Next time you take a walk alongside a stream, after reading the lead article in this issue, you may pause to think about the fascinating life cycle of the freshwater pearl mussel. I am most grateful to Dr Louise Lavictoire of the Freshwater Biological Association for providing the feature item about this intriguing mollusc – as Louise explains, the species is a true litmus test of the health of our rivers.

Our wastewater expert Steve Bungay takes a slight diversion from his usual Wastewater Matters series of articles, to write a Waste Matters piece. He examines the complicated and thorny issue of (so-called) biodegradable packaging. By now you are probably familiar with receiving magazines/journals/newspaper inserts/etc wrapped in compostable/biodegradable film. All is not as straightforward as you may think...

In conjunction with WWT (Water & Wastewater Treatment), FWR are pleased to offer readers a 15% discount on a place at the 2019 WWT Drinking Water Quality conference in Birmingham in November – see back page.

For information on water-related conferences and events, and news highlights, please go to our website www.fwr.org. You can also contact us via email on office@fwr.org.uk or by telephone on 01628 891589.

Maxine Forshaw - Editor

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LIVERS of our RIVERS

Population recovery of the endangered freshwater mussel

THE UNUSUAL LIFE CYCLE OF THE FRESHWATER PEARL MUSSEL

Margaritifera requires pristine conditions with low suspended solids and nutrient concentrations, high dissolved oxygen in both the water column and the shallow interstitial zone, oligotrophic nutrient status and a natural flow regime. Due to its complex but fascinating life cycle, salmon (Salmo salar) or sea/brown trout (Salmo trutta) also need to be present as fish hosts for the mussel larvae. The life cycle of Margaritifera is an intriguing one. To start with, they can live to be over 130 years old!
They grow very slowly in cool, oligotrophic, calcium-poor streams mainly in northern Europe, although the most southerly populations are clinging to existence in Spain and Portugal. Each year, the female mussel’s eggs are fertilised by sperm released from males in early spring. Females brood their eggs for several weeks as they develop into tiny larvae called glochidia which measure 80 µm (=0.08 mm) in length. In summer, glochidia are released from the female and must find a host fish in order to survive. The glochidia snap shut on the gills of salmonids, where they stay for 9 – 11 months and develop into tiny juvenile mussels. When they mature, they measure around 400 µm (=0.4 mm) in length; at this point they drop off the fish and must fall into clean river gravels in order to continue to grow and survive.

Whilst Margaritifera are technically parasitising the fish for a short period, this very specific relationship has evolved over thousands of years and the fish suffer no ill-effects from their mini hitch-hikers. Sexual maturity occurs when individuals are approximately 6.5 cm in length (12 – 15 years old), and the whole cycle starts again! However, this delicate cycle can be interrupted by poor habitat conditions meaning that the juvenile mussels die shortly after they enter the substrate, leading to an aging population with no juveniles. In some populations the youngest mussels are over 70 years old!!

**PROBLEMS LIE AHEAD…**

Unfortunately, all of the mussel rivers in the UK suffer from a wide range of issues affecting both the mussels themselves and their host fish populations. The largest problem is degradation or loss of suitable habitat through processes such as aggravated bank erosion, increased silt and nutrient run-off caused by land drainage, and intensive land uses and unnatural flows from increased run-off or from where rivers have been straightened, diverted or impounded by dams or weirs. This leads to loss of habitat or the creation of poor-quality habitat meaning that the juveniles cannot survive. These issues are also bad news for their fish hosts which utilise the same habitat as the mussels. Degraded river gravels means lower salmonid egg survival rates.

Some rivers have been impounded and are impassable to migrating fish meaning that host fish can no longer reach their native spawning grounds, and upstream mussels are potentially left without a host. The effects of climate change are also a threat with more frequent and higher intensity high-flow events and higher temperatures putting even more pressure on struggling populations.

**WHAT IS BEING DONE?**

So, there are many issues facing the freshwater mussel and its salmonid hosts, but all is not lost. Momentum is building to save the remaining populations of mussels in the UK and to restore the habitats both within the river and catchment-wide. All across Europe there are projects and initiatives to conserve the species through river restoration and captive breeding, and the UK has seen several large-scale projects in recent years with this aim.

Since 1999 the Ballinderry Rivers Trust (and its predecessors) has been involved in captive breeding and river restoration activities on the Ballinderry River in Northern Ireland. Several reintroduction efforts have taken place and research into the genetics of different populations in Northern Ireland has informed conservation efforts. In 2007 the Freshwater Biological Association (FBA),
in England project, sponsored by Biffa Award. This project focused on habitat improvement works in several English river catchments as well as supporting captive breeding efforts at the FBA. Outreach and education were also an important part of this project.

Since 2014 United Utilities have been working with the Environment Agency and Natural England to deliver a package of compensatory measures to allow continued abstraction from Ennerdale Water. This package of measures encompasses research on mussel rivers and risk removal from mussel habitats. The work includes continuation of a project officer role on the River Ehen following on from the ‘Pearls in Peril’ project and the Irt following the ‘Restoring Freshwater Mussel Rivers in England’ project. One of the newest projects to commence in January 2019 is the Mussel Reintroductions project which focuses on researching different methods of mussel reintroductions and what makes a successful mussel reintroduction. Juveniles propagated in partnership with Natural England and the Environment Agency, embarked upon the Freshwater Pearl Mussel Ark project which is the UK’s first large-scale captive breeding programme involving several mussel populations from England. In 2018 we started propagation on our first Welsh population in partnership with the Freshwater Habitats Trust. The aim of the project is to propagate juvenile mussels from these populations for eventual release into their native catchments. Captive breeding is an emergency effort to save populations at immediate risk of extinction, and provides time for catchment/river restoration activities in mussel rivers to improve habitats so they are able to support sustainable mussel populations.

Between 2012–2016 the Pearls in Peril project, funded by the EU’s LIFE programme, delivered a suite of river restoration, conservation, education and outreach activities in Scotland, England and Wales to restore habitats, secure long-term survival of mussel populations and communicate at a local and national level to raise awareness of the species. Between 2015–2018 the FBA ran the Restoring Freshwater Mussel Rivers project, sponsored by Biffa Award. This project focused on habitat improvement works in several English river catchments as well as supporting captive breeding efforts at the FBA. Outreach and education were also an important part of this project.

Volunteering – engagement and education are important elements of species conservation.
at the FBA’s Ark will be used for these reintroductions and the project includes ongoing habitat restoration activities in the catchment.

THE FUTURE

Going forward, we must continue to restore mussel habitats where they are degraded – partnership working is key to this. Even though awareness of the species and the issues affecting it has increased in recent years, education and outreach activities are more important than ever, particularly engagement with young people who will inherit these degraded habitats and have to deal with the consequences. Education of what functioning, healthy rivers look like and how our everyday activities affect our rivers is key to changing behaviours and attitudes.

Finally, research is a vital tool to inform decision-making and there is much left to discover. Increased understanding of mussel biology, ecology and ecosystem functioning is needed to better understand the biological effects on mussels of issues such as low dissolved oxygen, synthetic chemicals (such as bleaches, sheep dip, pesticides, fertilisers) and the effects of a changing climate on this complex and delicate species.

The FBA’s Ark will be used for these reintroductions and the project includes ongoing habitat restoration activities in the catchment.

At the FBA Ark we would love to be able to do ourselves out of a job. Captive breeding is necessary at the current time to secure populations at immediate risk of extinction, but the overall goal is to return mussel rivers to functioning systems so that captive breeding can be stopped and rivers can once again support sustainable populations. Our hope is that the juveniles we are breeding now will (long!) outlive us and their subsequent juveniles will have the opportunity to thrive and provide important ecosystem services to our rivers (and to humans too) well into the future.

The FBA undertakes this by:

- disseminating information through websites, publications, meetings and courses
- high quality training, both scientific and practical
- facilitating innovative and essential research, including undertaking targeted research
- providing sound independent advice and opinion
- we have specialist facilities on the shores of Lake Windermere in Cumbria: – conferences and meetings – training courses – scientific and laboratory facilities

For more information visit www.fba.org.uk
WASTE MATTERS
Biodegradable Packaging – an environmental alternative to plastic?

Steve Bungay, FWR Wastewater Section Co-ordinator

Through our increasing awareness of plastics in the environment, there is a growing move away from non-biodegradable plastic products such as plastic bags, containers, films, and wraps that are ubiquitous in our modern throwaway lifestyle.

Compostable and biodegradable packaging are becoming buzzwords in the packaging industry, but do bioplastics provide a suitable alternative to plastic? Black plastic plant pots are being replaced with an increasing number of recyclable carbon pigment free taupe pots. There is a shift away from using black plastic in food packaging. Some plant pot manufacturers are going one stage further, and in a similar move to many plastic bag, film and wrap manufacturers, they are replacing their products with biodegradable and compostable alternatives.

However, this transition to biodegradable plastics is not as simple as it first appears, and it is far from being controversy free. There is a lot of confusing and misleading information regarding whether or not a product is truly biodegradable, and this confusion has been added to by high profile contributors such as naturalist Chris Packham and the former Environment Secretary, Michael Gove. On the BBC’s One Show, Chris Packham promoted the use of oxo-biodegradable plastic bags, and on the same show Michael Gove said he has got the government’s Chief Scientific Advisor to look at the science behind this. What are oxo-biodegradable plastics? Do they differ from other biodegradable plastics? And what is the difference between biodegradable and compostable? Ultimately, do these bioplastics provide the environmental solution they appear to offer? Scientists from University College London have said that plastic packaging labelled ‘biodegradable’ or ‘compostable’ is misleading because most of these do not break down naturally and end up polluting the environment (The Telegraph online 6th June 2019). We may not all be polymer scientists, but as you delve into the subject the confusion becomes immediately apparent. So what is the difference between oxo-biodegradable, biodegradable, compostable? And how are these properties regulated?

Oxo-degradable, Oxy-degradable, or Oxo-biodegradable – These materials contain an additive which is intended to break the molecular chain within the polymer and make it biodegrade. The material, in an undefined time frame, will fragment into smaller particles when exposed to heat or ultraviolet light.

Biodegradable – A material is biodegradable if it can be completely biodegraded by microorganisms such as bacteria, fungi and algae. There are no defined time limits for the term ‘biodegradable’, therefore the use of this word can be confusing.

Compostable – A material is compostable if the material can biodegrade in a composting process through the action of naturally occurring microorganisms and can do so to a high extent within a specified time frame.

Composting – Where microorganisms break down material in the presence of oxygen.

Even within the packaging industry the definitions above vary to some extent. However, the compostability of a material is assessed through the EU Standard EN13432, which is a harmonised standard for packaging recoverable through composting and biodegradation. The requirement for biodegradability in EN13432 is that 90% biodegradation should occur through controlled composting in less than six months. The universal symbol used to identify compostable packaging is known as the Seedling logo. Only when a material passes the criteria set out in EN13432 can it be accepted for commercial composting systems and be certified ‘compostable’ and display the Seedling logo. Biodegradable bags, films, and wraps are typically manufactured using starch-based materials and can be compliant with EN13432. Oxo-biodegradable products, which require an additive, such as those supported by Chris Packham, are not compliant with EN13432; although they are biodegradable, they do not fulfil the requirements to be deemed compostable. In addition to this, as oxo-biodegradable plastics have to be subject to heat or ultraviolet light, where would this biodegradation take place? Is using a farmer’s field acceptable? So, as one bioplastic alternative potentially fails at the first hurdle, do the other ‘compostable’ alternatives offer a suitable alternative to plastic?

The composition of bioplastics used in bags, films, and wraps are typically thermoplastic polymers based on starch and/or thermoplastic copolymers, with multiple differing synthetic components and proportions. They are broadly based on destructured starch (starch where the crystallinity of starch (amylase and amylopectine) is destroyed), combined with complexing agents and a vegetable oil such as palm oil. Depending on the manufacture, these bioplastics will have a wide range of mechanical, physical-chemical, rheological properties and different biodegradation rates. For example, corn starch bags that are used as liners for food waste caddies should be robust enough not to tear, leak, or biodegrade whilst in the food...
The complexity continues...

Different manufacturers/suppliers also provide different recommendations for their products. For example, one supplier gives the following information: The product and its content may be disposed of in a home compost system, or when using a local authority scheme, please refer to their guidelines for the use of compostable liners and accepted waste. They are 100% compostable and do not harm or contaminate the environment. Other suppliers only state ‘Fully Compostable’ and include their certification number of their compliance to EN13432.

The advice regarding home composting is incorrect. Biodegradable food caddy liners will not biodegrade in home composting systems. The caddy liners are designed to biodegrade in commercial industrial composting facilities, which will operate at higher temperatures than home composting systems. Even if the local authority scheme uses composting, it is unlikely that the material will be composted within a six-month timeframe. Therefore, in practice, biodegradable films, wraps, and caddy liners will not be subject to the conditions specified in EN13432, which are designed to provide assurance of the biodegradability of a product. There is a complete disconnect between the European Standard and certification with the actual disposal of the certified product.

The image at the start of this article shows the variation in different magazine wraps. These six wraps include one paper envelope; one identified itself as compostable (which recommended using as a liner for food waste caddies as a way of disposal); three which, although not identified as such, appear to use compostable films; and one which is non-biodegradable plastic. The only magazine wrap that is truly biodegradable is the paper envelope. It is worth noting that the wrap that is clearly labelled as a ‘Home Compostable Bag’ is not actually suitable for home composting. CIWEM (Chartered Institution of Water and Environmental Management) have made the active decision to change the wrap of their magazine The Environment from a plastic film wrap to a paper envelope.

The confusion surrounding biodegradable and composting therefore becomes quickly apparent. However, it is once these so-called ‘compostable’ materials start their recycling journey that the real problems arise. The packaging industry has created a problem that the consumer may be completely unaware of. A local authority may operate a commercial composting facility. In practice, however, if there is a food waste collection scheme, it is more likely that the food waste is used as a feedstock at an organic waste treatment facility using anaerobic digestion.

Currently, compostable bags, films, and wraps are designed to biodegrade by 90% using controlled composting in less than six months. Composting is an aerobic process where microorganisms break down material in the presence of oxygen. In contrast, an anaerobic digester operates in an environment where oxygen is completely absent. Therefore, any compostable bags, films, and wraps finding their way into an anaerobic digester will not break down. A food caddy liner or compostable magazine wrap will not biodegrade in an anaerobic digester. To prevent contamination of the final treated digested biosolids, which may be recycled to agriculture as a biofertilizer, these wraps and caddy bags have to be removed from the system prior to the anaerobic digestion process. At this stage the recycling circle is broken, and the bags, films, and wraps become a waste. In their very manufacture, these wraps and bags use materials that are designed to elongate, stretch, absorb water, and are permeable to water vapour. The very properties that make them useable in the first place create problems in separating them from the food waste they originally contained. The bags and wraps become stretchy and can squeeze through or wrap themselves around equipment. Because of this propensity to stretch and deform, these ‘compostable’ bioplastics are actually more difficult to remove from food waste than plastic. The image below shows shredded compostable bags that have been recovered from food waste.

Biodegradable plastic recovered from food waste (© Steve Bungay)

Is biodegradable packaging an environmental alternative to plastic? In its current format, the answer has to be ‘no’. The end consumer has to be made aware of the restrictions relating to biodegradable or compostable materials. This confusing and misleading information isn’t restricted to bioplastics; there is similar confusion surrounding coffee grounds and eggshells. Coffee grounds can be used in composting, but only sparingly, and eggshells are not particularly suitable for composting. Where someone practices home composting, food caddies should not be lined with compostable caddy liners, and compostable bioplastics are not a solution to replace magazine wraps. These need to be replaced with paper envelopes, and paper envelopes that do not use plastic address windows. Biodegradable plant pots are a definite improvement over single-use plastic pots, but only time will tell what level of benefit this provides.

Biodegradable bioplastics do provide environmental benefit, but we must not fool ourselves that biodegradable packaging in its current form is a sustainable environmental alternative to plastic.
Leaky Loo position statement

NEW POSITION STATEMENT ON THE LEAKY LOO PROBLEM WAS LAUNCHED EARLIER THIS YEAR BY THE UK WATER EFFICIENCY STRATEGY STEERING GROUP. The position statement highlights the scale of the problem (around 1 in 20 toilets are leaking typically 200–400 litres per day) and calls for three headline actions:

- A national campaign, coordinated by Waterwise, to raise awareness of leaky loos amongst domestic and business water customers, fittings manufacturers, plumbers, housebuilders, water industry leaders and government policymakers.

- A review of the Water Regulation Advisory Scheme (WRAS) testing regime for the relevant products, along with the effectiveness of associated accreditation and enforcement processes, product standards and labelling. We should not see products approved that cause such significant water loss issues.

- A scaling up by the water sector of best practice approaches to find and fix leaky loos in both domestic and business users (to include providing information in bills, distributing leak strips, analysis of meter data, targeted home and business visits).

23,000 wet wipes discovered on stretch of Thames river bank

This staggering number of wet wipes were counted and removed from one stretch of the Thames foreshore (in Barnes) in just two hours in March this year.

Volunteers collected the rubbish as part of a mass citizen science event to monitor the impact of plastic on the capital’s river. Many wet wipes, even those marketed as flushable, contain plastic fibres and therefore do not break down. See the lead article *When is it ‘Fine to Flush’? in our last newsletter* (May 2019) where you can read more about this issue.

Latest data shows that the so-called ‘Thames Great Wet Wipe Reef’ is growing. Bathymetric surveys, published for the first time, reveal that one of the largest mounds has grown by 0.7m in the past few years, and is now 50m wide, 17m long and stands at more than 1m high.

The foreshore at Barnes contains nine large mounds which are formed from a thick plastic wet wipe mesh mixed up with mud from the river. Academics from Royal Holloway University volunteered at the event, taking samples for research, as they are concerned about the potential negative impact the plastic is having on Thames wildlife. Read more here: https://www.thames21.org.uk/2019/04/23-thousand-wet-wipes-discovered-stretch-thames-river-bank/

FWR Out & About

We have attended various shows over the past few months – the Royal Bath & West, the Cotswold, and the New Forest & Hampshire shows, providing information on all matters water-related to the public. We have one more show to attend: the Royal County of Berkshire Show which is being held on 21 and 22 September at the Newbury Showground.

*Images courtesy Neil Tytler*
Welcome to the Summer Issue of Our Newsletter. I hope this finds you enjoying some summer sun, whether at home or abroad. Our lead article, looking at efforts being made to ensure the population recovery of the freshwater pearl mussel, makes you realise how much life cycles of creatures are interrelated and how precarious this balance can be. The piece also highlights the importance of volunteers who help in many ways to improve our water environment, so from me also, a big thanks to all those volunteers out there who tirelessly give of their time and expertise. My thanks to Dr Louise Lavictoire of the Freshwater Biological Association (FBA) for her engaging article.

In our next issue we hope to bring you news of the Freshwater Biology and Ecology Handbook: A practitioners’ guide to improving and protecting river health. This is a venture we are undertaking in conjunction with the FBA.

As we come towards the end of the ‘show season’ we have just one more to attend – the Berkshire County Show at Newbury in September. And then Christmas will be upon us all too quickly!

World Water: Resources, Usage and the Role of Man-made Reservoirs

ROCK FR/R0012, 3rd edition

This updated Review of Current Knowledge concerns the global availability and usage of fresh water and the role of man-made reservoirs in providing storage of this essential human resource. Man-made reservoirs play a particularly important role where natural precipitation is erratic or seasonal because they store water during wet periods to make it available during dry periods. This updated version of the original ROCK utilises more recent data on population, water resources and reservoir storage where available; it also considers current evidence on global warming and climate change which may affect our perception of future water resources and storage needs. The review covers:

- Freshwater resources
- Water usage
- Population
- Freshwater storage in reservoirs
- Loss of storage due to sedimentation
- Conservation of reservoir storage
- Global warming and climate change
- Future needs for reservoir storage

and assess the impact of climate change on the drinking water industry.

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