

# II WATER PURIFICATION

*Paul Goodyer and Larry Goodyer*

A safe water supply is an essential part of camp hygiene. Water intake for adults in temperate conditions is around 3 litres per day, but this can rise to as much as 10 litres per day in hot climates because of loss due to sweating. In addition, around 4 litres of water per person per day will be needed for cooking and washing up. Therefore considerable supplies may be required both at base camp and by field parties. In many cases, water obtained from rivers, lakes and ponds, as well as from taps and wells, carries a considerable risk of contamination. Spring water collected away from human habitation may be safer but it would be wise to treat even this water source.

Before treating the water to kill any organisms, organic matter and silt need to be removed. This can pose considerable problems if you are trying to obtain supplies for a large expedition, where sedimentation tanks and large ceramic filters would need to be employed.

Various methods for water purification will be described in this chapter. Some are more suitable for the base camp and others for field workers. Before deciding on the system to use it is also important to consider the likely infective organisms and the risk posed by them to the expedition.

## **Transmission of disease by water**

Numerous organisms and chemical pollutants that may be found in water can lead to human disease. The organisms include bacteria, viruses, protozoa and other parasites, such as schistosomes, guinea worm larvae (in tiny shrimps) and leeches, which vary in the ease with which they can be killed. Water may be boiled or chemicals added for sterilisation, but if sediment is not first removed the sterilisation process may be ineffective. If the expedition is close to mines or factories, chemical pollution must be foreseen and appropriate filtration used.

### **Removal of sediment and organic matter from water**

If the water is cloudy or contains any suspended matter, this must be removed before further treatment. One method is to pass the water through a Millbank bag (Figure 11.1). This is a sock-shaped bag woven so that solids are retained but water flows by gravity through the weave. The bag can be left hanging over a receptacle with occasional top-ups to provide continuous production of filtered water ready for sterilisation. The bag is rugged and easy to clean. Millbank bags are available in two sizes: 2 litres for personal use and 9 litres for large quantities of water. Cloudy water can also be left to stand for some hours for solids to settle, either in a jerry can or in sedimentation tanks, depending on the volume to be treated. Very fine particles, such as “rock flour” in glacial outflow and mica flakes, are gastrointestinal irritants and must be removed by a ceramic filter (Table 11.1). Remember that simply clearing water does not sterilise it and that further treatment will be needed before it may be drunk.

## **METHODS OF WATER PURIFICATION**

### **Boiling**

This is undoubtedly the best method, but it is often inconvenient and wasteful of fuel supplies or natural resources. Water should be kept continuously boiling for 5 minutes, which is sufficient at any altitude. The water must be covered when cooling to prevent recontamination, and it will also taste better.

### **Iodine**

This is the most effective chemical method. Its main disadvantage is that it is unsuitable for some people: those with a thyroid condition or iodine allergy, pregnant women and young children. There are also concerns, largely unfounded, about the long-term use of iodine-treated water. A further drawback is that the cheapest method involves the use of iodine tincture, which must be carried in glass containers – this could be messy and hazardous if they should break. Iodine can be stored in plastic bottles if the bottle has been fluorinated to stop the iodine reacting with the plastic.

There is some discrepancy about the exact amount of iodine to use. Five drops of iodine tincture (2%) to 1 litre of water is most often used, increasing to 12 drops if *Giardia* is suspected. It is always best to assume that *Giardia* is present and add 12 drops to 1 litre when treating small amounts of water, or measure out 0.3–0.4ml/l when treating large tanks. The longer the treated water is left to stand – the contact time – the better, 30 minutes being the minimum.

An alternative to the tincture is to use water-sterilising iodine tablets, but these are expensive and lose their potency after the bottle has been opened. Iodine tablets should always be crushed into the water; they can take time to break down if left whole, which can seriously effect the contact time. Another method is to use iodine crystals (the Kahnn–Visscher method), but it is rather fiddly and not suitable for

**TABLE 11.1 REMOVAL OF SEDIMENT AND ORGANIC MATERIAL**

<i>Filter/purifier</i>	<i>Litres</i>	<i>Filtration time/litre (minutes)</i>	<i>Purification time (minutes)</i>	<i>Chemical/filter employed</i>
Pocket Travelwell	25	10	2	Filter/iodine
Millbank bag	Unlimited	5	n/a	Cloth filtration
First Need Microlite	100	2	Instant	Microfilter
Aqua Pure bottle	350	2	15	Filter/iodine
Trekker Travelwell	100	10	2	Filter/iodine
First Need Original	400	2	n/a	Microfilter
P U R traveller	400	2	3	Filter/iodine
The Pure Cup	500	25	5	Filter/iodine
P U R Scout	1,000	2	3	Filter/iodine
P U R Explorer	2,000	1	3	Filter/iodine
Katadyne Mini Filter	7,000	2	Instant	Ceramic filter/silver
Katadyne Pocket Filter	10,000	1.5	Instant	Ceramic filter/silver

Note: purifying water using a pump filter can be fast, but organic matter may cause frequent blockages, making the process labour intensive.



Figure 11.1 A Millbank bag in use (Nomad Traveller's Store)

preparing large amounts of water.

The horrible taste of iodine-treated water can be reduced by adding small amounts of ascorbic acid (vitamin C) to neutralise the iodine. Clearly this should be done only at the point of use.

### **Chlorine**

This is effective against a wide range of organisms, except for amoebic cysts, *Giardia* and *Cryptosporidium*. The effectiveness of chlorine is reduced by a number of factors which may not be easy to control, such as alkaline water, very cold water or the presence of organic matter – hence the need for prior filtration.

Puritabs tablets are the most widely available method of chlorination and one tablet of the maxi size will treat 25 litres. For very large tanks some expeditions prefer to use a substance called chloramine T, where 5mg is added to each litre of water. Treated water should be left for at least half an hour before drinking and longer if it is very cold.

Taste can be removed with sodium thiosulphate. This will inactivate the chlorine so it should be added by individuals only at the point of use, i.e. to a drinking cup. It should never be added to a storage receptacle such as a canteen or jerry can.

### **Silver compounds**

Micropure tablets contain a compound called Katadyne silver which is not effective against *Amoeba*, *Giardia* or viruses. It does not impart a bad taste and it is claimed to be able to prevent recontamination of water for many weeks. Micropure tablets should not be added to water previously treated with chlorine or iodine.

### **Filters and pumps**

There are now many devices available for purifying water (see Table 11.1), but care must be taken in choosing the right one for your expedition. Some devices employ a simple filtration method, whereby water is pumped through tiny holes through which organisms are unable to pass. Be careful to look at the pore size (measured in microns), as anything greater than 1 micron will not remove all organisms. Other devices employ both a filter and chemical treatment which strains and sterilises in one go. Choosing the right device is important, so here are some tips:

- Manufacturers often say how many litres of pure water a device will produce. However, this can be drastically reduced if the water is silty.
- If heavy use is expected, make sure that the purifier can be taken apart, cleaned and reassembled in the field to prevent blockages.
- Check the pump rate as some can take a lot of effort to produce a small amount of water.
- Many manufacturers of pumps go to great lengths to state what they will

remove, while keeping quiet about what is not removed. For example, pumps will not remove chemical effluent, such as mercury in the tributaries of the Amazon, without the addition of a carbon filter. For those visiting areas where there is mining or factories up-river this may be important.

- Water storage time is also important; ideally after sterilisation the water should be used within 24 hours.

## **CHOICE OF SYSTEM**

This will depend on the size and circumstances of the expedition. If practicable a large pot should be put on to boil at the end of an evening meal to allow preparation of water for the following morning. In addition, all members should have some method of sterilising their own drinking water. As a rough guide the choice of methods is as follows:

- Large groups could consider chlorination, where the condition of the treatment tanks can be carefully monitored.
- Smaller groups might use iodine, provided that everyone in the group can tolerate it.
- For smaller groups, particularly if on the move, it would be acceptable to prepare water that has been strained through a Millbank bag and provide members with their own small bottle of iodine or chlorination tablets to treat water after drawing it off in their own canteens. The strained water could be used for boiling water, e.g. for beverages.
- A new generation of water bottles with a filtration/purification method attached (e.g. Aqua Pure – see below) can be used to improve fluid intake (the ease of use helps the user to keep up a constant intake of water). However, there is a question of the contact time and it is suggested that the water be squeezed through and left to stand.

All field parties should be provided with small Millbank bags and some method of chemical sterilisation, or alternatively a portable filtration system.

### **Drinking bottle filters**

These are bottles with filters attached to the top. The most well known is the Aqua Pure traveller (99,000g, 24cm diameter). The bottle is filled with the water to be treated then squeezed into a drinking cup for purification. Drinking bottle filters are slightly misleading as they make it look as though you should be able to drink safe water straight from the bottle. By the addition of an iodine sleeve to the carbon micro-filter, the Aqua Pure can be turned into a purifier so long as the water is left to stand for 15 minutes once it has passed through the system.

### **Camp arrangements**

Providing enough treated water, from a natural source, for a camp of 20 is time-consuming but exceedingly important. The best approach is to incorporate a strict regime from the start by appointing one person as “water chief” to supervise the sterilisation, safe storage and use of the water. The appointed person should also make sure that every member of the expedition is capable of sterilising his or her own drinking water.

Rigid plastic containers with a tap and handle are the best for water. These come in 10- or 25-litre sizes, but the latter is heavy when full of water so keep in mind distances to water source and terrain. If you do not have a method of removing the taste of chemicals, water will taste better when cold. Storing water in special canvas bags will keep it cool through evaporation from the small pores of the canvas. If they can be obtained, army surplus ones are excellent and come in sizes suitable for storage of large volumes in camp or for tying to the back of a vehicle.

If a daily average of 6 litres per person is required for drinking and 4 litres for cooking/washing up, containers holding 10 litres per person per day will be required. Water treatment could be split into sessions if it is necessary to reduce the number of containers in use. To avoid confusion, have a good system of marking containers for the three different types of water treatment:

- untreated for storage, sedimentation or settling process;
- strained ready for treatment;
- fit for drinking.

### **Field parties**

Always make sure that field workers carry their own water bottles, with a metal cup. Avoid plastic beakers as these often break. Each member should also have personal equipment for sterilising water; if a filter system is used, a small Travelwell might be a good choice.

If travelling by vehicle, do not use one large container for storing water; a single puncture may have disastrous consequences. Jerry cans or the canvas bags previously mentioned are the best option, but try to adopt the same system of markings as employed in base camp.