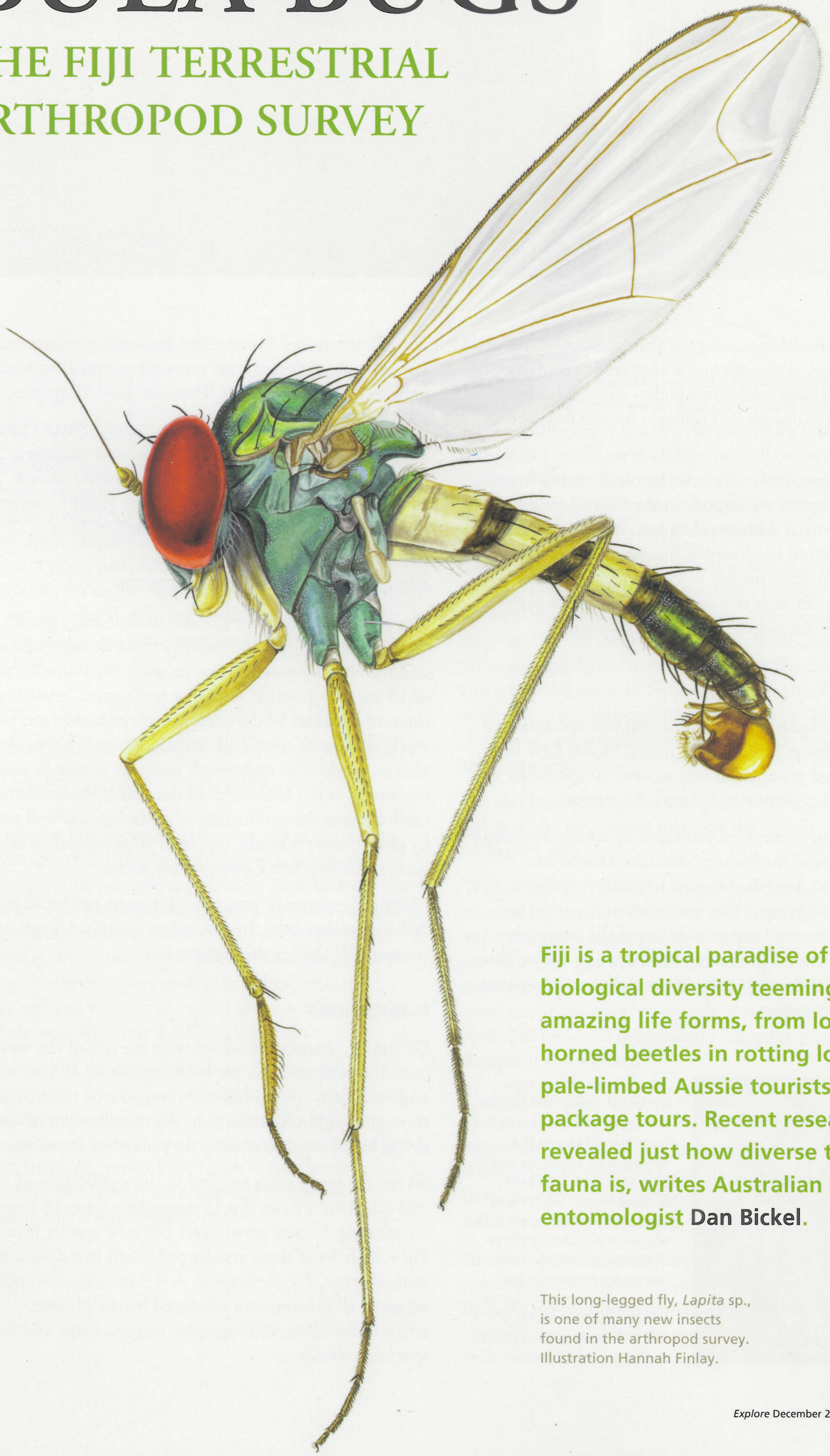
BULA BUGS

THE FIJI TERRESTRIAL ARTHROPOD SURVEY



Fiji is a tropical paradise of biological diversity teeming with amazing life forms, from long-horned beetles in rotting logs to pale-limbed Aussie tourists on package tours. Recent research has revealed just how diverse the Fijian fauna is, writes Australian Museum entomologist Dan Bickel.

This long-legged fly, *Lapita* sp., is one of many new insects found in the arthropod survey. Illustration Hannah Finlay.

right: Joske's Thumb, south-east Viti Levu, Fiji. Photo Dan Bickel.

centre right: Sampling methods used in the arthropod survey included Malaise traps (tent-like structures that intercept flying insects), litter sampling to capture ground-dwelling arthropods, sweeping with nets and beating vegetation. Photo Neal Evenhuis.

far right: Fiji islands showing collecting sites. Map Jeremy Austen.

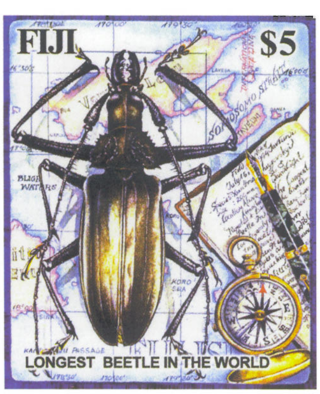
Arthropods are the most successful animals on Earth – diverse, abundant and widespread. The name means 'jointed legs' and arthropods – insects, spiders, crustaceans, centipedes and others – usually boast quite a few pairs.

For the past four years, I've been involved with a large survey of terrestrial arthropods in the Fijian Islands. The Fiji Terrestrial Arthropod Survey aimed to reveal the region's enormous biodiversity, knowledge of which was previously restricted mainly to vertebrates and plants. It also aimed to enhance the country's capacity for science and make new knowledge available to the world.

BIODIVERSITY

The survey collected an estimated 700,000 specimens of terrestrial arthropods. Of these, over 230,000 have been sorted to target groups and sent to over 50 specialists in 12 countries for identification and description.

A comprehensive checklist produced by survey investigator Neal Evenhuis of the Bishop Museum, Honolulu, cites over 4830 described species of arthropods from the Fijian Archipelago. This information is critical for the conservation and sustainable use of the country's biological diversity. The survey has helped to define areas of arthropod endemism and species richness throughout the Fijian archipelago.



This postage stamp from Fiji shows one of the largest beetles in the world. It is a long-horned beetle that can grow to 15 cm. Its larva, growing to 20 cm, feeds in dead logs in the mature rainforests on the large islands. Because it requires intact old-growth forests, the beetle has become a conservation icon, its future threatened by logging. It's just one of many arthropod curiosities found in Fiji.

As well, the survey has revealed great hidden diversity. For example, before the survey, we knew of 14 species of long-legged flies from Fiji. There are now 95 species, 79 of them new to science.

These insights will support Fijian resource managers to determine areas in need of special natural resource consideration, for example through the Fijian Government's National Biodiversity Strategy and Action Plan.

CAPACITY BUILDING AND EDUCATION

The survey included the key aim of building capacity within Fiji for future biodiversity research with education and training for native Fijian peoples. We trained a total of 15 parataxonomists in survey techniques, involving them in all stages of the survey, from planning and field work to identification and analysis. As an offshoot, I was able to conduct an eight-week graduate course in insect taxonomy at the University of the South Pacific, Suva. The methodology for conducting work in Fiji was well received by government officials, students, villagers and groups such as the Wildlife Conservation Society.

Our public outreach program on insects produced posters and videos that were distributed to schools, villages and community centres throughout Fiji.

PUBLICATIONS

Of course, sharing the results with the rest of the world is critical too. Species are the building blocks of biodiversity and every new species has to be introduced to science through a publication. In fact, the classification of the living world is based entirely on published taxonomy.

So far, the project has resulted in the publication of 103 scientific articles (by 41 researchers from 16 countries) – including 15 new genera and 148 new species from Fiji – with 34 of these articles published in a dedicated journal series, *Fiji Arthropods*. A website allows worldwide access to all information produced by the project: articles, checklists, bibliography, images, maps and the specimen database.

This impressive number of publications will certainly grow over the coming years.

DIVERSE LANDSCAPES

To understand just why there is such biodiversity in Fiji, we need to consider the underlying geographical and geological diversity of the landscape as well as climatic factors. These features conspire to create many habitats for different species, each with their own requirements, to thrive. It also means that a survey, to be comprehensive, must aim to sample all of the available habitats. To see the scope of this, we need some background on the island group itself.

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Geologically, Fiji was once part of an island arc system (the Vanuatu-Fiji-Lau-Tonga Ridge) that is located along the tectonically active boundary zone between the Australian and Pacific plates. Overall, repeated volcanism and tectonic activity, combined with uplift, limestone deposition, and erosion have resulted in a complicated geology. However, many geologists believe that the Fiji archipelago was not emergent above sea level until relatively recently, some 5 million years ago.

The interior of the major islands is often rugged, with volcanic plugs, eroded calderas, deep gorges and ravines carved by mountain streams. On some of the flatter coastal regions, there are wide valleys with extensive flood plains. Although some of the Fijian islands are true atolls, most of the low islands are composed of bedded limestone overlaying volcanic rock.

LUSH HABITAT

Fiji has a warm, humid tropical maritime climate, with the south-east trade winds bringing moist winds onto the land. On the larger islands, the orographic effect of the mountains results in abundant rainfall on wet windward sides and diminished rainfall on the dry leeward sides. Precipitation accounts for much of the variation in vegetation and biodiversity in general.

Dense rainforest is found on the windward side of the islands, with cloud forest occurring on ridges and peaks above 600 metres. Fijian rainforest has a comparatively large number of species in diverse families, with lianas, ferns and epiphytes, including orchids. By contrast, the drier, leeward zones of Fiji, which were once covered with distinctive sclerophyllous ('dry-leaved') forest and scrubland, are now dominated by grasses, ferns and sugar cane plantations.

Fiji also has considerable mangrove swamps, often in deltas of the large rivers or where the coastline is protected by barrier reefs.

What I find particularly intriguing is the unusual connection between the fauna of Fiji and faraway, apparently unrelated, places. The best known of these are the Fijian iguanas, with two living species and fossils known from both Fiji and Tonga. They are isolated in the southwest Pacific and have their closest relatives in Central America. How did these closely related species come to be so distant and isolated?

Our surveys have revealed other unusual patterns. The island of Taveuni, for example, has a blackfly species whose closest relatives are in South America, not the western Pacific which is the usual pattern. The blackflies have their larvae in fast-flowing streams, and are very unlikely to be good long distance dispersers.

Another question is the 'disjunct' distribution of terrestrial organisms, where closely related species are separated by hundreds of kilometres of ocean, an inhospitable saltwater barrier. How do these organisms actually reach such remote islands, some being relatively young volcanic

above left: Parataxonomists received a one-week crash course in arthropod identification and on-the-job training in survey methods. Photo Neal Evenhuis.

above right: Mangroves and rainforest near Naqara Island, Viti Levu, are critical habitats for arthropods. Photo Neal Evenhuis.

landmasses that have only recently emerged from the ocean floor? Long distance dispersal is often given as an explanation, and indeed this is documented for insects that can be transported as 'aerial plankton' and for species of plants whose seeds can survive long distance transport in saltwater. But long distance dispersal from the Americas, for both iguanas and blackflies, almost defies belief, and remains a Fijian biogeographical mystery.

NEW QUESTIONS

The survey has left its mark on our understanding of regional biodiversity and has provided a solid platform for further work. The data can be used to assess biogeographic hypotheses about origins of the Fijian fauna as well as its relationships to other neighbouring Pacific faunas. But despite its four years of work and scientific legacy, we still know the terrestrial arthropod fauna only in outline and, as is usual, the survey raises new questions about biogeographical links, all of which will require further investigation. The Fijian biota has great potential to illuminate the biogeographical patterns and processes operating in the rapidly changing Pacific region.

Dr Dan Bickel is a research scientist at the Australian Museum.

The Fiji Terrestrial Arthropod Survey was established in 2004 with funds from the US National Science Foundation (NSF) and the Schlinger Foundation, and is based at the Bishop Museum, Honolulu.

Further reading

Evenhuis, NL & Bickel, DJ, 2005. The NSF-Fiji Terrestrial Arthropod Survey: Overview. *Fiji Arthropods I. Bishop Museum Occasional Papers* 82: 3–25.

Fiji Arthropod Survey website http://hbs.bishopmuseum.org/fiji

SCIENCE BYTES

TAKING STOCK OF THE GREAT BARRIER REEF

■ A recent survey of the Great Barrier Reef netted more than 400 species of fish, writes the Museum's Rebecca Hancock.

What fishes are zooming around the blue waters of the Great Barrier Reef?

In September this year a group of Australian and Canadian scientists visited the Australian Museum's Lizard Island Research Station to survey the fishes inhabiting the island's reefs.

Amanda Hay and Sally Reader from the Australian Museum's Ichthyology (Fish) department joined the diving expeditions (and coordinated the trip) which collected and catalogued more than 400 species of fish.

The trip aimed to collect tissue samples for genetic analysis (DNA from the CO1 gene), which will provide species identifiers or 'barcodes'. Scientists also took 'live colour' photographs of the fishes and recorded information about the capture sites.

The data will be widely available as an identification tool, enabling fisheries managers, for example, to identify accurately any specimen in the field or laboratory, especially where the juvenile and adult stages of some species appear to be quite different.

It will also help us to understand and monitor the distribution of species while contributing to the better management and conservation of fisheries, and in understanding and monitoring the effects of climate change on Reef fish communities.

The collected specimens have been lodged at museums around Australia, with the majority at the Australian Museum, to allow the wider scientific community to access them for research.

Rebecca Hancock