930, unpublished data). *Diphyllobothrium* formerly was found in the droppings of four of ten wild black bears in Minnesota (Vergeer 1930) but more recently has become uncommon (Rogers 1975). Horstman (1949) reported *D. latum* from a captive polar bear in Minnesota.

In the Old World, *Diphyllobothrium latum* and *D. cordatum* were found in wild brown bears from southeastern USSR (Bromlei 1965). Additionally, *Bothriocephalus ursi* was found in a brown bear in a zoo in Germany (Landois 1877), and *Bothriocephalus* sp. was reported from a polar bear from a zoo in Dublin (Foot 1865). In the past the genus *Bothriocephalus* was a general receptacle for unassigned pseudophyllidean forms; more than 200 have been relegated to it at various times (Wardle and McLeod 1952).

Adverse effects upon bears from tapeworms usually are not evident (Rausch 1955). However, in an exceptional case, a captive black bear cub died in Alaska from complications that arose after strobilae of *Diphyllobothrium* sp. (probably *D. ursi*) completely occluded its pancreatic ducts (Rausch *op. cit.*). In Yellowstone National Park, Wyoming, Rush (1932) found that a wild black bear in poor condition contained about 100 tapeworms (*Diphyllobothrium* sp.) and had occlusions and invaginations of the intestine. The bear had been killed because of its nuisance activities.

NEMATODES

Intestinal Nematodes

For the ascaridoid nematodes, we have followed the classification of Sprent (1968) in which the ursine members of the genera *Ascaris* and *Toxascaris* are reclassified in a new genus, *Baylisascaris*. Members of this genus are common in bears and have been reported from all species except *Tremarctos ornatus* (Sprent 1968). *B. transfuga* has been found in wild black bears in Ontario (Sprent 1950; 1951), Wyoming in 1 of 8 bears (Rush 1932), Minnesota in 5 of 7 bears (Rogers 1975), Montana in 24 of 30 bears (Worley *et al.* 1976), and Alaska (Rausch 1961). *B. transfuga* also was found in wild grizzly bears in

northwestern Canada in 16 of 21 bears (Choquette *et al.* 1969) and Montana in 53 of 70 bears (Worley *et al.* 1976).

In the Old World, *Baylisascaris transfuga* was reported from wild brown bears in south-eastern USSR (Oshmarin 1963) and from a wild Yezo brown bear (*Ursus arctos yesoensis*) from Japan (Okoshi *et al.* 1962). Mozgovoi (1953) reported this parasite from *U. a. caucasicus* but did not state whether the bear was wild or captive. Bromlei (1965) stated that in the Old World *B. transfuga* is found in Caucasus, Baikal, Chukotka, Indonesia, Syria and Tibet.

Captive bears from which *Baylisascaris transfuga* were collected include polar bears from Australia (Sprent 1968) and Moscow (Mozgovoi 1953), brown bears from Czechoslovakia (Jaros *et al.* 1966) and Moscow (Mozgovoi 1953), and sloth bears (*Melursus ursinus*) and Himalayan bears (*Selenarctos thibetanus*) from India (Baylis and Daubney 1922). In the Philadelphia Zoo, it was collected from *Ursus americanus, U. maritimus, U. arctos syriacus, U. a. pruinosus, U. a. beringianus,* and *Helarctos malayanus* (Canavan 1929; Stiles and Baker 1935).

Three other species of roundworms of the genus *Baylisascaris* have been collected from bears (Sprent 1968). Khera (1951) described a new species, *B. melursus,* from the sloth bear in India. The giant panda (*Ailuropoda melanoleuca*), which some authors (e.g. Sarich 1973) consider to be a bear, was host to another species, *B. schroederi* (McIntosh 1939). *B. multipapillata* was collected from a captive black bear in Germany and described by Kreis (1938). The latter species also was collected in New York from captive black bears and from 20 of 65 wild black bears (King *et al.* 1960). Mozgovoi (1953) stated that *B. multipapillata* and *B. transfuga* may prove to be the same species.

Ascaridoids (species not given) were found in 9 of 12 wild black bears in Alaska (Hatler 1967), in wild black bears in western Washington (Poelker and Hartwell 1973), and in Himalayan bears in southeastern USSR (Bromlei 1965).

Baylisascaris sp. apparently caused the death of an unidentified and presumably captive bear (Mozgovoi 1953). The bear contained 100 specimens in the intestine, which is the usual location for this parasite. In addition, it contained 97 in the stomach, two in the oral cavity, and one in the larynx. Mozgovoi concluded that death in this case was due to the fact that 'the location was an abnormal one that is frequently observed with ascarids and that usually causes death.'

Toxocara canis and *T. mystax* were found in captive brown bears in Bale, Germany (Couturier 1954).

Four species of hookworms, *Ancylostoma brasiliense, A. ceylanicum, A. malayanum,* and *A. caninum,* were reported from captive sloth bears in India (Baylis and Daubney 1922). *A. ceylanicum* long was considered a synonym of *A. brasiliense,* but Biocca (1951) showed that the two are distinct. *Ancylostoma malayanum* also was reported from Himalayan black bears from India and Ceylon (Lane 1916) and from a captive sun bear from India (Baylis and Daubney 1922).

Female hookworms were collected from the polar bear and deposited in the Vienna Museum under the name *Strongylus ursi-maritimi;* Dujardin (1845) described these specimens and assigned to them the name *Dochmius ursi. Dochmius* now is considered a synonym of *Uncinaria* (Levine 1968). The northern carnivore hookworm (*Uncinaria stenocephala*) was found in brown bears (*Ursus arctos caucasicus*) from the vicinity of the Caspian Sea (Rukhliadev and Rukhliadeva 1953, Sadykhov 1962).

In North America, a new species of hookworm, *Uncinaria* (=*Dochmoides*) *yukonensis*, was described by Wolfgang (1956) from specimens collected from one of two wild black bears in Yukon Territory, Canada. Choquette *et al.* (1969) found the same species in 10 of 21 wild grizzly bears from the same area, and Jonkel and Cowan (1971) found it in a wild black bear in Montana. Worley *et al.* (1976), also working in Montana, found *Uncinaria* (species not given) in 1 of 30 wild black bears and in 12 of 69 wild grizzly bears. *U. yukonensis* was reported from both black and brown bears in Alaska (Rausch 1961; 1968). Additionally, Olsen (1968) described a new species of hookworm, *U. rauschi*, which is found in both black and brown bears in Alaska.

In the Philadelphia Zoo, Canavan (1929) found many stomach-worms (*Haemonchus contortus*) in the duodenum and large intestine of a 19-year-old polar bear. Stomach-worms more commonly live in the abomasum of certain ruminants. In the same zoo, *Cyathostoma bronchiale*, which usually is a parasite of the respiratory passages of waterfowl, was found in the small intestine of a brown bear (*Ursus arctos collaris*) (Stiles and Baker 1935).

Extra-intestinal Nematodes

Diesing (1851) listed *Nematoideum ursi*, a parasite of *Ursus arctos*, as *genere penitus dubia* and listed *Taenia ursi* in the synonomy of *N. ursi*. *Taenia ursi* has been reported as a parasite of bears (species not given) by Gmelin (1790).

King *et al.* (1960) found a new species of lungworm of the genus *Crenosoma* in the larger air passages of 3 of 53 wild black bears in New York, but they did not find it in 17 captive black bears. Bromlei (1965) found unidentified nematodes averaging 300 mm long and 1.5 mm thick in the bronchi of a wild Himalayan bear in south-eastern USSR. Hosford *et al.* (1942) noted that black bears are known to have been infected with the eye worm (*Thelazia californiensis*) in California, but they did not provide specifics. Hutyra *et al.* (1946) reported that the kidney worm (*Dioctophyma renale*) was found free in the abdominal cavity of an unidentified bear.

Chandler (1950) found numerous *Gongylonema pulchrum*, which more commonly parasitize the esophagus or rumen of ungulates, in the tongue of an emaciated, moribund, wild black bear in Pennsylvania. Chandler pointed out that there is no way to distinguish *G. pulchrum* from *'Spiroptera ursi'*, reported for the European brown bear by Rudolphi (1819), or from *Gongylonema contortum*, reported for the same host by Molin (1860).

Dirofilaria ursi, a filarial worm, first was reported from *Selenarctos thibetanus japonicus* from Japan (Yamaguti 1941). In the Old World, the species also was reported from *Ursus arctos beringianus* from Sakhalin Island, Siberia (Petrov and Krotov 1954) and from a brown bear from south-eastern USSR (Oshmarin 1963). Choquette (1952) obtained filarial worms from the abdominal cavities and the submucosa of the esophagus of wild black bears from Ontario and Quebec. He provisionally described the material as a new species, *Dirofilaria desportesi;* but after Anderson (1952) redescribed *D. ursi* from material obtained in southern Ontario, Choquette *et al.* (1969) placed the name *D. desportesi* in the synonomy of *D. ursi*. Anderson (1952) found *D. ursi* in the subcutaneous tissue of each of 20 wild black bears from Algonquin Park, Ontario. King *et al.* (1960) found adults in 3 of 55 wild black bears and found microfilariae (larvae of *Dirofilaria*) in the blood of 34 of 36 wild black bears in New York. However, this parasite, which is transmitted by mosquitoes, was not found in the blood of 17 black bears from zoos in New York (King *op. cit.*). Rogers (1975) found adult *D. ursi* in wild black bears in Michigan and Minne-

sota. Rogers and Seal (unpublished) found microfilariae in the blood of each of 47 wild black bears 14 months of age or older in Minnesota. Rausch (1961) stated that he collected *D. ursi* only once from a black bear in Alaska, although the same parasite is common there in the brown bear. Similarly, Worley *et al.* (1976) did not find *Dirofilaria* in 30 wild black bears in Montana but did find it in 2 of 13 wild grizzly bears. In the same state, Jonkel and Cowan (1971) found *D. ursi* in two wild black bears. Choquette *et al.* (1969) found *D. ursi* in 3 of 27 wild grizzly bears from north-western Canada.

Trichinella spiralis in bear meat poses a potential public health hazard, and workers have given considerable attention to determining the prevalence of this nematode in various geographic areas. *Trichinella* was found in polar bears in zoos in Germany (Bohm 1913), London (Leiper 1938), and Philadelphia (Canavan 1929, Brown *et al.* 1949). Grjuner (1915) reported trichinosis as the cause of death of a captive European brown bear that was fed trichinous rats. However, documentation that trichinosis was the cause of death was not provided.

Doege *et al.* (1969) reported *Trichinella* in a wild Himalayan black bear in Thailand. Reports of *Trichinella* in wild polar bears, brown bears and black bears are summarized in Tables 1, 2 and 3, respectively. The combined data

TABLE 1. SUMMARY OF REPORTS OF *TRICHINELLA SPIRALIS* IN WILD POLAR BEARS *URSUS MARITIMUS*.

Geographic location	Number examined	Number infected	(Percent infected)	Source
Alaska	17	9	(53)	Rausch *et al.* 1956
Alaska	104	57	(55)	Fay 1960
Canada*	—	—	—	Cameron 1960
Southampton I., Canada	3	2	—	Brown *et al.* 1948
Greenland	16	6	(39)	Thorborg *et al.* 1948
Greenland	112	31	(26)	Roth 1950
Greenland	231	56	(24)	Madsen 1961
Svalbard	7	7	—	Brown *et al.* 1949
Svalbard	8	7	—	Connell 1949
Norwegian and Barents Seas	278	163	(59)	Thorshaug and Rosted 1956
Rudolph Land I.*	—	—	—	Kozemjakin 1959
Palearctic*	—	—	—	Brusilovskiy 1957
N.E. Siberia	19	1	(5)	Ovsjukova 1965
Holarctic Total	795	339	(42.6)	Average of all reports

* One or more infected bears were found at this location, but the number of bears examined was not reported.

TABLE 2. SUMMARY OF REPORTS OF *TRICHINELLA SPIRALIS* IN WILD BROWN-GRIZZLY BEARS *URSUS ARCTOS*.

Geographic location	Number examined	Number infected	(Percent infected)	Source
Alaska	20	10	(50)	Rausch *et al.* 1956
N.W. Canada	24	21	(86)	Choquette *et al.* 1969
Montana	171	103	(60)	Worley *et al.* 1976
California*	—	—	—	Walker 1932
USSR	1	1	—	Lukashenko *et al.* 1971
N.E. Siberia	19	11	(58)	Ovsjukova 1965
E. Siberia	14	2	(14)	Toschev 1963
N. Siberia	10	0	(0)	Gubanov 1964
Caucasus mountains	5	0	(0)	Rukhliadev and Rukhliadeva 1953
Azerbaijan*	—	—	—	Sadhykov 1962
Germany*†	—	—	—	von Bockum-Dolffs 1888
Holarctic Total	264	153	(59.8)	Average of all reports

* One or more infected bears were found at this location, but the number of bears examined was not reported.
† Species not given, presumably *Ursus arctos*.

show a higher incidence of *Trichinella* in brown bears (59.8 percent) and polar bears (42.6 percent) than in black bears (3.2 percent). The data do not support the hypothesis advanced by King *et al.* (1960), Brown (1967) and Wand and Lyman (1972) that garbage is the main source of trichinosis in bears. In general, the data suggest that a higher proportion of the bears are infected in remote areas than in areas with a dense human population. Worley *et al.* (1974) also noted that in the United States trends of trichinosis in grizzly bears 'strongly suggest that the availability to bears of infected sources of food was inversely proportional to their degree of association with civilization.' Madsen (1961), Zimmermann and Hubbard (1969), Rausch (1970) and Lukashenko *et al.* (1971) suggested that, for carnivores, carcasses of other carnivores are a major source of *Trichinella*. Madsen (1961), Rausch (1970) and Rogers (1975) suggested that cannibalism of carcasses could be a major source of infection for bears. In fact, 12 of 13 carcasses of black bears in Minnesota were cannibalized, often by more than one bear (Rogers *op. cit.*).

In remote areas of the Far North, hunting increases the number of carcasses available to bears because hunters usually leave carcasses in the field after skinning them (Rausch 1970). Conversely, in areas that are accessible by road, hunters usually use both the meat and hides of bears and leave only gut piles (Dahlen 1959). *Trichinella* larvae usually are not found in visceral organs (Soulsby 1968), so gut piles usually are not infective unless they contain the diaphragm. Hence, intense hunting pressure in accessible areas may reduce the number of carcasses available to bears if hunting deaths tend to replace natural deaths and crippling losses are less than the natural death rate. Hunt-

TABLE 3. SUMMARY OF REPORTS OF *TRICHINELLA SPIRALIS* IN WILD BLACK BEARS *URSUS AMERICANUS*.

Geographic location	Number examined	Number infected	(Percent infected)	Source
New York	49	3	(6)	King *et al.* 1960
Vermont	35	0	(0)	Babbott & Day 1968
Vermont*	—	—	—	Roselle *et al.* 1965
New England	372	5	(1.3)	Harbottle *et al.* 1971
Michigan	23	0	(0)	Zimmermann 1974†
Wisconsin	163	6	(3.8)	Zimmermann 1974†
Minnesota	6	0	—	Zimmermann 1974†
Colorado	66	0	(0)	Zimmermann 1974†
New Mexico	14	0	(0)	Zimmermann 1974†
Arizona	4	0	—	Zimmermann 1974†
Wyoming	15	0	(0)	Zimmermann 1974†
Montana	80	5	(6.3)	Worley *et al.* 1976
Idaho	44	1	(2.3)	Zimmermann 1974†
Oregon	50	0	(0)	Zimmermann 1974†
California	54	7	(13)	Zimmermann 1974†
Alaska	1	0	—	Zimmermann 1974†
S. Alaska	23	5	(22)	Rausch *et al.* 1956
United States (Total)	999	32	(3.2)	Average of all reports

* One or more infected bears were found at this location, but the number of bears examined was not reported.
† Personal communication.

ing pressure in the eastern United States is intense (Stickley 1961, Wakefield 1972) and may account in part for the low incidence (1.3 percent) of *Trichinella* in bears there.

ARTHROPODS

Lice

Lice, *Trichodectes pinguis pinguis*, were reported from brown bears in Europe by Burmeister (1838) and Werneck (1948) and from a Himalayan black bear in zoo in Paris by Neumann (1913). Bromlei (1965) found unidentified lice on a wild Himalayan bear in southeastern USSR.

In North America, a new subspecies of louse (*Trichodectes pinguis euarctidos*) was described by Hopkins (1954) from specimens obtained from black bears in Ontario and British Columbia. This subspecies also was found on wild black

bears in Michigan (Rogers 1975), Minnesota (unpublished data), New York on 23 of 306 examined (King *et al.* 1960), and Montana on 2 of 153 examined (Jonkel and Cowan 1971). Worley *et al.* (1976) found *Trichodectes* (species not given) on 1 of 6 wild black bears in Montana. No lice have been reported from grizzly-brown bears from North America.

Fleas

For the fleas, we have followed the classification of Hopkins and Rothschild (1956). Fleas identified as *Chaetopsylla setosa* were reported from wild black bears in southern British Colombia (Rothschild 1906, Hopkins and Rothschild 1956) and Montana (Hubbard 1947) and from wild grizzly bears from British Columbia (Jellison and Good 1942, Ewing and Fox 1943, Holland 1949).

A larger species of flea, *Chaetopsylla* (*Arctopsylla*) *tuberculaticeps ursi*, was reported from wild grizzly bears in southern Alberta (Rothschild 1902, Hopkins and Rothschild 1956), southern British Columbia (Holland 1949), and Alaska (Rausch 1961). The same subspecies was found on wild black bears in south-central Alaska (Jellison and Kohls 1939) and in Montana (Hubbard 1947). In Montana, Jonkel and Cowan (1971) found it on 4 of 153 live-trapped black bears, and Worley *et al.* (1976) found *Chaetopsylla* spp. on 1 of 3 wild grizzly bears.

Another subspecies, *Chaetopsylla tuberculaticeps tuberculaticeps*, was reported from brown bears from Norway, Russia and the Italian Alps (Hopkins and Rothschild 1956). The close taxonomic relationship between *C.t. tuberculaticeps* of Eurasia and *C.t.ursi* of North America is shown by the fact that fleas with characteristics intermediate between the two subspecies were collected from a wild brown bear (*Ursus arctos yesoensis*) on the island of Hokkaido, Japan (Sakaguti 1960). The specimens from Japan tentatively were classified as *C.t. tuberculaticeps* (Sakaguti *op. cit.*).

Another flea, *Thrassis spenceri*, was reported from a grizzly bear from British Columbia (Hubbard 1947). This species of flea usually lives on marmots (*Marmota*) which occasionally may be eaten by grizzly bears. *Pulex irritans* were collected from four wild black bears in northern California by D. Kelley-house and were identified by H. Egoscue (Egoscue 1975, pers. comm.). Worley *et al.* (1976) found fleas tentatively identified as *Pulex* sp. on one of six wild black bears in Montana.

Fleas apparently are less common on bears in eastern North America. King *et al.* (1960) found no fleas on 306 wild black bears in New York. However, unidentified fleas were found on a wild black bear in Michigan (Rogers 1975), and a large population of *Orchopeas caedens*, which usually are associated with red squirrels (*Tamiasciurus*), were found in Minnesota in the den of a young bear a few days after the bear had left the den. The bed in the den was undisturbed, and there was no sign that any animal other than the bear had used the den.

Acarina

In North America, wood ticks (*Dermacentor andersoni*) were found on wild grizzly bears in Montana and on wild black bears in Montana and Colorado (Henshaw and Birdseye 1911, Cooley 1938, Horstman 1949, Worley *et al.* 1975). Jonkel and Cowan (1971) found *D. andersoni* on each of 117 black bears captured in Montana during May and June but found none on 36 black bears captured in late summer. Jonkel and Cowan stated that infestations in spring generally were heaviest on subadult bears, possibly because 'subadults are in poorer

condition than the adults at this time of year, [and] they probably have more difficulty resisting ectoparasites'.

Rogers (1975) collected dog ticks (*Dermacentor variabilis*) from wild black bears in Michigan and Minnesota during late spring and early summer, and Dodds *et al.* (1969) took the same species from a wild black bear in Nova Scotia. Rogers (1975) also reported 30 winter ticks (*D. albipictus*) from one of seven adult bears examined in dens in Minnesota in late March; two 2-month-old cubs in the den with the infested bear were free of ticks. King *et al.* (1960) found soft ticks of the genus *Ixodes* (tentatively identified as *I. cookei*) on 4 of 306 wild black bears in New York.

In the Old World, *Ixodes ricinus* and *Dermacentor* cf. *venustus* were found on brown bears in the Pyrenees (Couturier 1954). Bromlei (1965) reported that although Himalayan bears and brown bears in south-eastern USSR commonly are infested with large numbers of ticks (*Dermacentor silvarum, Haemaphysalis japonica douglasi* and *Ixodes persulcatus*) during late spring and summer, only one of 19 Himalayan bears examined during winter carried ticks (*Ixodes persulcatus*). Again, newborn cubs denning with the infested bear were free of ticks.

Dermacentor auratus and *Haemaphysalis hystricis* were collected from Himalayan black bears in Burma, and *H. formosensis* was taken from the same host in Taiwan (Stiles and Baker 1935). *Haemaphysalis hystricis, H. leachi* and *H. semermis* were found on sun bears (*Helarctos malayanus*) in Malaya (Stiles & Baker 1935, Hoogstraal *et al.* 1966). Stiles and Baker (*op. cit.*) reported several additional ticks (*Dermacentor compactus, Hyalomma aegyptium, H. hussaini, H. monstrossum, Rhipicephalus haemaphysaloides, R. sanguineus, Haemaphysalis spinigera* and *H. bispinosa*) from unidentified bears. The locality of *H. bispinosa* was not given, but all others were listed as from India.

Fain and Johnston (1970) described a new species of mite (*Ursicoptes americanus*) from the skin of a captive black bear in Europe. Neumann, in 1892, reported *Sarcoptes scabiei* from a wild brown bear from the Pyrenees (Couturier 1954).

HOST LISTS

No reports of parasites were found for the spectacled bear (*Tremarctos ornatus*) of South America, and only one report was found of a parasite from the giant panda *Ailuropoda melanoleuca*. That parasite, an ascarid worm (*Baylisascaris schroederi*), has been reported only from the giant panda (Sprent 1968).

Parasites of Polar Bears

Seven parasites were reported from polar bears, but only one, *Trichinella spiralis*, was reported as being from a wild host. The remaining six species of parasites include three species of nematodes (*Haemonchus contortus, Dochmius ursi* and *Baylisascaris transfuga*) and three cestodes (*Diphyllobothrium latum, Bothriocephalus* sp. and *Taenia ursi-maritimi*).

Parasites of Black Bears

Thirty-one parasites have been reported from black bears in North America. These include two protozoa (*Eimeria albertensis* and *E. borealis*), a trematode

(*Nanophyetus salmincola*), the rickettsia-like agent of Elokomin fluke fever transmitted by *N. salmincola*, ten cestodes (*Taenia saginata, T. pisiformis, T. krabbei, T. hydatigena, Anacanthotaenia olseni, Mesocestoides krulli, Diphyllobothrium latum, D. cordatum, D. cordiceps* and *D. ursi*), nine nematodes (*Baylisascaris transfuga, B. multipapillata, Uncinaria yukonensis, U. rauschi, Crenosoma* sp., *Thelazia californiensis, Gongylonema pulchrum, Dirofilaria ursi* and *Trichinella spiralis*), and eight arthropods (*Trichodectes pinguis euarctidos, Chaetopsylla setosa, C. tuberculaticeps ursi, Pulex irritans, Ixodes* sp. (probably *cookei*), *Dermacentor andersoni, D. variabilis* and *D. albipictus*). In addition, a mite (*Ursicoptes americanus*) was reported from a captive black bear in Europe, and numerous fleas (*Orchopeas caedens*) were found in the den of a wild black bear in Minnesota a few days after the den was abandoned.

Parasites of Brown-grizzly Bears in North America

Fifteen parasites have been reported from brown-grizzly bears in North America. These include a trematode (*Echinostoma revolutum*), three cestodes (*Taenia krabbei, Diphyllobothrium latum* and *D. ursi*), six nematodes (*Baylisascaris transfuga, Cyathostoma bronchiale, Uncinaria yukonensis, U. rauschi, Dirofilaria ursi* and *Trichinella spiralis*), and five arthropods (*Chaetopsylla setosa, C. tuberculaticeps ursi, Thrassis spenceri, Pulex* sp. and *Dermacentor andersoni*). Eleven of these species also were reported from wild black bears.

Parasites of Brown Bears in Eurasia

Twenty-eight parasites have been reported from brown bears from the Old World. These include two protozoans (*Eimeria ursi* and *Isospora fonsecai*), a trematode (*Nanophyetus salmincola*), and presumably the rickettsia-like agent of Elokomin fluke fever carried by *N. salmincola*, five cestodes (*Diphyllobothrium latum, D. cordatum, Taenia ursina, Cysticercus cellulosae* and *Bothriocephalus ursi*, eleven nematodes (*Nematoideum ursi, Dochmius ursi, Spiroptera ursi, G. contortum, Baylisascaris transfuga, B. multipapillata, Toxocara canis, T. mystax, Uncinaria stenocephala, Dirofilaria ursi* and *Trichinella spiralis*), and eight arthropods (*Chaetopsylla t. tuberculaticeps, Trichodectes p. pinguis, Ixodes persulcatus, I. ricinus, Dermacentor silvarum, D.* cf. *venustus, Haemaphysalis japonicus douglasi* and *Sarcoptes scabiei*).

Parasites of Himalayan Black Bears

Thirteen parasites have been reported from Himalayan black bears in southeast Asia or Japan. These include a trematode (*Dicrocoelium lanceatum*), a cestode (*Taenia* sp.), five nematodes (*Baylisascaris transfuga, Ancylostoma malayanum, Dirofilaria ursi, Trichinella spiralis*, and unidentified nematodes from the bronchi), six ticks (*Ixodes persulcatus, Haemaphysalis formosensis, H. hystricis, H. japonicus douglasi, Dermacentor silvarum* and *D. auratus*), and unidentified lice. In addition, a louse (*Trichodectes p. pinguis*) was reported from a Himalayan black bear in the Paris Zoo.

Parasites of Sun Bears

Five parasites have been reported from sun bears in southeast Asia. These include a cestode (*Pentorchis arkteios*), a hookworm (*Ancylostoma malayanum*), and three ticks (*Haemaphysalis semermis, H. leachi* and *H. hystricis*).

Parasites of Sloth Bears

Five nematodes (*Baylisascaris transfuga, B. melursus, Ancylostoma malayanum, A. brasiliense* and *A. caninum*) were reported from sloth bears in India.

Parasites of Unidentified Bears

Seven ticks (*Hyalomma aegyptium, H. hussaini, H. monstrossum, Rhipicephalus sanguineus, R. haemaphysaloides, Haemaphysalis spinigera* and *Dermacentor compactus*) were listed from unidentified bears from India. Five other parasites from unidentified bears include two protozoans (*Babesia* sp. and *Leishmania* sp.), the larval form of a cestode (*Echinococcus granulosus*), a nematode (*Dioctophyma renale*), and a tick (*Haemaphysalis bispinosa*).

PARASITISM OF BEARS DURING HIBERNATION

Bears that live in northern latitudes hibernate during cold seasons when food is scarce (Folk *et al.* 1976). In Alaska and northern Canada, denning begins as early as September and ends as late as mid-May (Rausch 1961, Choquette *et al.* 1969). During hibernation, bears usually do not eat, and the metabolic rate is reduced markedly (Maxwell *et al.* 1972, Folk *et al.* 1976). Several authors (Rush 1932, Rausch 1954, 1961, Bromlei 1965, Choquette *et al.* 1969, Rogers 1975) have presented evidence that intestinal parasites that derive nourishment directly from the ingesta of the host pass out of the alimentary canal before hibernation begins. Rausch (1961) stated 'Ascarids may be found in considerable numbers in bears during the fall, but they are evidently lost prior to denning (unpublished data).'

Choquette *et al.* (1969) found *B. transfuga* in 16 of 21 grizzly bears examined in north-western Canada between mid-May and mid-October but found ascarids in only one of five grizzlies examined during November through early May. The infected bear probably had not begun its winter sleep when killed in December and still may have been feeding on frozen salmon.

Rogers (1975) collected 962 fecal droppings throughout the year from wild black bears in Minnesota. Ascarids (*Baylisascaris transfuga*) were found only in droppings passed on 9 September, 6 October and 16 October. The bear that passed ascarids on 9 September began denning ten days later.

Rush (1932) obtained strobilae of *Diphyllobothrium* from droppings of three of five black bears treated with an anthelmintic medicine in late summer. He obtained no strobilae from five bears treated similarly but from a different area in October. Rausch (1954) reiterated reports from a professional hunter, noting that each of 11 brown bears killed on Kodiak Island in September contained cestodes, but that none was found in six bears killed after 20 October. Five bears killed during June before they could become reinfected by eating salmon also appeared to be free of cestodes. On the other hand, Rausch (1954) also reported that, according to a biologist on Kodiak Island, an old bear killed on 26 December contained approximately 500 cestodes.

Some *Diphyllobothrium* may survive through winter by means of destrobilization (Rausch 1961). *Diphyllobothrium* with only slightly developed strobilae were found in the intestine of a female black bear killed at its den in Alaska on 26 February (Rausch *op. cit.*).

Helminths that do not derive nourishment directly from the ingesta of the host apparently are not lost during denning. Rausch (1961) and Choquette *et al.*

(1969) found hookworms (*Uncinaria yukonensis*) in denning black and grizzly bears, and Rogers (1975) collected winter ticks (*Dermacentor albipictus*) and adult *Dirofilaria ursi* from denning black bears. However, Rogers and Seal (unpublished data) found that microfilariae were much less abundant in blood samples taken from bears during the summer.

Life cycles of fleas (*Chaetopsylla*) that infest bears have yet to be documented but probably are tied to the denning habits of their hosts. Fleas typically leave their host as adults to lay eggs in bedding material. There the eggs hatch, and the young develop and wait for a suitable host. For fleas to build up a high population on a given host, the host must return to beds where fleas have bred. Perhaps one reason that few black bears carry heavy populations of fleas is that the black bear tends to use a different den each winter and a different bed each night during the summer (unpublished data). However, a large population of fleas (*Orchopeas caedens*) was found in the recently abandoned den of a young bear in Minnesota (unpublished data). Presumably if certain fleas reach the den of a bear, they can build large populations during the denning period which is longer than six months in many cases.

SUMMARY

At least 77 species of parasites have been reported from bears, but there is no evidence that parasites are a common cause of mortality. Pathological effects usually are not apparent in parasitized bears (Horstman 1949, Rausch 1955, Jonkel and Cowan 1971, Poelker and Hartwell 1973). However, in two exceptional cases, captive bears died because helminths became located in unusual sites where they occluded passageways (Mozgovoi 1953, Rausch 1955, Poelker and Hartwell 1973). Four heavily parasitized wild bears in poor condition have been reported (Rush 1932, Chandler 1950, Martin 1950, Jonkel and Cowan 1971), but in each case it was impossible to distinguish cause from effects, i.e. whether the poor condition was caused by parasites or whether parasites took over because the bear already was weakened. In the latter situation, parasitism easily could lead to further deterioration of health.

Parasites of bears from northern regions apparently are well adapted to the hibernating and fasting habits of their hosts. Intestinal parasites that derive nourishment directly from materials ingested by the host usually pass out of the alimentary canal before hibernation begins. Further study is needed to determine whether or not the demands of parasites that derive nourishment from blood or other body fluids are reduced while the host is hibernating.

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REFERENCES

ANDERSON, R. C. 1952. Description and relationships of *Dirofilaria ursi* Yamaguti, 1941, and a review of the genus *Dirofilaria* Raillet and Henry, 1911. *Trans. Royal Canadian Inst.* **29**(2): 35-65.

BABBOTT, F. L. and DAY, B. W. 1968. A survey of trichinosis among black bears in Vermont. *Arch. Environ. Health* **16**: 900-902.

BATSCH, A. J. G. 1786. *Naturgeschichte der Bandwurmgattung überhaupt und ihrer Arten insbesondere, nach den neuem Beobachtungen in einem systematischen Auszuge.* Halle. 298 pp.

BAYLIS, H. A. and DAUBNEY, R. 1922. Report on the parasitic nematodes in the collection of the zoological survey of India. *Mem. Indian Mus.* **7**: 263-347.

BIOCCA, E. 1951. On *Ancylostoma braziliense* (de Faria, 1910) Morphological differentiation from *A. ceylanicum* (Looss, 1911). *J. Helminthol.* **25**: 1-10.

BOCKUM DOLFFS, C. von. 1888. Trichinen in Barenshinken. Tiermedicinische Rundschau mit besonderer Berücksichtigung der Vergleichenden Pathologie und des Gesammten. *Veterinar-Medicinalwesens* **2**: 13.

BOHM, J. 1913. Trichinen bei Eisbären. *Z. Fleisch-Milchhyg.* **23**: 3.

BROMLEI, F. G. 1965. *Bears of the south far-eastern USSR.* (Translated from Russian.) Available from the U.S. Dept. of Commerce, Springfield, Va. 138 pp.

BROWN, H. W. 1967. Trichonosis. In *Textbook of Medicine,* ed. 12, P. B. Beeson and W. McDermott eds. Philadelphia, W. B. Saunders Co. pp. 398-400.

BROWN, M., CRONK, B., de SINNER, F., GREER, J. E., GIBBONS, J. E. and KUITUNEN-EKBAUM, E. 1949. A note on trichinosis in animals of the Canadian Northwest Territories. *Canadian J. Public Health* **40**: 20-21.

BROWN, M., SINCLAIR, R. E., CRONK, L. B., CLARK, G. C. and KUITUNEN-EKBAUM, E. 1948. Intestinal parasites of Eskimos on Southampton Island, Northwest Territories, a preliminary survey. *Canadian J. Public Health* **39**: 451-454.

BRUSILOVSKIY, I. Z. 1957. Gruppovoe zabolevanie trihinellozom na krajnem Severe. *Medskaya Parazit.* **26**: 161.

BURMEISTER, K. H. K. 1838. Handbuch der Entomologie **2**: 418-443.

CAMERON, T. W. M. 1960. Trichinosis in Canada. *Wiad. Parazytol.* **6**: 304.

CANAVAN, W. P. N. 1929. Nematode parasites of vertebrates in the Philadelphia Zoological Garden and vicinity. *Parasitology* **21**: 63-102.

CHANDLER, A. C. 1950. *Gongylonema pulchrum* in the black bear, *Euarctos americanus,* and the probable synonymy of *G. pulchrum* Molin, 1857, with *G. ursi* (Rudolphi, 1819). *J. Parasitol.* **36**: 86-87.

CHOQUETTE, L. P. E. 1952. *Dirofilaria desportesi* sp. nov., a filariid from the black bear in Canada. *Canadian J. Zool.* **30**: 344-351.

CHOQUETTE, L. P. E., GIBSON, G. G. and PEARSON, A. M. 1969. Helminths of the grizzly bear, *Ursus arctos* L., in northern Canada. *Canadian J. Zool.* **47**: 167-170.

CONNELL, F. H. 1949. Trichinosis in the Arctic: a review. *Arctic* **2**: 98-107.

COOLEY, R. A. 1938. The genera *Dermacentor* and *Otocentor* (Ixodidae) in the U.S., with studies in variation. *U.S. Natl. Inst. of Health Bull.* **171**: 1-89.

COUTURIER, M. A. J. 1954. *L'Ours Brun.* Grenoble, France: Cours J. Jaurès.

DAHLEN, J. H. 1959. Black bear distribution and harvest. Wisconsin Dept. Nat. Resour. Job VI-B Compl. Rep. Project W-79-R-5, 11 pp.

DIESING, C. M. 1851. *Systema helminthum. Vol. 2.* Vienna. 591 pp.

DODDS, D. G., MARTELL, A. M. and YESCOTT, R. E. 1969. Ecology of the American dog tick, *Dermacentor variabilis* (Say), in Nova Scotia. *Canadian J. Zool.* **47**: 171-181.

DOEGE, T. C., THIENPRASIT, P., HEADINGTON, J. T., PONGPROT, B. and TARAWANICH, S. 1969. Trichinosis and raw bear meat in Thailand. *The Lancet* **7592**: 459-461.

DUJARDIN, F. 1845. *Histoire naturelle des helminthes ou vers intestinaux.* Paris. 654 pp.

EDWARDS, M. A. and HOPWOOD, A. T. 1966. *Nomenclator Zoologicus* VI. London: The Zoological Society of London. 329 pp.

EWING, H. E. and FOX, I. 1943. The fleas of North America. *USDA Misc. Publ.* No. 500. 143 pp.

FAIN, A. and JOHNSTON, D. E. 1970. Un nouvel acarien de la famille Audycoptidae chez l'ours noir *Ursus americanus* (Sarcoptiformes). *Acta Zool. Pathol. Antverpiensa* **50**: 179-181.

FARRELL, R. K. 1968. Elokomin fluke fever: a rickettsial disease of bears and canidae. Typewritten report in files of Washington Dept. of Game, Olympia, Washington. 5 pp.

FAY, F. H. 1960. Carnivorous walrus and some arctic zoonoses. *Arctic* **13**: 111-122.

FILIMONOVA, L. V. 1966. Distribution of nanophyetosis in the territory of the Soviet Far East. *Trudy Gel'mintol.* Lab. Akad. Nauk, USSR **17**: 240-244.

FOLK, G. E., LARSON, A. and FOLK, M. A. 1976. Physiology of hibernating bears. This volume Paper 38.

FOOT, A. W. 1865. On entozoa from some animals in the Royal Zoological Gardens, Phoenix Park, Dublin. *Nat. Hist. Soc. Dublin, Proc.* **4**: 201-207.

GMELIN, J. F. 1790. *Caroli à Linné. Systema naturae,* Tom. 1. Pars 6 (Vermes). Leipzig.

GRJUNER, S. A. 1915. Trihinoz dikih zverej soderjimyh v nevole. *Arkh. Vet. Nauk.* **7**: 745-752.

GUBANOV, N. M. 1964. *Gel'mintofauna Promyslovykh Mlekopitaiushchikh Iakutii* (Helminthfauna of economically important mammals of Iakutia). Moscow. Akad. Nauk SSSR, Sibirsk. Otdel., Iakutsk. Fil. 164 pp.

HAIR, J. D. and MAHRT, J. L. 1970. *Eimaria albertensis* n. sp. and *E. borealis* n. sp. (Sporozoa: Eimeridae) in black bears *Ursus americanus* from Alberta. *J. Protozool.* **17**: 663-664.

HARBOTTLE, J. E., ENGLISH, D. K. and SCHULTZ, M. G. 1971. Trichinosis in bears in northeastern United States. *HSMHA Health Rep.* **86**: 473-476.

HATLER, D. F. 1967. Some aspects in the ecology of the black bear (*Ursus americanus*) in interior Alaska. Unpublished MS thesis, Univ. Alaska, College, 111 pp.

HENSHAW, H. W. and BIRDSEYE, C. 1911. The mammals of Bitter Root Valley, Montana, in their relation to spotted fever. *U.S. Bur. Biol. Surv. Circ.* **82**: 1-24.

HOLLAND, G. P. 1949. The Siphonaptera of Canada. Canadian Dept. Agr., Publ. 817, Tech. Bull. 70. 306 pp.

HOOGSTRAAL, H., TRAPIDO, H. and KOHLS, G. M. 1966. Southeast Asian *Haemaphysalis* ticks (Ixodoidea, Ixodidae). *H.* (*Kaiseriana*) *papuana nadchatrami* ssp. n. and redescription of *H.* (*K.*) *semermis* Neumann. *J. Parasitol.* **51**: 433-451.

HOPKINS, G. H. E. 1954. Notes on some Mallophaga from bears. *The Entomologist* 87(1094): 140-146.

HOPKINS, G. H. E. and ROTHSCHILD, M. 1956, *An illustrated catalogue of the Rothschild Collection of Fleas* (*Siphonaptera*) *in the British Museum.* London: The Trustees of the British Museum. 455 pp.

HORSTMAN, B. N. 1949. A survey of parasites of the black bear in southwestern Colorado. Unpublished MS thesis, Colorado A & M, Fort Collins, 60 pp.

HOSFORD, G. N., STEWART, M. A. and SUGARMAN, E. I. 1942. Eyeworm (*Thelazia californiensis*) infection in man. *Arch. Ophthalmol.* **27**: 1165-1170.

HUBBARD, C. A. 1947. *Fleas of western North America.* Ames: The Iowa State College Press, 533 pp.

HUTYRA, F., MAREK, J. and MANNINGER, R. 1946. *Special pathology and therapeutics of the diseases of domestic animals. Vol. 2.* Chicago: Alexander Eger, Inc.

JAROS, Z., VALENTA, Z. and ZAJICEK, D. 1966. A list of helminths from the section material of the Zoological Garden of Prague in the Years 1954-1964. *Helminthologia* **7**: 281-290.

JELLISON, W. L. and GOOD, N. E. 1942. Index to the literature of Siphonaptera of North America. *Natl. Inst. Health Bull.* No. 178. 193 pp.

JELLISON, W. L. and KOHLS, G. M. 1939. Siphonaptera: a list of Alaskan fleas. *U.S. Public Health Serv. Rep.* **54**: 2020-2023.

JONKEL, C. J. and McT. COWAN, I. 1971. The black bear in the spruce-fir forest. *Wildlife Monogr. No. 27.* 57 pp.

KHERA, S. 1951. *Toxascaris melursus* n. sp. (sub-family Ascarinae Travassos, 1913: family Ascaridae Cobbold, 1864: Nematoda) from the sloth bear, *Melursus ursinus* Shaw. *Indian J. Helminthol.* **3**: 67-71.

KING, J. M., BLACK, H. C. and HEWITT, O. H. 1960. Pathology, parasitology, and hematology of the black bear in New York. *New York Fish and Game J.* **7**: 99-111.

KOZEMJAKIN, N. G. 1959. K voprosu o trihinelleze belyh medvedej. *Sb. Rabot Leningrad Vet. Inst.* **16**: 76-79.

KREIS, H. A. 1938. Beiträge zur Kenntnis parasitischer Nematoden. VI. Parasitische Nematoden aus dem Zoologischen Garten in Basel.—*Zentralbl. Bakter. Jena. Orig.* **141**: 279-304.

LANDOIS, H. 1877. Ueber den Bären-Grubenkopf, *Bothriocephalus ursi* n. sp. *Jahrbuch westfalischer Province. Verhandl. Wiss. Kunst. Munster* **18**: 281-290.

LANE, C. 1916. The genus *Ancylostoma* in India and Ceylon. *Indian J. Med. Res.* **4**: 74-92.

LEIPER, R. T. 1938. Trichinosis in Arctic animals. *Proc. Zool. Soc. London,* **108** (Ser. C): 13-14.

LEVINE, N. D. 1968. *Nematode parasites of domestic animals and of man.* Minneapolis: Burgess Publishing Co. 600 pp.

LINSTOW, O. F. B. von. 1878. *Compendium der Helminthologie.* Ein Verzeichnis der bekannten Helminthen die frei oder in tierischen Körper leben, geordnet nach ihren Wohntieren, unter Angabe der Organe, in denen sie gefunden sind, und mit Beifügung der Literaturquellen. Hannover. 382 pp.

LINSTOW, O. F. B. von. 1893. Zur Anatomie und Entwicklungsgeschichte der Tanien. *Arch. Mikroskop. Anat. Entwicklungsmech.* **42**: 442-459.

LUKASHENKO, N. P., VOL'FSON, A. G., ISTOMIN, V. A. and CHERNOV, V. Yu. 1971. Trichinellosis of animals of Chukotka Peninsula. *Parasitol. Polonica* **19**(13): 151-161.

MADSEN, H. 1961. The distribution of *Trichinella spiralis* in sledge dogs and wild mammals in Greenland under a global aspect. *Medd. Grøn.* **159**: 1-124.

MARCHIONINI, A. 1967. Epidemiologie der Hautleishmaniose. *Dermatol. Int.* **6**(3): 149-151.

MARTIN, W. E. 1950. A severe larval cestode infection in the California black bear. *J. Entomol. Zool.* **42**(2): 16-19.

MAXWELL, R. K., ROGERS, L. L. and BRANDER, R. B. 1972. The energetics of wintering bears (*Ursus americanus*) in northeastern Minnesota. *Bull. Ecol. Soc. Amer.* **53**(2): 21.

McINTOSH, A. 1939. A new nematode, *Ascaris schroederi,* from a giant panda, *Ailuropoda melanoleuca. Zoologica* **24**: 355-357.

MEGGITT, F. J. 1924. *The cestodes of mammals.* London. 282 pp.

MEGGITT, F. J. 1927. On cestodes collected in Burma. *Parasitology* **19**: 141-153.

MOLIN, R. 1860. Trenta specie di nematoidi. Akad. der Wiss. in Wien. Math.—*Naturwiss. Cl. Sitzungsber.* **40**: 331-358.

MOZGOVOI, A. A. 1953. Essentials of Nematodology. Vol. 2. Ascaridata of animals and man and the diseases caused by them. (Trans. from Russian.) Jerusalem: Israel Program for Scientific Translations. 390 pp.

NEUMANN, L. G. 1913. Notes sur les Mallophages, III. *Arch. Parasitol.* **15**: 608-634.

OKOSHI, S., TAKASHIO, M. and NAKAGAWA, S. 1962. *Toxascaris transfuga* (Rudolphi, 1819) Baylis et Daubney 1922, found in captive bears in Japan. *Japanese J. Vet. Sci.* **24**: 151-156.

OLSEN, O. W. 1968. *Uncinaria rauschi* (Strongyloidea: Nematoda), a new species of hookworms from Alaskan bears. *Canadian J. Zool.* **46**: 1113-1117.

OSHMARIN, P. G. 1963. Paraziticheskie chervi mlekopitayushchikh i ptits Primorskogo Kraya. Izd. AN SSSR. Moscow.

OVSJUKOVA, N. I. 1965. Rasprostranenie trihinelleza sredi zhivotnykh Chukotskogo Poluostrova. *Mat. Nauch. Konf. VOG,* **2**: 178-182.

PETROV, A. M. and KROTOV, A. I. 1954. The discovery of *Dirofilaria ursi* Yamaguti, 1941, in the subcutaneous tissue of a bear. *Tr. Gel'mintol.* Lab. Akad. Nauk SSSR **7**: 335-336.

POELKER, R. J. and HARTWELL, H. D. 1973. Black bear of Washington. *Washington State Game Dept. Biol. Bull. No. 14.* 180 pp.

RAUSCH, R. L. 1954. Studies on the helminth fauna of Alaska. XXI. Taxonomy, morphological variation, and ecology of *Diphyllobothrium ursi* n. sp. provis. on Kodiak Island. *J. Parasitol.* **40**: 540-563.

RAUSCH, R. L. 1955. Unusual pathogenicity of *Diphyllobothrium* sp. in a black bear. *Proc. Helminthol. Soc. Washington* **22**(2): 95-97.

RAUSCH, R. L. 1961. Notes on the black bear, *Ursus americanus* Pallas, in Alaska, with particular reference to dentition and growth. *Z. Säugetierk.* Bd. 26, H. 2: 65-128.

RAUSCH, R. L. 1968. Personal communication to L. P. E. Choquette.

RAUSCH, R. L. 1970. Trichinosis in the Arctic. In *Trichinosis in man and animals,* S. E. Gould, ed. Springfield, Ill.: Charles C Thomas, publisher. Pp. 348-373.

RAUSCH, R. L., BABERO, B. B., RAUSCH, R. V. and SCHILLER, E. L. 1956. Studies on the helminth fauna of Alaska. XXVII. The occurrence of larvae of *Trichinella spiralis* in Alaskan mammals. *J. Parasitol.* **42**: 259-271.

ROGERS, L. L. 1975. Parasites of black bears of the Lake Superior Region. *J. Wildl. Diseases* **11**: 189-192.

ROGERS, L. L. and SEAL, U. S. Annual rhythm of microfilariae in the black bear (in prep).

ROSELLE, H. A., SCHWARTZ, D. T. and GEER, F. G. 1965. Trichinosis from New England bear meat. *New England J. Med.* **272**: 304-305.

ROTH, H. 1950. Nouvelles expériences sur la trichinose avec considérations spéciales sur son existence dans les régions arctiques. *Bull. Off. Int. Epizoot.* **34**: 197-220.

ROTHSCHILD, N. C. 1902. Some new Nearctic fleas. *Entomol. Rec. J. Var.* **14**: 62.

ROTHSCHILD, N. C. 1906. Three new Canadian fleas. *Canadian Entomol.* **38**: 321-322.

RUDOLPHI, C.A. 1810. Entozoorum sive vermium intestinalium historia naturalis. II. Pars. 2. 386 pp.

RUDOLPHI, C.A. 1819. Entozoorum Synopsis cui Accedunt mantissa Duplex et Indices Locupletissimi. Berolini. 811 pp.

RUKHLIADEV, D.P. and RUKHLIADEVA, M.P. 1953. Kizucheniiu Gel'mintofauny Burogo Medvedia. *Raboty Gel'mint. k 75-let. Akad. K.I. Skriabina.* Moscow, Akad. Nauk SSSR. Pp. 598-602.

RUSH, W.M. 1932. *Diphyllobothrium latum* in bears. *J. Mamm.* **13**: 274-275.

SADYKHOV, I.A. 1962. Helminths of fur-bearing animals of Azerbaidzhan. (In Azerbaidzhani.) Baku. (Original not seen.)

SAKAGUTI, K. 1960. A flea, *Chaetopsylla tuberculaticeps,* from a brown bear of Hokkaido. Studies on the Japanese Siphonaptera IX. *Japanese J. Sanit. Zool.* **11**: 137-145.

SARICH, V.M. 1973. The giant panda is a bear. *Nature* **245**: 218-220.

SCOTT, J.W. 1932. *Diphyllobothrium cordatum* (Leuckart, 1863) in bears of Yellowstone Park, Wyoming. *J. Parasitol.* **19**: 162-163.

SIMMS, B.T., DONHAM, C.R., SHAW, J.N. and McCAPES, A.M. 1931. Salmon poisoning. *J. Amer. Vet. Med. Assoc.* **78**: 181-195.

SKINKER, M.S. 1931. *Diphyllobothrium latum* from bears in North America. *J. Parasitol.* **18**: 55.

SOULSBY, E.J.L. 1968. *Helminths, arthropods, and protozoa of domesticated animals, 6th ed.* Baltimore: The Williams and Wilkins Company.

SPRENT, J.F.A. 1950. Observations on the life history of *Ascaris columnaris. J. Parasitol.* **36**: suppl. p. 29.

SPRENT, J.F.A. 1951. Observations on the migratory activity of the larvae of *Toxascaris transfuga* (Rud, 1819) Baylis & Daubney 1922. *J. Parasitol.* **37**: 326-327.

SPRENT, J.F.A. 1968. Notes on *Ascaris* and *Toxascaris,* with a definition of *Baylisascaris* gen. nov. *Parasitology* **58**: 185-199.

STICKLEY, A.R. 1961. A black bear tagging study in Virginia. *Proc. Ann. Conf. S.E. Assoc. Game Fish Comm.* **15**: 43-54.

STILES, C.W. and BAKER, C.E. 1935. Key-catalogue of parasites reported for Carnivora (cats, dogs, bears, etc.) with their possible public health importance. *U.S. Natl. Inst. Health Bull.* **163**: 913-1223.

THORBORG, N.B., TULINIUS, S. and ROTH, H. 1948. Trichinosis in Greenland. *Acta Pathol.* **25**: 778-794.

THORSHAUG, K. and ROSTED, A. 1956. Researches into the prevalence of trichinosis in animals in arctic and antarctic waters. *Nord. Vet. Med.* **8**: 115-129.

TOSCHEV, A.P. 1963. Trikhinellez pushnykh zverei v zone Vostochnoi Sibiri. *Trudy Vsesoiuz. Inst. Gel'mint. im. Akad. K.I. Skriabina* **10**: 53-55.

VERGEER, T. 1930. Causes underlying increased incidence of broad tapeworm in man in North America. *J. Amer. Med. Assoc.* **95**: 1579-1581.

WAKEFIELD, G.C. 1972. A summary of the black bear population characteristics in Pennsylvania. In *Bears—Their Biology and Management,* S. Herrero, ed. Morges, IUCN Publ. new series **23**: 43-52.

WALKER, A. T. 1932. Trichiniasis—Report of an outbreak caused by eating trichinous bear meat in the form of 'jerky'. *J. Amer. Med. Assoc.* **98**: 2051-2053.

WAND, M. and LYMAN, D. 1972. Trichinosis from bear meat. *J. Amer. Med. Assoc.* **220**: 245-246.

WARD, H. B. 1927. A study on the life history of the broad fish tapeworm in North America. *Science* **66**(1704): 197-198.

WARDLE, R. A. and McLEOD, J. A. 1952. *The zoology of tapeworms.* Minneapolis: The University of Minnesota Press. 780 pp.

WERNECK, S. 1948. *Os malofagos de mamiferos,* Part 1. 243 pp.

WOLFGANG, R. W. 1956. *Dochmoides yukonensis* sp. nov. from the brown bear (*Ursus americanus*) in the Yukon. *Canadian J. Zool.* **34**: 21-27.

WORLEY, D. E., FOX, J. C. and WINTERS, J. B. 1974. Prevalence and distribution of *Trichinella spiralis* in carnivorous mammals in the United States Northern Rocky Mountain Region. In *Trichinellosis: Proc. 3rd Int. Conf. on Trichinellosis,* C. W. Kim ed. New York: Intext Educational Publishers. Pp. 597-602.

WORLEY, D. E., FOX, J. C., WINTERS, J. B., JACOBSON, R. H. and GREER, K. R. 1976. Helminth and arthropod parasites of grizzly and black bears in Montana and adjacent areas. This volume Paper 45.

YAKIMOFF, W. L. and MATSCHOULSKY, S. N. 1935. As coccidioses dos ursos, lobos e caes selvagens. *Arch. Inst. Biol.* **6**: 171-177.

YAKIMOFF, W. L. and MATSCHOULSKY, S. N. 1940. Koktsikii zhivotnykn zoologicheskogo sada Tashkent. *Yarazimologecheski Sbornik Zen AN SSSR* 13.

YAMAGUTI, S. 1941. Studies on the helminth fauna of Japan. Part 35. Mammalian nematodes, 2. *Japanese J. Zool.* **9**: 409-439.

ZIMMERMANN, W. J. and HUBBARD, E. D. 1969. Trichiniasis in wildlife of Iowa. *Amer. J. Epidemiol.* **90**: 84-92.