

Investigations of Waterborne Pathogens in Eurasian Beaver (*Castor fiber*) from Telemark County, Southeast Norway

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The presence of pathogenic bacteria and parasites in drinking water is a well-known cause of human disease outbreaks (Isaac-Renton & Cordeiro 1993, Koenraad *et al.* 1997). There is however, a lack of knowledge of the contamination routes to water. In Norway, the supply of drinking water to the public and the food industry is primarily based on chlorinated surface water. Since the Eurasian beaver (*Castor fiber*) has a widespread distribution in southern Norway (Nolet & Rosell 1998), and lives in water, it may excrete pathogens into drinking water sources. The present study was carried out to examine whether beaver in Norway might be a reservoir of parasites belonging to the protozoan genera *Giardia* and *Cryptosporidium*, or bacteria of the genera *Campylobacter* and *Salmonella*.

Flagellates of the genus *Giardia* are common intestinal parasites of many mammals and are considered the most common cause of waterborne gastroenteritis in North America (Erlandsen *et al.* 1996). *Giardia* cysts are frequently found in Norwegian surface water sources (Gjerde 2000) and the number of reported human cases of giardiasis is rising here (Anon. 1998, 1999). In the USA, the preva-

lence of *Giardia* infection in beaver (*C. canadensis*) has been reported to be 7-16% (Erlandsen *et al.* 1990) and the beaver is considered a potential health threat if inhabiting watersheds used as sources of drinking water (Erlandsen *et al.* 1996). The parasite is resistant to chlorination (Moorehead *et al.* 1990).

Cryptosporidium spp. are coccidian parasites causing intestinal infections in a wide range of mammals including man (O'Donoghue 1995, Upton & Current 1985, Rose *et al.* 1997). *Cryptosporidium* oocysts are frequently isolated from surface water sources in Norway (Gjerde 2000) but the number of reported human cases of Cryptosporidiosis is low here (Anon. 1998, 1999). The parasite is highly resistant to chlorination (Fayer *et al.* 1997). Cryptosporidium infection in beaver has been reported from Poland (Bajer *et al.* 1997) and the USA (Isaac-Renton *et al.* 1987).

Campylobacter spp. is the most common water and food-borne pathogen causing human enteritis in Norway (Anon. 1998, 1999). The bacterium has been demonstrated in the intestinal contents of a wide variety of domestic and wild animal species (Rosef *et al.* 1983) and is regularly isolated from river water in Telemark

Table 1. The number of Eurasian beavers (*Castor fiber*) from Telemark County, Norway, analysed for the presence of the bacterias *Campylobacter* spp. and *Salmonella* spp., and the protozoens *Giardia* spp. and *Cryptosporidium* spp. in faecal contents. Animals are categorized according to capture form, sex, age and the habitat they were taken from.

Category	Campylobacter	Salmonella	Giardia	Cryptosporidium
Live-trapped	83	106	111	103
Shot	50	129	130	79
Total	133	235	241	182
Males	72	126	129	98
Females	61	109	112	84
Juveniles (0-10 kg)	20	38	41	27
Subadults (10-15 kg)	21	46	47	35
Adults (≥ 15 kg)	92	151	153	120
River (>5 m wide)	105	172	177	142
Stream (<5 m wide)	14	24	24	15
Tarn/lake	14	39	40	25

(Rosef et al. 2001). In Norway, human waterborne outbreaks have been traced to faecal contamination from gulls (*Larus* spp.), geese (*Anser brachyrhynchus*) and sheep (Andreassen 1981, Dahl & Melby 1987, Varslot et al. 1996). Pacha et al. (1983) reported the absence of *Campylobacter* infection in 75 beavers examined in North America.

Salmonella contamination and salmonellosis in humans and farm animals is an increasing problem in the industrialized countries (Rodrigue et al. 1990). In Norway however, *Salmonella* is a limited problem and most of the human clinical cases (80-90%) are infected abroad (Bredal & Langeland 1993, Fossum et al. 1996). In spite of this, a waterborne outbreak of human *S. typhimurium* infection has been reported here (Foldal & Vatne Bjørdal 1999). *Salmonella* may infect a wide range of wild and domestic mammals and birds which may also act as carriers. *Salmonella* spp. have also been isolated from beavers in Germany and Russia (Romasov 1992).

Faecal samples were collected from beavers of different sex and age-classes living in the water systems of Bø, Sauherad and Nome municipal-

ities (59° 17'-25'N, 09° 03'-17'E) in Telemark County, southeast Norway during the years 1997-1999 (Table 1). The animals were either live-trapped with landing nets (Rosell & Hovde 2001), Hancock or Bailey live-traps, or shot during the hunting season (Table 1). The beavers were sexed by the colour of the anal gland secretion (Rosell & Sun 1999) or the presence of the os-penis (Osborn 1955) and partitioned into three age-classes based on body weight (Hartman 1992): juveniles (≤ 12 months, <10 kg), subadults (13-24 months, 10-15 kg), and adults (>24 months, ≥ 15 kg).

Campylobacter was isolated from faecal swab samples brought to the laboratory and streaked out onto a selective blood free agar [CCDA-modified Preston agar, Oxoid CM 739 and SR155 supplement] within 2 hours. The agar plates were incubated at 42°C in a micro aerobic atmosphere achieved by using the Oxoid, Campy Gen code CN025A and read after 24 and 48 hours.

Salmonella was isolated by examining one gram of fresh or frozen faeces following the procedure described in NMKL 71 (Anon. 1991). *Giardia* and *Cryptosporidium* detection. The

ProSpectT[®] microplate assay for in-vitro diagnosis of *Giardia* and/or *Cryptosporidium*, Alexon inc., Sunnyvale, CA 94089, USA was used. Preliminary positive samples were followed up by individual assays. For confirmation of *Giardia* the ProSpectT[®] *Giardia* EZ microplate assay for in-vitro diagnosis of *Giardia*, Alexon-Trend, Inc Ramsey, MN 55303, USA was used. For confirmation of *Cryptosporidium* the ProSpectT[®] *Cryptosporidium* microplate assay, Alexon-Trend, Inc. Ramsey, MN 55303, USA was used.

Neither *Giardia*, *Cryptosporidium*, *Campylobacter* nor *Salmonella* were detected in any of the samples examined. We conclude that the beaver does not seem to be involved in drinking water contamination with these pathogens in Telemark County.

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References

- Andreassen H: MSIS ukerapport 35, 36 and 38 (MSIS weekly reports 35, 36 and 38). Statens institutt for folkehelse 1981, Oslo, Norway.
- Anonymous: Meldesystem for smittsomme sykdommer (System for reporting infectious diseases). Statens institutt for folkehelse 1998, 1999, Oslo, Norway.
- Anonymous: Nordic committee on food analysis, no 71 *Salmonella* bacteria. Detection in foods 1991, 4th edition. Oslo, Norway.
- Bajer A, Bednarska M, Sinski E: Wildlife rodents from different habitats as a reservoir for *Cryptosporidium parvum*. *Acta Parasitologica* 1997; 42, 192-194.
- Bredal W, Langeland G: *Salmonella* i næringsmidler og miljø (*Salmonella* in food and the environment). Statens næringsmiddeltilsyn, Oslo, SNT rapport nr 11 1993.
- Dahl O, Melby K: En vannbåren epidemi forårsaket av *Campylobacter jejuni* (A waterborne epidemic caused by *Campylobacter jejuni*). *Tidsskr. Norsk Lægeforen.* 1987; 107, 349-351.
- Erlandsen SL, Macechko PT, van Keulen H, Jaroll EL: Beaver and *Giardia* in the environment: a current perspective on the existence of "beaver fever". In: Rowan AN, Weer JC (eds.). *Living with wildlife: The biology and sociology of suburban deer and beaver*. Donna Pease, production editor 1996; 210 pp.
- Erlandsen SL, Sherlock LA, Bemrick WJ, Ghobrial H, Jakubowski W: Prevalence of *Giardia* spp. in beaver and muskrat populations in Northeastern States and Minnesota: detection of intestinal trophozoites at necropsy provides greater sensitivity than detection of cysts in faecal samples. *Appl. Environ. Microbiol.* 1990; 56, 31-36.
- Fayer R, Speer CA, Dubey JP: The general biology of *Cryptosporidium*. In: Fayer R (ed.). *Cryptosporidium and Cryptosporidiosis*. CRC Press LLC, 1997.
- Foldal AS, Vatne Bjørdal AS: Nærkontakt med *Salmonella*-epidemien (Close contact with a *Salmonella* epidemic). *Nærkontakt* 1999; 2, 15-18.
- Fossum K, Grønstøl H, Kapperud G, Schaller G, Skjerve E: *Salmonellainfeksjoner hos dyr og mennesker* (Infections with *Salmonella* organisms in animal and man) *Norsk Vet. Tidsskr.* 1996; 108, 639-645.
- Gjerde B: Parasittar i drikkevasskjeldar (Parasites in drinking water). *Norsk Vet. Tidsskr.* 2000; 112, 170.
- Hartman G: Age determination of live beaver by dental x-ray. *Wildl. Soc. Bull.* 1992; 20, 216-220.
- Isaac-Renton JL, Cordeiro C: Characterization of *Giardia duodenalis* isolates from waterborne outbreak. *J. Infect. Dis.* 1993; 167, 431-440.
- Isaac-Renton JL, Moricz MM, Proctor EM: A *Giardia* survey of fur-bearing water mammals in British Columbia, Canada. *J. Environ. Health.* 1987; 50, 80-83.
- Koenraad PMFJ, Rombouts FM, Notermans SHW: Epidemiological aspects of thermophilic *Campylobacter* in water-related environments: a review. *Water. Environ. Res.* 1997; 69, 52-63.
- Moorehead WP, Guasparini R, Donovan CA, Mathias RG, Cottle R, Baytalan G: Giardiasis outbreak from a chlorinated community water supply. *Can. J. Public. Health* 1990; 81, 358-361.
- Nolet B, Rosell F: Comeback of the beaver (*Castor fiber*): an overview of new and old conservation problems. *Biol. Conserv.* 1998; 83, 165-173.

- O'Donoghue PJ*: *Cryptosporidium* and cryptosporidiosis in man and animals. *Int. J. Parasitol.* 1995; 25, 139-195.
- Osborn DJ*: Techniques of sexing beaver, *Castor canadensis*. *J. Mammal.* 1955; 36, 141-142.
- Pacha RE, Clark GW, Williams EA, Carter AM, Scheffelmaier JJ, Debusschere P*: Small rodents and other mammals associated with mountain meadows as reservoirs of *Giardia* spp. and *Campylobacter* spp. *Appl. Environ. Microbiol.* 1987; 53, 1574-1579.
- Rodrigue DC, Tauxe RV, Rowe B*: International increase in *Salmonella enteritidis*: a new pandemic? *Epidemiol. Infect.* 1990; 105, 21-27.
- Romasov BV*: Krankheiten der biber (Beaver diseases). *Semiaquatische Säugetiere, Wiss. Beitr. Univ. Halle* 1992; pp. 199-203.
- Rose JB, Lisle JT, LeChevallier M*: Waterborne Cryptosporidiosis: Incidence, outbreaks and treatment strategies. In: Fayer R. (ed.). *Cryptosporidium and Cryptosporidiosis*. CRC Press LLC, 1997.
- Rosef O, Gondrosen B, Kapperud G, Underdal B*: Isolation and characterization of *Campylobacter jejuni* and *Campylobacter coli* from domestic and wild animals in Norway. *Appl. Environ. Microbiol.* 1983; 46, 855-859.
- Rosef O, Rettedal G, Lågeide L*: Thermophilic campylobacters in surface water: a potential risk of campylobacteriosis. *Int. J. Environ. Health Res.* 2001; 11, 321-327.
- Rosell F, Hovde B*: Methods of aquatic and terrestrial netting to capture Eurasian beavers. *Wildl. Soc. Bull.* 2001; 29, 269-274.
- Rosell F, Sun L*: Use anal gland secretion to distinguish the two beaver species. *Wildl. Biol.* 1999; 5, 119-123.
- Upton SJ, Current WL*: The species of *Cryptosporidium* (Apicomplexa: Cryptosporidiidae) infecting mammals. *J. Parasit.* 1985; 71, 625-629.
- Varslot M, Resell J, Fostad IG*: Vannbåren campylobacterinfeksjon-trolig forårsaket av kortnebbgjess (Water-borne outbreaks of *Campylobacter* gastroenteritidis due to pink-footed geese in Norway in 1994 and 1995). *Tidsskr. Norsk Lægeforen.* 1996; 116, 3366-3369.

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