Testing the water

Water from the boat's tank is often unpleasant, and may even be contaminated. While some water filters simply improve the taste, others remove harmful bacteria. **Pat Manley** and team try out the options at Wessex Water lab

Most of us fill our water tanks at a marina or fuelling berth, and in the UK and northern Europe, we expect this to be safe to drink. But this water is straight from the mains, so it has only undergone a primary treatment, which involves the application of small quantities of chlorine. It may not be safe to drink if stored for a long period of time. Furthermore, many yachtsmen are careless when handling marina water hoses, allowing the hose and nozzle to be dunked in the sea. Running the water for a few minutes before putting the hose in the tank filler is not enough to remove bacteria. If the weather is hot, the water in the hose heats up, and bacteria admitted at the nozzle end grow and spread up the coiled hose. We complain that some marinas don't supply hoses, but they could be doing us a favour. Use your own hose or fit a bacteria filter.

Very rarely, the UK mains water may contain impurities such as a cryptosporidium (a parasitic cyst) or high metallic or organic contamination (from pesticides and herbicides). A standard taste filter will not be effective in removing these contaminants.

Choosing a filter

It is useful to distinguish between carbon-activated filters, which simply improve the taste (and should therefore only be used with water that is already safe to drink), and sub-micron filters, which remove impurities. Water can be boiled to kill bacteria, but boiling will not remove chemical or metallic contaminants. Parasites can be removed only by sub-micron filtration. For those cruising abroad, where the potability of the water may be suspect, a sub-micron filter may be essential.

Most of us decontaminate our water tanks from time to time, usually with chlorine bleach. Baby bottle sterilising tablets work well, as does Boots's sterilising liquid which, at £1.99 for a litre bottle, is good value.

The tank's water fill and vent pipes can become mouldy quite fast due to the presence of air, so these may need replacing.

Activated carbon filters

Tank water sometimes tastes of fibreglass, rubber, or of the chlorine used to sterilise the tank. This taste (and smell) can be removed by passing the water through an activated carbon filter. This filter will not remove bacteria or parasites, so it must be used only with potable water.

Over time, bacteria becomes lodged in the microstructure of the activated carbon filter. Manufacturers sometimes use silver to inhibit the growth of this bacteria over long periods of inactivity, such as on a recreational boat. But Simon Cole of Wessex Water points out that where silver is incorporated, the residue in the filtered water often exceeds the silver levels laid down by the UK water authorities for standard drinking water. For this reason, a higher limit is allowed for water filters that use silver.

Jug filters

Using a jug filter is a simple and relatively cheap way of obtaining filtered water. When filled, the water passes through a disposable activated carbon filter into a reservoir, from where it is poured. You can purchase a jug filter in the high street for less than £20. The filter cartridge, which has to be replaced every four weeks, costs about £3.50.

Sub-micron filters

To remove bacteria and cysts, you need a sub-micron filter (which has pores less than one millionth of a metre wide). A finely pored ceramic filter can provide this protection, but will not remove taste and odour. Therefore, sub-micron filters may also be fitted with an activated carbon element (taste filter) to make them dual-purpose. Due to the extreme fineness of the sub-micron filter, the flow rate of the filtered water is considerably lower than that of an activated carbon filter. Also, as the pressure required to force water through the filter is high, an electric pump is preferable to a hand pump.

But a sub-micron filter cannot remove

THE FILTERS TESTED

Whale Aquasource

Type: Activated carbon
Price: £18

Freshness

Type: Activated carbon
Price: £31

Penguin Hydropure

Type: Activated carbon
Price: £38

PBO test team

The team tested the water filters for quality of taste. Pictured from left to right are: Liz Bryant, Yvette Hammond, Rob Malcolm, David Gibby, Pat Bryant, Malcolm Hammond, and Pat Manley

The lab test

The sub-micron filters were taken to Wessex Water laboratory for tests with dirty river water to see how effective they were at removing bacteria

impurities of less than 0.1 micron. To remove pesticides, herbicides and solvents, another device is required. Hydrocarbon molecules, which are found in oil-based products, are about 0.06 microns in diameter. The only filter we tested that could remove such contaminants was the Nature Pure, which uses surface absorption to remove these.

It is possible to remove heavy metals, such as copper and lead, by permanently polarising the surface of the filter or casing.

Bottled water

Many people buy bottled water for drinking on the boat. Although this is spring water, it may still contain impurities. Taste also varies considerably, as does price.

Filter maintenance

Caring for your water filter is important. You will need to change the filter cartridge on a regular basis to prevent bacterial growth within the filter body. The Penguin Hydropure filter cartridge, which is sub-micron, slots into a transparent housing, enabling the user to observe any build-up of dirt or algae. With some filters, such as the Shoreline (sub-micron), you can scrub the cartridge to remove surface fouling and prolong the life of the filter.

Flow rate of the water reduces with time as the filter clogs. Bob Stacey of Wessex Water warns that if the cartridge becomes too clogged, water pressure may build up until eventually it is forced through the filter in one go, carrying with it a large dose of live bacteria. However, this is unlikely on smaller boats with low water-pressure.

Also, over time, the bacteria can grow through the pores of the filter and end up on the wrong side. You should not carry on using a water filter that has a reduced water flow. Having no water filter might be preferable to one that isn't changed frequently enough.

The team test

The team conducted a taste test with the filters, after which the sub-micron filters and the Penguin filter were to taken to Wessex Water's laboratsory for bacteria tests. The team also investigated how easy the filters were to install and how fast they worked.

Shoreline

Type: Sub-micron
Price: £89 incl. taps and pipes

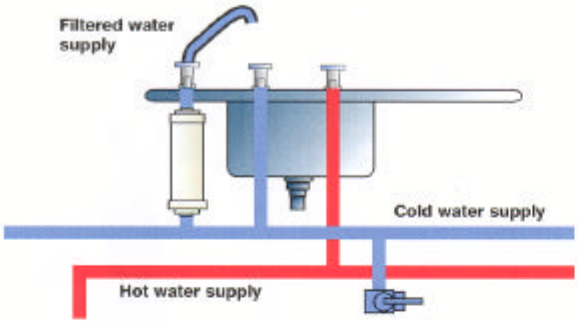
Nature Pure

Type: Sub-micron
Price: £170

Brita water jug

Type: Activated carbon
Price: £25

Plumbing in the filter



Ideally, you should install a separate tap for filtered water

Some water filters come with fittings so that they can be plumbed into the existing galley tap, but this means you use filtered water for washing up as well as for drinking. Because filters have a limited capacity, it may be better to provide a separate tap for filtered drinking and cooking water. If your filter is not supplied with a tap, you can buy one separately.

Ensure there's plenty of room under the sink for the pipes, and removing the filter bowl

If installing a drinking-water tap, you need to cut a hole in the work surface to house it. The cold water supply pipe will have a tee installed. A pipe is then run from the tee to the filter and from the filter to the tap.

It is recommended that filters should be installed as close as possible to the drinking-water tap. However, some of the filters we tested were quite large, which could make them tricky to fit under the sink.

Connecting the filter to an existing tap is a somewhat easier task. You need to cut the cold water supply pipe as close as possible to the tap and insert the filter in-line (between the cut ends of the pipe), using a screw or push-on fittings, or flexible pipe and jubilee clips. This option means that all the galley's cold water passes through the filter, which could shorten its life.

When checking the space available, remember that you need enough room to remove the filter bowl so you can change the cartridge, as well as plenty of space for the pipes, especially if they come out of the top of the filter.

INSTALLATION

FILTER	STANDARD KIT			INSTALLATION		
	Housing	Filter Cartridge	Brackets	Pipes	Tap (Faucet)	
Whale Aquasource	n/a	Y	Y	N	N	in-line
Freshness	n/a	Y	Y	N	N	in-line
Hydropure	Y	Y	Y	N	N	in-line
Shoreline	Y	Y	Y	Y	Y	saddle
Nature Pure	Y	Y	Y	Y	Y	tee connector
Brita Filter Jug	Y	Y	n/a	n/a	n/a	jug

The taste test

The water used in the taste test was taken from the 60-gallon tank of a Westerly Oceanquest. Chlorine was added in order to give it an unpleasant taste. Six water filters were tested; two sub-micron filters (bacteria-removing) and four activated carbon filters (to improve taste). The test team tasted the boat water before and after filtration, and also compared it to bottled water and house tap water.

The team sampled the water on its own and in a cup of tea, and gave marks out of 10 for taste.

Boat tap water

To appreciate the difference water filters can make, chlorine was added to the test boat's tanks to make the pre-filtered water taste unpleasant. David thought the tea made with this water was just about drinkable but it got a resounding thumbs down from every one else.

Whale Aquasource

This was the smallest and joint-cheapest activated carbon filter and although the flow rate was good, the overall taste was poor. This small filter did not seem to cope with the amount of chlorine in the tank water. This was a throw-away filter needing to be changed each season.

Freshness

This activated carbon filter was larger and more costly than the Aquasource. It also had a good flow rate, but gave better results. Again, this was a disposible filter needing annual replacement.

Penguin Hydropure

This was the most expensive activated carbon filter we tested. Taste results were almost identical to those of the Freshness filter, and it had a good flow rate, too. But what gives the Penguin an edge over its competitors is its transparent filter cartridge housing, which lets you see when it needs changing.

With a pore size of 25 microns, the Penguin filter cartridge is a taste-only filter. As both the Penguin and Shoreline filters use standard 10in cartridges, we decided to try the Penguin housing with the Shoreline sub-micron filter. We got good taste and flow results (see Shoreline results in the taste test table).

As a result of the team's findings with the sub-micron filter, Penguin now offers a 0.45 micron filter in this housing, which costs £60. We have not tested this, but Penguin informs us that flow rates will be reduced and users will require a high-pressure electric pump. The company also points out that a 10 micron filter installed upstream of the sub-micron filter will help to maintain the flow rate by preventing clogging.

The Penguin filter is not supplied with fittings, so the installer would need to provide flexible tubing and pipe fittings, which are available from Penguin. This aside, we thought installation would be easy, as long as there is enough room to accomodate it, as it is quite big. Remember that all tubing must be of food-grade quality.

Rob and David contemplate the different tastes of the filtered water

Pat, Liz, Yvette and Malcolm fill out their taste test scores

Shoreline

Taste results were excellent with this sub-micron filter but the flow rate was very disappointing. This could be because the pipe bore size was extremely small. In support of this theory, we found that when we tried the Shoreline filter cartridge in the Penguin filter housing (which had larger bore pipes), the flow rate improved by 30%.

As a result of the PBO team test, Shoreline is currently investigating the introduction of larger bore pipes.

The large-size filter housing of the Shoreline means that you would need a fair bit of room in the cupboard under the sink.

Installing the Shoreline was easy, but a piece of 15mm copper pipe in the supply line was necessary because the tee connection was made by means of a saddle valve. The instructions, which were designed for inch sizes, did not make it clear which insert was required for 15mm pipe. We made the wrong choice and, initially, the joint leaked.

Does filtered water improve the taste of tea?

Nature Pure

This sub-micron filter scored very highly on the taste test. It is compact in design, and easy to install as you only need to cut the supply line and insert the supplied tee piece. However, at £170, it was by far the most expensive one we tested.

The Nature Pure was the only filter we tested that claimed to remove viruses, heavy metals, phosphates and hydrocarbons as well as bacteria. Indeed, these filters are supplied to some inland waterways boats so that the canal or river water can be filtered and used as potable water.

Brita jug filter

Having followed the instructions carefully, we all found that the filtered water from the Brita Jug did not remove the taste of chlorine. We tried two more times, leaving the filter cartridge resulted in some improvement, but the overall score was not very good. Brita points out that the filter is only recommended for use with mains-treated tap water. It is not designed to deal with the level of chlorine we had added to the boat water.

Although it is cheap to begin with, you need to change the £4 filter cartridge every four weeks. You are prompted to do this by an electronic reminder, which we thought was a very good idea. The non-replaceable battery lasts about five years.

Flow rate straight from the jug was good, but it only holds about a litre of water at a time. It then takes about three minutes for the next litre to filter through into the bottom chamber. This would be frustrating when you wish to fill the kettle, but fine if you only require a glass of water.

Waitrose bottled water

The team rated the Waitrose bottled water below the Shoreline filtered boat water, with nearly everyone downgrading it when it was used to make tea. At 20p a litre, the cost of a couple drinking the recommended two litres a day for 40 days a year, would be about £32 annually – the same as a replacement filter cartridge.

House tap water

Southern Water, as obtained from the kitchen tap at home, was rated the highest for taste – not surprising, as it had not been deliberately contaminated with chlorine.

TASTE TEST RESULTS

	Yvette		Malcolm		Liz		Pat		David		Rob		TOTAL SCORE	AVERAGE	INITIAL FLOW RATE Ltr/min measured	FILTER TYPE
WATER SOURCE	WATER TASTE	TEA TASTE	WATER TASTE	TEA TASTE	WATER TASTE	TEA TASTE	WATER TASTE	TEA TASTE	WATER TASTE	TEA TASTE	WATER TASTE	TEA TASTE				
Boat Tap (chlorinated)	1	1	1	1	1	1	1	2	1	5	1	1	17	1.4	–	no filter
Whale Aquasource	3	3	5	1	4	5	6	4	8	5	3	2	49	4.3	5.26	activated carbon
Freshness	6	5	7	7	7	5	7	6	8	7	6	6	77	6.4	5.26	activated carbon
Penguin Hydropure	6	5	7	7	6	4	8	7	6	7	6	7	78	6.5	5.36	activated carbon
Shoreline*	9	9	8	8	9	9	9	9	9	8	9	8	104	8.7	1.0	sub-micron
Brita Filter Jug	3	4	2	5	3	4	3	7	3	6	4	4	48	4.0	0.41	activated carbon
Nature Pure	9	9	9	9	9	9	9	9	9	9	9	8	107	8.9	3.2	sub-micron
Waitrose bottled water	10	8	10	5	9	7	9	7	9	8	9	9	100	8.3	–	no filter
House tap (Southern Water)	10	9	10	8	9	9	10	9	9	9	9	9	110	9.2	–	no filter

*Flow rate of Shoreline filter in Penguin housing was 1.3

Bacteria test

Only two of the filters, the Nature Pure and the Shoreline, claimed to remove bacteria, but Penguin requested that we test its filter as well, out of interest. We agreed as it acted as a control.

The lab testing was carried out by Wessex Water's science and testing facility near Bath. Bob Stacey, the lab manager, and Dr Simon Cole, who carried out the tests, were extremely helpful.

The River Avon is close to Wessex Water's lab, so we collected about 45 litres of river water and used this to test the filters.

The lab tests showed that the river water was contaminated, having a total coliform bacteria count of 6,900 to 7,300 per millilitre and a faecal coliform count of 2,100 to 2,200 per millilitre. In the three-day growth test at 22°C, all the organisms multiplied considerably. However, as Dr Cole pointed out, the results must be understood in the context that the sample was river water, and so presented a much harsher challenge than normal boat water would.

The lab ran 10 litres of the river water through each filter, with half-litre samples being taken at the start and finish and on three occasions in between to see if the effectiveness of the filter changed over time.

The samples underwent a standard laboratory water test. They were analysed for total coliform, faecal coliform and turbidity (suspended particle content). Plate counts (readings from a petri dish) were taken after one day at 37°C and three days at 22°C, because different types of bacteria grow at different temperatures. To pass the test, no bacteria should have got through the filter. The turbidity limit for household drinking water is four NTU (Nephelometric Turbidity Units) but most drinking water is well below one NTU.

Lynette Manley and Dr Cole find that pumping the water with a hand pump is hard work

Penguin Hydropure

This filter did not claim to remove bacteria so it came as no surprise that it did not do so. However, it served as a good illustration that an activated carbon filter should never be used with anything but potable water.

The lab report:

'The Penguin filter is a coarser grade of filter, claiming only to have a 25 micron nominal pore size. This would not be sufficient to remove bacteria. The filter presented very little resistance to filtration and all 10 litres went through in little more than two minutes. The bacteriological quality of the product was similar to the input river water. There was no reliable evidence of reduced turbidity, although it is likely that over a longer period the effective pore size would decrease as the pores become clogged and more would be removed than over the first 10 litres. Clearly this filter would present no particular advantage for assuring the quality of drinking water on a boat.'

Nature Pure

The lab report:

'The results show that the Nature Pure filter produced a good clear product and removed bacteria effectively under these conditions.'

My Whale Gusher 8 Mk III hand-bilge pump pumped 10 litres of test water through the Nature Pure in five-and-a-half minutes. This was not an easy process, but much easier than when pumping water through the Shoreline. It does suggest, however, that using a galley hand-pump with a sub-micron filter may not be practical.

General Ecology, the maker of the Nature Pure, also markets a hand-pumped portable version using the same filtration principle, and this may do the job if you need to use a hand-pump.

Shoreline

It was difficult to pump the water through this filter using my hand-pump. Shoreline recommends using an electric pump. During the taste test, flow rate using the electric pump was 1 litre per minute, compared with 3.2 litres per minute for the Nature Pure. However, upon concluding the test, we found that the opaque filter body was only half-filled with water. Without being able to see inside or bleed out any air, there was no means of knowing whether the filter was full or not. If only half the filter was being used, it would have clogged up more rapidly.

The lab report:

'The bacteriological quality of the water was initially good. There was considerable resistance to filtration which may partly be due to the unit not being fully filled. Under these conditions, it took over 25 minutes to filter 10 litres. There is evidence for progressive breakthrough of bacteria during the course of the test. Questions remain about the effectiveness of this filter. While there was significant bacterial removal, the product was very cloudy and performance was not stable.'

LABORATORY TEST RESULTS

Sample Description	Flow litres/minute	Total coliforms /100ml	E.coli /100ml	Plate Counts 22°C per ml	Plate Counts 37°C per ml	Turbidity (NTU)
Raw 1	(25 litre) C to L	6900	2100	23000	2200	8.6
Raw 2	(20 litre) M to Q	7300	2200	20000	970	6.7
Nature Pure Filter	2 litres 50 sec	0	0	1	0	0.32
Nature Pure Filter	4 litres 2min 20sec	0	0	0	0	0.35
Nature Pure Filter	5 litres 3min 20sec	0	0	0	0	0.77
Nature Pure Filter	7.5 litres 4min 30sec	0	0	0	0	0.31
Nature Pure Filter	10 litres 5min 30sec	0	0	0	1	0.32
Shoreline Filter	1 litre 1min 30sec	0	0	8	0	57.6
Shoreline Filter	3 litres 4min 30sec	0	0	100	0	54.8
Shoreline Filter	5 litres 9min 30sec	3	0	244	0	56.1
Shoreline Filter	7.5 litres 16 min	4	0	430	27	49.8
Shoreline Filter	10 litres 25min 30sec	4	0	265	3	44.8
Penguin Filter	1 litre 15 sec	6900	1460	15700	1020	8.3
Penguin Filter	3 litres 50 sec	7100	1900	22000	1040	6.2
Penguin Filter	5 litres 1min 10sec	5700	1700	31000	1200	6.2
Penguin Filter	7 litres 1min 50sec	8000	1700	18100	1180	5.7
Penguin Filter	10 litres 2min 30sec	6900	1800	21000	1230	6

The Shoreline Filter shows turbidity far in excess of the raw water's NTU. A possible explanation for this may be that the excess carbon particles were not washed from the new filter, despite the instructions being followed.

Test team's conclusions

Pat & Liz Bryant own a Prout 38 which they took across the Atlantic in 2001 and lived in for the majority of 2002 while cruising the Caribbean and the east coast of America. They have an activated carbon water filter which is connected to a hand pump, and a separate drinking water tap to conserve the life of the filter. As they have a water maker, they can be choosy where they pick up water, but after the taste test they are now considering a sub-micron filter.

Malcolm & Yvette Hammond own a six-year-old Moody 36, which they took through the French canals to the Med several years ago. The boat is now based in Barcelona. They don't have a water filter at present but were keen to join our test team to see whether fitting one would be worthwhile.

After the tests, Malcolm made the following comments: 'The most effective taste filters are also those which remove the bacteria. Of these, the one I would consider buying is Nature Pure. It was small enough to fit easily onboard, and a simple DIY job.

'The benefits of water filters are marginal if compared with tap water and probably most Northern Europe marina water. The running cost and capital is quite significant so I don't believe I would save much, if anything, over the cost of bottled water in Spain. We pay about 14p per litre when buying 5-litre bottles and spend about 20 weeks a year living aboard. Bottled water is widely available, and costs us about £28 per annum, which is less than the cost of a replacement filter. However, we do only use bottled water for drinking and making tea or coffee. For cooking, we use tank water.

'I would be more interested if desalination were also available with these filters. It would be extrememly useful, particularly in some of the more remote places, such as in the Balearics, where the desalinated water does taste very salty at times.

David Gibby owns a steel hull Callisto 385, which he takes on long summer cruises. He said, 'If I was only cruising in UK and north European marinas, I'd probably choose the Penguin filter housing with the Shoreline filter cartridge. However, as I intend to head to the Med and other areas where the water quality is unreliable, I will probably get Nature Pure.

Rob Malcolm owns a Contessa 32 and is planning to buy a water filter. He says he would probably buy the Penguin filter, but use a Shoreline sub-micron filter in it. This would give a taste filter at a reasonable price of £38 initially, and £33 for the sub-micron filter cartridge.

Pat's conclusions

In the UK and northern Europe, mains tap water is almost certainly safe to drink. However, this may not be true of the water that comes out of the dockside hosepipe. Bacteria in the water can be killed by adding a sterilising liquid to the tank or by boiling the water before drinking, or they can be eliminated by using a sub-micron filter.

If you choose an activated carbon filter, you need to remember that the addition of silver will not turn it into a bacterial filter. The silver just helps to prevent bacteria from multiplying in the filter.

None of the filters remove dissolved salts, so they can't be used as desalinators.

Although the activated carbon filters did improve the taste of the boat water, we were disappointed with their performance when compared to the sub-micron filters.

The team thought initially that the Penguin Hydropure filter housing used with Shoreline's sub-micron filter might be a good combination for removing both bacteria and unpleasant taste, although this combination was not tested in the laboratory.

For full protection, the team unanimously agreed that the Nature Pure sub-micron filter appeared to be the best – but at a price. The Hammonds and the Gibbys would both consider buying the Nature Pure for the sort of sailing that they do.

Success for Nature Pure

Some readers may recall that a few years back, I inadvertently put eight gallons of diesel fuel into my water-tank filler. Having cleaned up the system and achieved potable water using a Nature Pure filter, we used the boat all summer. When I came to replace the filter element the following season, I found to my amazement that there was a considerable amount of diesel fuel in the filter housing. There was even some diesel fuel left over this winter when I changed the filter element again – three years after the event! The water had always tasted fine.

WHAT'S AVAILABLE, HOW MUCH THEY COST TO RUN AND BUY

FILTER	HEIGHT (IN)	TRANSPARENT BOWL	ACTIVATED CARBON	SILVER BACTERICIDE	SUB-MICRON	MICRON SIZE	PRICE OF UNIT	FILTER CHANGE INTERVAL (months)	PRICE OF FILTER CARTRIDGE	ANNUAL RUNNING COST	VOLUME CAPACITY
Whale Aquasource	11.5**	N	Y	Y	N	not stated	£18	12	£18	£18	4,500 litres
Freshness	13**	N	Y	Y	N	not stated	£31	12	£31	£31	not stated
Penguin Hydropure standard***	14	Y	Y	N	N	25	£38	12	£14	£14	not stated
Shoreline	13	N	Y	Y	Y	less than 1	£89	reduced flow	£33	£17 - £33	6,000 litres
Brita Filter Jug		Y	Y	Y	N	not stated	£25	1	£4	£48	100 litres (hard water)
Nature Pure	7.5*	N	N	Y	Y	less than 1	£170	reduced flow	£42	£21 - £42	2,250 litres

* Needs room for pipes at top ** Needs room for pipes at top & bottom *** As we went to press, Penguin Hydropure had just manufactured a sub-micron filter at £60

WHALE AQUASOURCE: Whale Water Systems, Old Belfast Road, Bangor BT19 1LT; tel: 02891 270531; email: info@whalepumps.com.
FRESHNESS: Ring Mark Dowland Marine, tel: 01929 551138; website: www.burdengroup.com
PENGUIN HYDROPURE: Penguin Engineering Limited, Furniss Way, Station Road, Hayling Island, Hampshire PO11 0ED; tel: 023 9246 5607, website: www.penguineng.com
SHORELINE (UK) LTD: Shoreline, Unit 16, Martello Enterprise Centre, Courtwick Lane, Littlehampton BN17 7PA; tel: 01903 733877, email: info@shoreline-uk.com
BRITA: Brita Water Filters Ltd, Brita House, The Summit Court, Hanworth Road, Sunbury-on-Thames; tel: 01932 793959; website: www.brita.co.uk.
NATURE PURE: General Ecology, St Andrews House, 26 Brighton Road, Crawley RH10 6AA; tel: 01293 400644; website: www.generalecologyeurope.com