Oz duckbills, but US dollar bills

Platypus ... central to the genome project under way at Washington University.

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Other nations will reap the benefits of research into our much-loved plants and animals, writes Deborah Smith.

THINK of a platypus, and the United States does not usually spring to mind. Visions of gum trees also rarely inspire thoughts of Japan. But they should.

These countries are busily deciphering the genetic codes of our iconic animal and plant and could benefit most from what they find. The platypus genome project is under way at Washington University and the eucalypt genome project is being carried out at the Kazusa DNA Research Institute.

It's a trend that worries Australian scientists.

The nation is failing to take advantage of the enormous economic opportunities offered by its distinctive flora and fauna in this rapidly developing area of science, says Professor Phil Batterham of the University of Melbourne. "It's time for Australia to take action to harvest our unique genetic heritage before other countries do it for us."

Genomics - determining the sequence of all the letters of an organism's DNA - forms the basis for most biological research today, says Professor John Mattick, a Federation Fellow at the University of Queensland. It will transform biology-based industries in the areas of health, the environment and food production, and it will create new businesses, he says. "That's why it's important to invest in it."

He predicts it will be only 10 years before everyone can have a copy of their own genome on the back of their Medicare card, so quickly is genome research advancing.

If Australia does not become more involved, it will not develop the scientific expertise to deal with the enormous amount of genetic information that will be generated.

It could also miss out on any commercial applications that flow from the new knowledge about its people, plants and animals.

Dr Sue Forrest, the director of the Australian Genome Research Facility, adds that studying the genomes of the country's flora and fauna is also vital to their preservation.

Forrest's laboratory is helping carry out the only major genome project in Australia - the kangaroo genome - which is a joint effort with the US National Institutes of Health.

Skippy's genes, however, almost weren't decoded, when Australian funds could not be found two years ago to match the offer of $6 million from the Americans. At the 11th hour the Victorian Government stepped in with extra money and a draft of the genetic code of the tammar wallaby should be ready by the end of the year.

Kangaroos have many unusual characteristics, including that the mother can carry a newborn and a larger joey and produce different kinds of milk from neighbouring teats.

Unlocking the secrets of their unusual genome would benefit medicine and agriculture, says Forrest. "It could lead to new treatments for premature birth, better milk production in cows, as well as novel antibiotics."

Along with Batterham, Forrest has set up the Australian Genome Alliance, an association of researchers pushing for a national strategy for genome research. Most genome projects require large amounts of money, usually more than $10 million each, putting them beyond the scope of grants from the Australian Research Council and National Health and Medical Research Council.

The scientists believe a third research agency should be established to fund genome projects chosen by an expert panel for their economic and social benefit to Australia.

Canada has this set-up, says Mattick, who advises Genome Canada on projects to fund. Its budget so far has been more than $800 million, and it is "no accident" that Canada has the second most vibrant biotechnology industry in the world, he says.

At a recent conference in Canberra many of the country's genetic scientists outlined projects they think would be good candidates for funding.

Professor Robert Saint of the Australian National University says the corals that built the Great Barrier Reef are of major significance to the country, with the reef bringing in

$1.6 billion a year in tourism. Yet little is known at a genetic level about how corals build reefs and their relationships with the algae that give them their colour. Nor do we know why this symbiosis breaks down during bleaching episodes caused by warmer waters. "We have so much to learn and so little time. A genome sequence would dramatically speed up discoveries," he says.

Surprisingly, Australian researchers have recently found that coral has many genes in common with people that are missing in worms or flies. So there could be benefits for medicine in studying its genome.

The Japanese are expected to finish the first gum tree genome project - on a species called *Eucalyptus camaldulensis* - next year.

An international consortium, including Brazil and South Africa, is planning to sequence a second species, *Eucalyptus grandis*, in a $15 million project that it hopes will be backed by the US Department of Energy.

Australian scientists, however, have yet to find the $1 million that could make us a partner in the enterprise.

"This is clearly one of the areas where we have a capacity to excel and we're not exploiting the opportunity," says Professor Rod Griffin, of the Co-operative Research Centre for Sustainable Production Forestry.

Australia's scientific expertise in gum trees means we are in a good position to influence research by the international consortium to our advantage, for example by encouraging genome research on the species most important to our pulp and paper industry, *Eucalyptus globulus*.

"We do have some bargaining chips. But we have to be at the table in order to play them," says Griffin. "It's not too late, but it's almost too late."

There are about 800 species of eucalypts, yet only three account for most plantations worldwide. Eucalypts represent a largely unexploited resource, and we're the custodians, he says. "If we want to conserve it we need to understand more about its genome."

Environmental research is an area where genomics has not been widely exploited and where Australia still has the chance to grab the leadership, says Professor Ary Hoffmann, a Federation Fellow at the University of Melbourne.

He has already shown that analysing the DNA of the clouds of tiny midges flying around muddy waterways can reveal what pollutants are present, because species sensitive to the contaminants are missing.

The little flies that hover around fruit can also act as a sensitive warning system for climate change, he says. A study of their DNA has already revealed that hotter, drier conditions in eastern Australia have changed the flies' genetic make-up in the past 20 years.

Australia is a great place to study the genomes of insect species and the way they have adapted to environmental change, because it stretches from tropical regions in the north to temperate regions in the south, says Hoffmann. "And it has a stable political climate."

Batterham, who is the director of the International Genetics Federation, says the war against insect pests is often a case of "spray and pray", with the action of pesticides still poorly understood. "We lose too many battles because we fight with little intelligence."

The world's No.1 insect pest, the somewhat inappropriately named cotton bollworm, would be an economically sensible target for genome research, he says. The little moth and its close relatives, which attack more than 100 different crops, cost Australia about $225 million a year in lost production and control measures, and the worldwide figure is $5 billion.

Genome research could identify the detoxification genes that allow it to destroy insecticides, as well as the genes that make it resistant to chemical insecticides, so this problem could be more easily tracked.

The insect's biological weak spots could also be found, says Batterham. "New intelligently designed insecticides could be developed and sold into a vast global market providing a blockbuster product for Australian biotechnology."

In 2004 his team was awarded a $1.4 million grant from Australian Wool Innovation to work on the genome of the sheep blowfly.

Other possible genome projects include crops, fungi, parasites and microbes unique to Australia.

Batterham points to the international cattle genome project as one where Australia will benefit from its early involvement. It has been able to influence how the project was carried out and will be able to use the information to improve cattle breeding here, he says.

10 YEARS OF GENOMICS

1995 the bacterium *Haemophilus influenzae*

1996 bakers' yeast

1998 round worm

2000 fruit fly, watercress plant

2001 humans, E. coli

2002 malaria parasite and mosquito that carries it, mouse, rice, puffer fish, sea squirt

2003 dog (a poodle called Shadow), bacterium that causes anthrax

2004 dog (Tasha the boxer dog), rat, honeybee, chicken, cryptosporidium parasite

2005 chimpanzee

2006 the opossum