ADVERTISEMENT FEATURE

Sweeping synergy in ecological research

Located in China's most biodiverse province, YUNNAN UNIVERSITY boasts a wide range of basic and translational research initiatives.

The Nu-Salween river system provides a vast laboratory for studying trans-border ecological security.

The black-and-white snub-nosed monkey is an endangered species endemic to southwest China.

The discovery in 2016 of the Mesozoic mammal *Anebodon luoi* was led by the Centre for Vertebrate Evolutionary Biology.

Unique wildlife and palaeoecological treasures make Yunnan a perfect site for the School of Ecology and Environmental Science (SEES), a part of Yunnan University. Since 1937, it has been the launching pad for budding ecologists and international scholars in developing frontier research.

From profiling newly discovered species, to mapping international ecosystems, they have dug deep into the past to guide research and conservation strategies.

SPEARHEADING RESEARCH ACROSS SPACE AND TIME

About 52 km southwest of Yunnan's provincial capital, Kunming, the Maotianshan Shales at Chengjiang county is home to scattered fossil sites of the early Cambrian era from 518 million years ago. This significant assemblage of the early Cambrian organisms, known as the Chengjiang biota, was discovered in 1984 by Xianguang Hou, who led a team at Yunnan Key Laboratory for Palaeobiology (YKLP).

In addition to surveys of fossil biotas across southwest China, they have produced new theories surrounding adaptive radiation during the Cambrian explosion, revealing how ancestral species rapidly diversified into a multitude of new forms. Their studies into evolutionary palaeobiology, as well as the palaeoecological origin of modern marine ecosystems, were recognized by multiple State Natural Science Awards in China.

At the end of the Permian period some 252 million years ago, the largest mass extinction event ever killed off 81% of marine animals and 75% of land vertebrates. Zhuo Feng has led a team at the Institute of Deep Time Terrestrial Ecology to bring first-hand findings unearthed from southwest China. Their systematic taxonomic studies of fossil plant groups and the reconstruction of interspecies co-evolution have painted a comprehensive picture of palaeoecosystems in the region.

Their 2020 study, based on a thorough examination of more than 30,000 fossil plant specimens from 20 geological sections, demonstrated a highly diversified rainforest ecosystem of the Cathaysia flora before the extinction. As one of the four principle late Paleozoic floras, the Cathaysia flora collapsed and was replaced by the nearly mono-specific seed fern vegetation on upland and herbaceous lycopsids in the coastal area. Their finding of the abrupt disappearance of the Cathaysia flora sheds new light on how land plants responded to the end-Permian mass extinction.

SEES scientists at the Centre for Vertebrate Evolutionary Biology have also been working to help paint a bigger picture. Apart from reporting on new dinosaur findings, they are recognized for highlighting the biodiversity of mammals through time, Neogene-era climate changes and mammalian evolutionary responses, and the origin and evolution of key characteristics for mammals. An example is their 2016 fossil discovery of *Anebodon luoi*, a new genus and species of Mesozoic mammal with a distinctive dentition, which gives clues on the evolution of marsupial and placental mammals.

Just as comprehensive are SEES's national research projects into trans-border ecological security, from pest control and disaster prevention, to mapping water resources in the region's 18 shared river systems with neighbouring countries. Supported by the Institute of International Rivers and Eco-security, they focus on the Longitudinal Range-Gorge Region (LRGR), resulting from the longitudinal towering mountains and deep valleys across southwest China. Data collected from their observation points offer a new view of LRGR topography, including the corridor and barrier effects of the mountain ranges. Their systematic modelling and numerical simulation identified unique eco-geographical effects on monsoon circulation, which affects the redistribution of rain and hydrothermal patterns.

LRGR also features a UNESCO-listed world heritage site, the Three Parallel Rivers of Yunnan Protected Areas. This 1.7 million-hectare region contains the upper reaches of the Yangtze River, as well as two cross-border river systems: Nu-Salween, and Lancang-Mekong, which is known as the world's second-most biodiverse region for fish species. SEES has helped establish Asia's first conservation base for migratory fish across borders, in addition to new conservation and legal enforcement strategies across borders with Laos and Myanmar. Within China, they have created the first monitoring centre for the effects of tributary dam demolition on habitat and resource restoration for fish. They have also supported the construction of 12 national aquatic germplasm reserves in southwest China, and dedicated fish reserves in the lower section of Lancang River, targeting 106 fish species.

Another research goal for SEES has been reducing ecological impact of infrastructure, ranging from dam construction to more than 50 major hydropower and river transport projects. Conservation strategies range from the early identification and assessment of ecological risks, to striking a better balance between tributary protection and mainstream development.

RETHINKING BIOCONTROL AND BIODIVERSITY

Two SEES professors at the State Key Laboratory for Conservation and Utilization of Bio-Resources, Keqin Zhang and Li Yu, have developed new strategies for biocontrol and biodiversity conservation.

Biocontrol, or the eco-friendly use of natural predators to reduce invasive species, has been central to Zhang's studies since the early 1990s. As the laboratory director, he has led research into root-knot nematodes (RKNs), a parasite of plants which causes huge economic losses. While traditional chemical nematicides fail to account for the complex interactions between introduced biocontrol agents and the agricultural ecosystems, they also pose potential environmental and health problems.

Zhang focuses on control agents based on microbes which feed on RKNs. They contain several nematophagous fungi to reduce their population density or disease impact. Their screening technique and identification of a number of

Advertiser retains sole responsibility for content

Keqin Zhang's team developed biocontrol agents against root-knot nematodes for crops, including *Panax notoginseng*, a traditional Chinese medicine.

fungal strains, have achieved an increase in nematicidal efficiencies. Such success can be attributed to their improved understanding of fungistasis, or the capacity of soils to inhibit the germination and growth of soil-borne fungi in the presence of optimal abiotic conditions. They have identified factors in the soil causing fungistasis for the biocontrol microbes, and the reduction of fungistatic effects. Separate investigations also revealed that temporal variations for microbiome around the roots in the soil were partly responsible for biocontrol effectiveness.

When there is a microbial imbalance in the soil environment, certain nematodes become dominant in the environment. Zhang has also improved the germination and growth of the applied fungi, while helping to initiate its nutrition switch from saprophytes feeding on dead and decaying matter to nematode predators.

At the other end of spectrum for positive human intervention is the promotion of genetic diversity. Yaping Zhang and Li Yu are co-leaders of the study group 'Evolution and Conservation of Animal Genetic Resource Diversity in Southwest China'.

Their animal conservation research has benefited national and provincial governments, offering a scientific guide for the protection and use of genetic resources. Their transdisciplinary advances in evolutionary biology, such as functional genetics and comparative genomics, have contributed to diverse findings from identifying genetic factors that endanger rare wild animals, to discerning the molecular mechanisms underlying genetic diversity, and evolutionary convergence for the domestication of highland animals.

Such study subjects include the Tibetan mastiff, which had been used by indigenous Tibetans, and once was one of the most expensive pets in the world, prized for their distinctive furry appearance. Dogs have accompanied human migrations across the world — and understanding this global spread facilitates the understanding of human history.

The research group led by Zhang and Li traced the origin of Tibetan mastiffs, suggesting that they are an ancient breed derived probably from east Asia, and originally domesticated from the Chinese native dogs of the plains. In addition, they identified specific functional genes and genotypes associated with high-altitude adaptation of the Tibetan mastiff. They also assessed the genetic diversity and evolutionary convergence for several domesticated highland animals, promoting the conservation and utilization of the germplasm resources.

Yu's investigations into adaptation strategies also extended to the endangered Yunnan snub-nosed monkeys, which made the cover of *Nature Genetics* in August 2016. They have performed the de novo whole-genome sequencing and population genomic analyses of the snub-nosed monkey genus, which comprises five closely related species distributed across altitudinal gradients from 800m to 4,500m, to address the adaptation to high altitude in the snub-nosed monkeys (*Rhinopithecus bieti, R. roxellana*, and *R. strykeri*). They uncovered the genetic mechanism underlying their high-altitude adaptation.

Their 2020 genomic study highlighted another critically endangered animal, pangolin, which has been frequently poached and trafficked worldwide. Apart from looking at how environmental and human factors led to their population decline, the paper shows the resulting increase in their inbreeding and genetic load, with mutations in genes linked to cancer and cholesterol homeostasis, further decreasing their adaptive potential.

This study revealed the types of illegally traded pangolins, and outlined previously unrecognized genetic populations that should be protected as evolutionarily distinct conservation units, revealing useful insights for the global protection of pangolins. ■