

Water Purification for *Giardia*: What Works in the Backcountry?

Editor's Note: Since the winter of 1980-81, when what was then Pacific Park Science (p. 10, Vol. 1, No. 2) published an account of a giardiasis outbreak in Olympic NP, the infection has gained Servicewide attention. Accordingly, Park Science revisits this distressing condition with updated guidance from three experts . . . an exhaustive treatment of an exhausting disease.

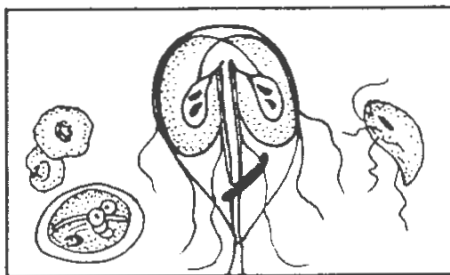
By Don L. Monzingo, Juliette Wilson, and Sam Kunkle

Many backpackers and campers are now aware of the single-celled protozoan parasite *Giardia duodenalis* (= *G. lamblia*, *G. intestinalis*). They have been introduced to the disease, properly called giardiasis but also known as "beaver fever" or "backpackers disease," through the popular press, through brochures and pamphlets, by "word of mouth," or by becoming infected.

Infection results from ingestion of *Giardia* in its cyst form. Once in the gut, the cyst "excysts" into its reproductive, trophozoite form, which thrives in the small intestine and multiplies to huge numbers. After a time the trophozoites "encyst" (return to the cyst form), and are passed in the stool. The cysts are extremely hardy in cold water and at 3°C can survive for up to three months.

Symptoms include diarrhea, abdominal cramps, flatulence, abdominal bloating, weight loss, and fatigue, varying from one person to another. Some individuals exhibit no symptoms; others develop severe gastrointestinal symptoms that can lead to a debilitating malabsorption-maldigestion syndrome; many more are somewhere in between. Those unaware that they have giardiasis become carriers of the parasite, and can spread the infection.

Giardia is transmitted from person to person most commonly via a direct fecal-oral route, but it is waterborne transmission that is attracting attention in national parks and other recreation areas. Here, cysts are introduced by an infected human or animal into a watercourse, where they can survive and remain infective for long periods, especially in cold waters. Downstream recreationists who consume the contaminated water risk ingesting the cysts and contracting giardiasis. Several species of domestic and wild



animals – including beaver, muskrat, dogs, cats, raccoons, cattle, marmots, and voles – can carry and transmit *Giardia*. Several outbreaks of waterborne giardiasis in communities using surface water for a source of drinking water have been traced to infected beaver living in the streams. An outbreak involving 34 of 54 campers in the Uinta Mountains of Utah occurred in 1974, and epidemiological evidence indicated that water drunk from the mountain streams was the source of infection (Barbour 1976). In a case-control study in Colorado giardiasis was again associated with drinking untreated mountain water (Wright et al. 1977).

Many mountain streams that appear pristine and safe for drinking are contaminated with *Giardia* cysts (Kunkle et al. 1985; Monzingo and Stevens 1986; Monzingo and Hibler 1987). It is therefore important to have a simple, reliable method for treating small quantities of water. Currently, the following treatments are used: 1) heating or boiling, 2) chemical disinfection, and 3) mechanical filtration. Each of these methods is effective to varying degrees, and each has its advantages and disadvantages.

Heating or Boiling Water

Heating water would appear the simplest and most reliable means of purification. If water contaminated with any viral, bacterial, or parasitic agent is maintained at a rapid boil for 10 to 20 minutes (State of New Mexico 1981; Brock and Brock 1986), it should be safe to drink. It has been found that bringing water only to 55°C will inactivate *Giardia* cysts in water (Monzingo and Aukerman, 1986, unpublished data).

Using heat to purify water means no chemicals to mix or filters to plug. On the other hand, a backpacker may find it impractical to carry enough fuel to boil water for drinking and cooking; and in many areas, suitable firewood is limited or campfires are prohibited. When *Giardia* is the only disease agent of concern, heating the water to just 55°C will provide savings in fuel, but a thermometer must be used to determine temperature accurately.

Chemical Disinfection of Water

Two chemicals, iodine and chlorine, commonly are used to render small quantities of drinking water safe. They are available as household products (bleach or tincture of iodine) or in commercially prepared tablets. Tablets include Halazone® (chlorine) and Globaline®, Coughlan's® or Potable Aqua® (iodine). An unopened, unexpired bottle of these tablets should be used, and the tablets protected from heat, direct sunlight, and exposure to the air. Directions on the label should be followed except as explained below. For bleach and tincture of iodine, Table 1 lists the amount of chemical and contact times as recommended in a brochure distributed by New Mexico's Health and Environment Department.

One method suggests iodine crystals to make a saturated iodine solution, which is then added in small amounts to the water to be disinfected (Kahn and Visscher 1975; Manley 1983). This method does not destroy *Giardia* cysts in very cold water (3°C) (Jarroll et al. 1980a). Because of this and the danger that the toxic iodine crystals could accidentally be ingested, this method is not recommended.

At water temperatures of 20°C, Halazone, Globaline, bleach, and 2% tincture of iodine destroyed *Giardia* with 20 to 30 minutes' contact time (Jarroll et al. 1980b). Potable Aqua is effective at 20°C with the 10-minute contact time recommended on the product label. (Monzingo and Aukerman, 1986, unpublished data). At 3°C with 30 minutes contact time, Globaline, bleach, and 2% tincture of iodine did not destroy all the cysts (Jarroll et al. 1980b), and Potable Aqua was not effective at 10°C with 10 minutes' contact time. (Monzingo and Aukerman, 1986, unpublished data). Therefore, water to be treated with any of these chemicals should be warmed to at least 20°C prior to chemical treatment. Solar radiation or body heat can be used to bring water to 20°C, but to be safe, a thermometer should be used.

Turbidity also will lessen the effectiveness of these chemicals. Turbid or cloudy water should be filtered through a cloth, and the contact time with the treatment chemicals should be at least double the time recommended on the bottle.

Mechanical Filtration of Water

Several brands of backpackable water filters are available. To reliably remove *Giardia* cysts from water, a filter must have a nominal pore size of 1 micron or less. Although *Giardia* cysts measure 9 to 12 microns in length and 5 to 8 microns in diameter, their pliability allows them to squeeze through openings 5 microns in diameter.

Two filter units widely accepted as effective in removing *Giardia* and most pathogenic bacteria and General Ecology's First Need® filter and the Katadyn® filter: both are EPA-certified to remove *Giardia* cysts. The units are expensive, ranging from \$35 to \$150,

Table 1. Amount of bleach or iodine needed for disinfecting 1 L of water. Adapted from State of New Mexico, 1981.

Chemical	No. of drops needed per L ^{1,2}	
	Clear water	Cold or turbid water
Bleach		
Available chlorine (listed on container label):		
1%	10	20
4-6%	2	4
7-10%	1	2
Unknown	10	20
Tincture of iodine		
2%	5	10

¹ 1 drop = 0.05 ml

² Mix water with chemical agent thoroughly in container by stirring or shaking. Let stand at least 30 minutes. Very cold or turbid water may require contact times of several hours.

and filters in the cheaper units will eventually plug, requiring replacement at \$15 to \$18 per filter. The filters will plug rapidly if care is not taken to first remove debris and sediment from the water: turbid water should be strained through several layers of cloth prior to filtration and the filter intake should never be put directly in the stream. When used properly, these filter systems will provide large quantities of safe drinking water for several persons at a time. They are relatively easy to operate, and filtered water lacks the "flat" taste of boiling and the chemical aftertaste of disinfectants.

For many recreationists, a combination of methods works best, usually filtration or heat followed by chemical disinfection. The individual must make the final decision. The important message is that caution is the best policy in avoiding gastrointestinal illness: treat all surface water before drinking it, and if you are treating it for *Giardia*, be sure your treatment methods are effective!

Monzingo and Wilson are Research Associates and Sam Kunkle is Land-Use Hydrologist, NPS Water Resources Division, Colorado State University, Fort Collins.

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