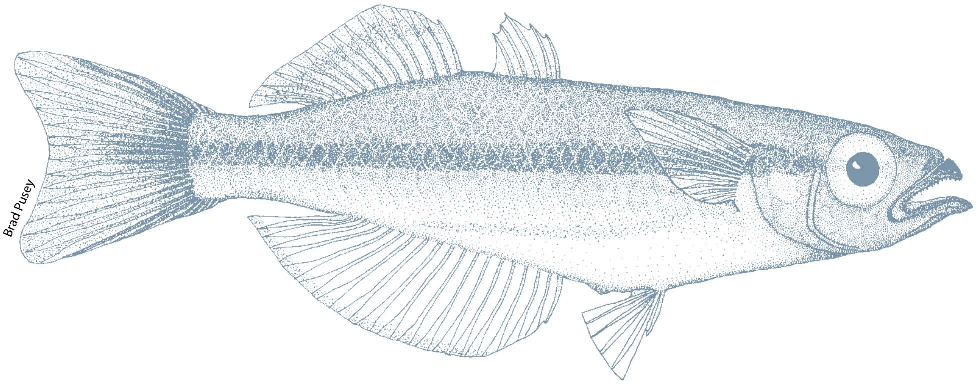
Fish need healthy stream banks



The Cairns rainbow fish (*Cairnsichthys*) is a freshwater species of Northern Australia

THE RIPARIAN ZONES of rivers and streams – essentially the areas between the low and high water marks – occur at the interface between terrestrial and aquatic ecosystems. They are usually high in biodiversity. Fish communities suffer when riparian vegetation is destroyed and recover only when riparian integrity is re-established.

Drs Bradley Pusey and Angela Arthington, of the CRC for Tropical Rainforest Ecology and Management, have researched the many links between the aquatic ecosystem and the riparian zone and the mechanisms by which such linkages may affect freshwater fish, particularly in northern Australia. Here streams are usually fringed by gallery forests composed largely of rainforest trees and shrubs. Clearing along such streams to make way for pasture grasses and sugar cane poses a threat to aquatic fauna.

The scientists present a model indicating how the riparian zone regulates the transfer of solar energy, inorganic material (such as nutrients and sediments) and organic material (such as wood, leaves and fruits) to streams and so influences the composition of fish communities. Both the individual fitness of fish and species diversity are influenced by the riparian zone – mediated by changes in water quality, habitat quality and food-chain or trophic dynamics.

The numerous interacting processes are complex, as one example illustrates. Reducing riparian cover increases average summer temperatures, but decreases winter temperatures and in one study such changes to thermal conditions returned to normal only after the stream had passed through 300 metres of intact forest. Changes in water temperature can:

- impact on fish metabolic rate, growth and reproduction; shift the balance between unicellular microalgae and filamentous green algae (unpalatable to invertebrates that many fish feed on);
- kill fish due to electrolyte imbalance and other physiological effects;
- reduce disease resistance in fish during winter;
- upset cues for spawning; and
- prolong embryonic development in fish.

Both the individual fitness of fish and species diversity are influenced by the riparian zone

And in-stream temperature is just one of many factors affected by changes to riparian vegetation.

The researchers noted many other direct and indirect riparian-stream linkages, including the important roles of woody debris and terrestrially derived food in streams which have implications for management. Although large-scale revegetation works are under way in many parts of northern Australia, rarely, say Pusey and Arthington, are stream fish the target of such restoration schemes other than in general terms of improving water quality. Could this be because fish lack the charisma of some other vertebrates?

Consideration of stream ecosystems in revegetation projects would help to conserve the freshwater biodiversity of northern Australia – home to such species as the Cairns rainbow fish, mangrove jack, barramundi and jungle perch.

Steve Davidson

MORE READING:

Pusey BJ and Arthington AH (2003). Importance of the riparian zone to the conservation and management of freshwater fish: a review. *Marine and Freshwater Research*, 54:1–16.

What's wood worth?

To accurately calculate CO_2 emissions from land-use change and forest management, scientists must understand the decomposition rates of coarse woody debris (CWD) on forest floors. This is because the carbon stored in dead trees, branches and stems, is released as CO_2 when left to decay on cleared or harvested sites.

Dr Juergen Bauhus and his colleagues from the Australian National University and the CRC for Greenhouse Accounting in Canberra, and the United Nations Environmental Program in Nairobi, recently reviewed the patterns and rates of decomposition of coarse woody debris, documented in a large number of studies from around the world.

'Currently, the information on woody debris decay in Australian forests and plantations is insufficient to allow reliable calculations of CO_2 emissions, or to manage for this structural element in forest ecosystems,' Bauhus says.

'Our review aimed to document the range of decay rates and patterns that have been observed for woody debris, to identify factors influencing its decomposition, and to estimate the lifetime (time to reach 95% mass loss) of debris from Australian tree species.'

Their analysis of CWD decay rates showed that mean annual temperature was the main driver of decomposition, accounting for 34% of the variation in decay rates of logs and branches. Log diameter accounted for 22% variation, and initial wood density was also important.

Analysis of CWD lifetimes for Australian and other species, revealed that an average of 92 years was required for 95% decomposition, with a median of 49 years.

More plastic from plants

Plant oils might replace petrochemicals as the basis of plastics if an Australian-Swedish team succeeds.

Most people associate vegetable oils with salad dressings and pasta dishes. But they are also important in the production of resins, plasticisers, glues, surface coatings and lubricants. Of the two million tons of plasticisers produced globally, for example, 75% are synthesised from petrochemicals, while 25% originate from ‘chemically epoxidised’ soybean, linseed and tung oils.

Unfortunately, the need to epoxidise commercial vegetable oils – a process that alters the structure of the fatty acids in oils to produce ‘epoxy fatty acids’ – makes them more expensive and inefficient to use. What industry needs are oils that already contain industrially useful fatty acids. A source of such oil would also provide a renewable and biodegradeable alternative to our dwindling petrochemical reserves.

CSIRO scientists in Canberra could soon supply this demand, thanks to research that aims to harness the ability of some plants to produce epoxy fatty acids. In collaboration with scientists from Sweden, Dr Allan Green, Dr Surinder Singh and Dr Xue-Rong Zhou have isolated and cloned a gene (*Cpal2*) which directs the synthesis of epoxy fatty acids in *Crepis palaestina* – a relative of the dandelion. The team aims to insert this gene into a commercial oilseed crop, such as linseed, to produce commercial quantities of epoxy fatty acid. But there are a few challenges to overcome first.

‘*Crepis palaestina* seeds contain about 70% epoxy fatty acid, but when we transfer the *Cpal2* gene to linseed, we get only 2% epoxy fatty acid produced,’ Singh says.

‘We need at least 50% epoxy fatty acid production for commercial purposes. So we’ve been trying to understand the function and expression of the gene to determine why it isn’t operating to its full potential in linseed.’

Part of the answer may lie in the need for other genes involved in the biochemical pathway that leads to epoxy fatty acid production in *C. palaestina*. The team will now insert these genes, along with the *Cpal2* gene, into *Arabidopsis* (the ‘lab-rat’ of the plant world), to see what happens.

‘We want to get the *Cpal2* gene to function to its full potential in *Arabidopsis*, and then transfer that capability to linseed,’ Singh says.

If the team succeeds, their findings will likely be applicable to a family of genes that direct the synthesis of other industrially useful fatty acids. These include genes for the production of hydroxy fatty acids, found in castor oil and used in lubricants and inks; conjugated fatty acids from tung seeds; and acetylenic fatty acids found in another dandelion relative, *Crepis alpina*.

‘Other leading international research groups are helping to develop these fatty acids’, Singh says.

‘Swedish colleagues are working on producing acetylenic fatty acids, which could be used in the production of nylon, specialty chemicals and lubricants.’

Singh says farmers, industry and society will benefit from the technology.

‘Farmers will have expanded market opportunities for their crops and will generate higher returns. The new crops will increase the genetic and biological diversity in agricultural production systems. Industry will be able to avoid costly chemical processing steps and minimise environmental impact. And society will benefit from the reduced depletion of non-renewable resources,’ he says.

Companies switching to a plant-based epoxy product will have a marketing advantage associated with using a ‘green raw material’.

Wendy Pyper

CSIRO Plant Industry

Linseed is under trial as a plastic plant.

This work is funded in part by BASF Plant Science GmbH .

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MORE READING:

Singh, S. *et al* 2001. Transgenic expression of a Δ12-epoxygenase gene in *Arabidopsis* seeds inhibits accumulation of linoleic acid. *Planta,* 212: 872–879.

Lee, M. *et al* 1998. Identification of non-heme diiron proteins that catalyze triple bond and epoxy group formation. *Science,* 280: 915–918.

‘These values clearly indicate that the Intergovernmental Panel on Climate Change (IPCC) default value of 10 years, for the calculation of the complete mass loss of above ground biomass following land-use change and forest harvesting, is unrealistic,’ Bauhus says.

For native Australian species, lifetimes derived from wood durability studies ranged from seven years for *Eucalyptus regnans*, to 375 years for *E. camaldulensis*. However, as the experimental conditions under which these studies were conducted were substantially different from wood decay conditions in the field, Bauhus says that the majority of these estimates must be regarded as minimum lifetimes for most species. Better information could be obtained through long-term decomposition studies of wood debris in different environments.

‘Our review indicates that further investigation of the determinants of wood decomposition is needed, to permit a modelling approach to an estimation of CWD turnover and the release of CO2 from decaying wood,’ Bauhus says.

Wendy Pyper

MORE READING:

J Mackensen, J Bauhus and E Webber (2003). Decomposition rates of coarse woody debris – A review with particular emphasis on Australian tree species. *Australian Journal of Botany*, **51:** 27–37.

John Coppi, CSIRO Land & Water

Lichens accelerate wood decay.