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Seropositivity for Different Pathogens in Polar Bears (*Ursus maritimus*) from Barents Sea Islands

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Abstract—Analysis of serum prevalence of antibodies to six pathogens was performed in 26 polar bears from the Barents Sea population. Animals seropositive for the viruses of pseudorabies, canine distemper, and influenza A, *Dirofilaria* sp., *Trichinella spiralis*, and *Toxoplasma gondii* were revealed, with prevalence of antibodies to *T. spiralis* being the highest. Most of them were adult bears, while cubs (under 1 year of age) proved to be seronegative for all pathogens.

Keywords: seropositivity, polar bear, canine distemper, *Trichinella spiralis, Toxoplasma gondii*

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INTRODUCTION

The polar bear (*Ursus maritimus*), the largest land carnivore, has a circumpolar distribution and is a top predator in the Arctic. A characteristic feature of the species is that animals travel over long distances, mainly in the ice period. This habit and severe conditions in the species range make it difficult to evaluate the abundance and dynamics of natural populations and the main factors limiting their development. Infectious diseases are one of these factors.

The prevalence of various diseases among polar bears has been analyzed by a number of specialists (Follmann et al., 1996; Oksannen et al., 2009), with the size of test samples reaching 200–500 animals. They have been captured in the course of intensive experimental research carried out on the territories of Canada, the United States, Norway, Greenland, and Russia, i.e., almost all countries where the polar bear is currently found. In Russia, basic serological studies were performed on the Chukchi–Alaska population (Follmann et al., 1996), and polar bears from the Kara Sea were surveyed for seropositivity for certain pathogens (Rah et al., 2005). In the Barents Sea, such studies were performed mainly in Spitsbergen and east of it (Tryland et al., 2005). The results provided evidence for considerable geographic differences in the distribution of pathogens.

The purpose of this study was to estimate serum prevalence of antibodies to a set of pathogens in polar bears of the Barents Sea population living in the vicinity of Franz Josef Land.

The set of test pathogens included the viruses of pseudorabies, canine distemper, and influenza A and parasites *Toxoplasma gondii, Dirofilaria ursi*, and *Trichinella spiralis*. The canine distemper virus (CDV) is contagious to animals from all families of the order Carnivora, including bears, and can cause high mortality in natural populations (Roelke-Parker et al., 1996). The virus of pseudorabies, also known as Aujeszky's disease, is a swine herpesvirus highly widespread among wild boars (*Sus scrofa*) in Europe (Lari et al., 2006), but it is also contagious to carnivores (Schultze et al., 1986; Salvelli and Zanin, 1996), including polar bears (Banks et al., 1999). The disease in carnivores progresses acutely, is accompanied by hyperexcitability and characteristic severe itching of the muzzle and certain body and limb areas, and has lethal outcome. Influenza A viruses cause a number of dangerous diseases, including swine flu and avian flu. Carnivores are vulnerable to highly pathogenic avian flu and can excrete the virus into the environment (Reperant et al., 2008). Toxoplasmosis caused by the protozoan parasite *Toxoplasma gondii* is often responsible for abortion, intrauterine fetal death, neonatal mortality, and disorders of central nervous, lymphatic, and endocrine systems in adult carnivores (Meli et al., 2009). *Dirofilaria ursi*, a helminth parasitizing species of the bear family, is closely related to *D. repens* and *D. immitis* infecting other carnivores. Adult *D. ursi* worms live in the heart of the animals (Petrov and Krotov, 1954; Oshmarin, 1963). The helminth *Trichinella spiralis* is the etiological agent of trichinosis, the disease that affects mainly carnivorous and omnivorous

mammals (Bourque, 1985) and focally occurs on all continents except Australia.

MATERIALS AND METHODS

Polar bears were captured in Franz Josef Land (April, September, and October 2010 and October–November 2011) and Novaya Zemlya (June 2011, one bear) according to the Russian Arctic Polar Bear Research Program. They were immobilized by drugs administered with a DAN-Inject JM-25 dart gun either from a blind over bait (pieces of rotten fish or meat) or after a chase over tundra on an off-road vehicle. The darts contained a combination of medetomidine (Domitor; Orion Corporation, Finland) and tiletamine + zolazepam (Zoletil; Virbak, France) at doses of 40 μg/kg and 3 mg/kg body weight. Blood samples were taken from the sublingual vein with a syringe, cooled for 60–90 min, centrifuged at 6000 rpm for 20 min, and aliquots of blood plasma were collected in Eppendorf tubes. The tubes were labeled, frozen at –20°C, and stored before analysis. When the procedure was completed, the animal was injected with 10–20 mg of atipamezole (Antisedan, Pfizer), an antidote to medetomidine.

Serological analysis was performed at the Chernogolovka Experimental Research Station (Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences). All samples were tested for the presence of antibodies to all aforementioned pathogens.

Analysis for antibodies to canine distemper virus was performed using commercial ELISA kits (Chema-Medica, Russia), quantifying the concentration of antibodies according to the manufacturer's protocol. Antibodies to *T. gondii* were also detected by ELISA with kits from Chema-Medica, but without quantitative evaluation (the cut-off variant). The same variant of ELISA with kits from Narvac (Russia) was used to detect antibodies to influenza A and pseudorabies viruses. Antibodies to *T. spiralis* were detected by ELISA with kits from IVT (France), and antibodies to *Dirofilaria* sp., by rapid immunochromatographic tests (BVT, France).

A total of 26 polar bears were captured and examined to determine their sex and age. Three age groups were distinguished: cubs (<1 year of age, 7 ind.), juveniles (1–2 years, 3 ind.), and adults (>2 years, 16 ind.). For statistical analysis the cubs and juveniles were pooled into one group (young animals). Group comparisons for prevalence of antibodies to a given pathogen were made using a test for comparing proportions. The number of tests (n) is indicated in the text only if different from the total number of adult and young animals examined (16 and 10 ind., respectively).

RESULTS

Three out of 26 polar bears (12%, $n = 25$), two adults (13.3%, $n = 15$) and one yearling (10%) were seropositive for canine distemper virus. Therefore, no difference in the proportion of seropositive individuals between the adult and young groups was revealed, although all seven cubs (<1 year of age) were negative for this pathogen.

Antibodies to influenza A virus were detected in two bears (8%, $n = 25$), both of them adult (12.5%). All juveniles and cubs ($n = 9$) were seronegative for the virus.

Two out of 21 bears (9.5%) tested for pseudorabies virus contained antibodies to this pathogen. Since both of them were adult, the proportion of seropositive animals in this group reached 15.4% ($n = 13$). All young animals were seronegative.

Two adult bears were seropositive for *T. gondii* (7.4% of the total sample and 12.5% of the adult group). According to the statistical test, however, the proportion of such animals did not differ between the adult and juvenile groups.

One bear proved to be seropositive for *Dirofilaria* sp. (5.3%, $n = 19$). This was an adult animal (9.1%, $n = 11$); all young bears were seronegative for this helminth.

Antibodies to *T. spiralis* were detected in 12 bears (60%, $n = 20$), ten adults (90.9%, $n = 11$) and only two juveniles (22.2%, $n = 9$), with the difference between the groups being statistically significant ($p < 0.01$). Both juveniles (>1 year of age) were from the same litter, and their mother was also seropositive for *T. spiralis*. However, none of the cubs contained antibodies to this pathogen.

DISCUSSION

Large-scale serological surveys of polar bears for various pathogens have been made over the greater part of the species range. However, they have not covered the Barents Sea (the area of our study), except for its western part (Follmann et al., 1996; Oksannen et al., 2009). Although our data are based on analysis of blood samples from only 26 animals, they can help to achieve an insight into the prevalence of individuals affected by pathogens in the Barents Sea population of polar bears.

The proportion of polar bears seropositive for canine distemper virus (12%) is roughly similar to that in the Spitsbergen population (8.3%) (Tryland et al., 2005) but significantly lower than in other surveyed regions, e.g., 17.0% in northern Canada (Cattet et al., 2004), 30.6% in Hudson Bay, and 35.5% in the Chukchi Peninsula and Alaska (Follmann et al., 1996). Thus, it is likely that polar bears from the Barents–Kara population least frequently come in contact with carriers of this pathogen. Since most morbilliviruses isolated from the tissues of polar bears are similar to those of terrestrial mammals (Follmann et al., 1996), it appears that polar bears acquire the virus mainly from polar foxes and domestic dogs, with the low tem-

peratures of the Arctic facilitating long-term survival of excreted virus in the environment.

The proportion of polar bears seropositive for *T. gondii* in Franz Josef Land (<10%) is approximately the same as in the western part of the Barents Sea (11.4%) (Oksanen et al., 2009), but that in Spitsbergen is markedly higher: 25.4% in the east and 28.6% in the west. Thus, there is a certain gradient of pathogen prevalence in this group of polar bears, with this parameter increasing westward from Franz Josef Land. The proportion of seropositive animals in the eastern part of the Barents–Kara population is markedly higher than in its western part and reaches 23.3% (Rah et al., 2005). Their proportion in other surveyed populations is much lower: e.g., 6% in the Chukchi Peninsula and Alaska (Rah et al., 2005) and 11.4% in Greenland (Oksanen et al., 2009). It is noteworthy that no such animals were found in Greenland in the mid-1980s (Clausen and Hjort, 1986). Apparently, black bears become infected by *T. gondii* mainly while hunting. Among carnivores, only cats (Felidae) excrete this pathogen into the environment, but they almost never occur in tundra landscapes; therefore, the spread of *T. gondii* with excrements is practically excluded.

One polar bear from Franz Josef Land was seropositive for influenza A virus (avian or swine flu). However, the possibility of this infection in polar bears has not yet been proven, and the presence of corresponding antibodies can only be regarded as evidence that the animal has been in contact with pathogen.

About 10% of polar bears were seropositive for pseudorabies virus. This disease with lethal outcome was described in captive brown bears (*U. arctos*) (Salvelli and Zanin, 1996). An American black bear (*U. americanus*) infected by this virus died after 3 days (Schultze et al., 1986). Lethal cases of pseudorabies were also described among captive polar bears (Banks et al., 1999). However, the spread and prevalence of this infection among polar bears in the wild have not yet been elucidated. Our data show that polar bears in Franz Josef Land have contact with this virus.

Another adult polar bear had antibodies to *Dirofilaria* sp. The nematode *D. ursi* has been found in the heart of the brown bear in Eurasia (Petrov and Krotov, 1954; Oshmarin, 1963) and North America (Worley et al., 1976), the American black bear (Choquette, 1952; Anderson, 1952; Rogers and Rogers, 1976), and the Asian black bear (*U. thibetanus*) (Yokohata et al., 1990). Thus, this parasite is common to species of the bear family, but we are the first to describe its occurrence in the polar bear. To elucidate the possibility of *D. ursi* parasitism against polar bears, it is necessary to perform careful pathological analysis of the hearts and lymph nodes from dying animals.

A long-known fact is that trichinosis is widespread in the Arctic. In the spring of 1944, for example, an outbreak of this disease (caused by ingestion of infected polar bear meat) at the German weather station on Franz Josef Land made it necessary to shut the station down and evacuate its personnel (Connell, 1948). Studies on polar bears in Spitsbergen have shown that antibodies to *T. spiralis* are absent in cubs aged <1 year (Asbakk et al., 2010), which is confirmed by our data. On the other hand, almost all adult bears (including females with offspring) proved to be seropositive (i.e., probably infected by this parasite). Therefore, it appears that the probability of its vertical transmission (from females to cubs) in the polar bear is minimal. In addition, we have found that the titer of antibodies received by cubs from their mother sharply drops almost to zero at an age of about 6 months The fact of seropositivity is indicative of pathogen prevalence but nevertheless does not mean that the animal is ill. Analysis of the muscle tissue for *T. spiralis* in polar bears from Spitsbergen showed that the proportion of infected animals among them averaged 32.7%; for comparison, this proportion among arctic foxes was only 15.5%, and *T. spiralis* infection in seals was not revealed (Larsen and Kjos-Hanssen, 1983).

Thus, the results of analysis for antibodies to viruses of pseudorabies, canine distemper, and influenza A and to *Toxoplasma gondii, Trichinella spiralis*, and *Dirofilaria ursi* show that polar bears from Franz Josef Land have contact with all six pathogens. The proportions of animals seropositive for canine distemper virus and *T. gondii* among them are low, whereas that of animals seropositive for *T. spiralis* is higher than in other groups. Differences in serum prevalence of antibodies to these pathogens between geographically close groups of Franz Josef Land and Spitsbergen may indicate a certain degree of their isolation.

As for other pathogens, wild polar bears carrying antibodies to pseudorabies and influenza A viruses and *Dirofilaria* sp. are described here for the first time. Taking into account high pathogenicity of these agents (first of all, pseudorabies virus), special attention should be paid to control of the above diseases in natural polar bear populations.

Young polar bears, primarily cubs aged <1 year, has proved seronegative for all six pathogens. This fact suggest that the animals acquire them after weaning and transition to predation. Other pathways of infection transmission (via contact with conspecifics or excrements of infected animals) appear unlikely.

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