

# LENGGURU 2014

**A scientific exploration  
of Papuan karsts**

**- INDONESIA -**

**21 January - 6 March**

**Press Kit**

**January 2014**





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## LENGGURU 2014: a scientific exploration of Papuan karsts

The LENGGURU 2014 scientific exploration will take place in Papua from 21 January to 6 March 2014. Conducted by the Institut de recherche pour le développement (IRD), the Indian Institute of Sciences (LIPI), and the Académie des pêches de Sorong (APSOR - Sorong Fisheries Academy), with corporate sponsorship from COLAS, this exploration involving nearly 95 European and Indonesian researchers is the largest scientific exploration ever undertaken in Indonesia.

### A hotspot for unique and still undiscovered biodiversity

For millions of years, the Papuan karsts have evolved through complex tectonic movements. Characterised by a unique geological history and a mosaic of original ecosystems, these misunderstood regions that are difficult for humans to access are unique reservoirs of biodiversity, hosting many endemic species.

A preliminary exploration initiated in 2010 led to a first census of the exceptional biodiversity of the Western Papuan karsts. The LENGGURU 2014 exploration will enrich these preliminary observations by expanding the areas of study. It will help better understand the processes responsible for establishing and maintaining biological diversity in these extreme ecosystems.

### A sustainable and responsible partnership

The scientific exploration is based on a sustainable partnership with Indonesia and is part of the protocol for Access to Genetic Resources and Just and Equitable Sharing of the Benefits of their Usage (APA) adopted at the Nagoya Conference on biological diversity in 2010. This protocol is based on three pillars: access, sharing of benefits, and compliance with national and contractual rules.

Within the LENGGURU 2014 framework, the teams will carry out the essential analyses of the biological samples in the zoology and botany laboratories of the LIPI in Cibinong, near Jakarta, Indonesia. Thus, molecular barcoding will be carried out at the IRD-LIPI joint experimental platform, a structure devoted to this type of analysis also established in Cibinong. Only certain analyses that cannot be processed locally will justify removal of genetic material from the country, in the form of DNA extraction or specimens, which will be returned after analysis.

### Educating young people and the general public

An extraordinary scientific and human adventure, the exploration is an opportunity to educate the general public, and young people in particular, about the role of research in building knowledge and the preservation of biodiversity. Exhibits and many educational opportunities will be held in France, Indonesia, and Papua New Guinea.

PRESS RELEASE



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## The secrets of LENGGURU

### Lengguru: a mosaic of original ecosystems

The Lengguru range is characterized by series of fold-and-thrust mountainous wedges culminating between 900 and 1,500 metres (3,000 to 5,000 ft.) separated by deep valleys, sometimes completely enclosed where the run-off of water gets lost in crevices – they are called endhoreic valleys.

The topography of Lengguru mainly consists of lime stone formations called “karst”, designed over the latest millions of years by the combined action of run-off water and dissolved carbon dioxide.

This rough and rugged terrain is the shelter for a multitude of natural labyrinths, on the surface or underground, and its maritime part. As many original ecosystems such as lapiez, poljes, siphons, dotted rivers and numerous endhoreic lakes, dolines, caves and underground networks. Altitude, depth, humidity, isolation, salinity and temperature maintain a mosaic of ecological niches, which favour the adaptation and evolution of species.

#### Lapiez and high forests

Lapiez are cracked and eroded lime stone plateaux, covered with various forest habitats depending on the altitude, the geological substrate, the exposure to dominant winds, monsoons, and their level of isolation. Papua biodiversity being known to increase with altitude, these unexplored environments are potential havens for unique and unknown animal and vegetal communities.

#### Poljes, endhoreic lakes, dotted rivers

Poljes are large, elliptic depressions taking the shape of canyons or valleys, which sometimes shelter endhoreic systems such as marshes or lakes. The water disappears in the depth of the karst, sometimes as submerged siphons or underground rivers referred to as “dotted” – divided into open air sections (on the surface) and underground sections.

The most ancient poljes, at the heart of Lengguru, date back to the times when the massif was formed, 10 million years ago. Isolated by steep cliffs, these poljes probably host an unexpected biodiversity as well as living remains of the past biodiversity.

The real challenge for the expedition scientists is to wait until they can explore these isolated areas, probably never visited by Homo Sapiens.



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#### Dolines, caves, underground networks

Dolines are circular depressions caused by erosion and the collapse of lime stone in a karst environment. From a few tens to several hundreds of metres in diameter, they are sometimes, just like caves, a gateway to the underground world and several kilometres of network.

Biodiversity in underground tropical karst environments has hardly been studied. These habitats are known however to host a more significant proportion of endemic species than any environment on the surface.

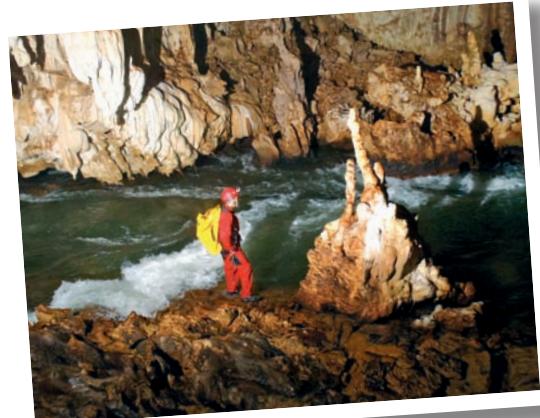


The stability of underground environments and the age of underground sometimes allow relic species to survive, which can no longer be found on the surface. Their discovery may help the identification of missing links, thus leading to a better understanding of the evolution of terrestrial groups.

When they are old enough, karsts may host hypogean species such as blind fish or crustaceans. These species have adapted to underground environments, and generally feature a de-pigmented body, an extended sensory system and blindness.

### Maritime karsts and reef slopes

The Lengguru frontal zone plunges more than 2,000m (3,300 ft.) into the Seram Sea. Like its emerged part, it is a karst network submerged by the sea. This karst was formed during the various maritime regressions, and equally hosts a broad variety of habitats such as caves and immersed underground networks, fresh water seepages (Vruljas), canyons and fossil valleys, coastal maritime lakes and numerous reef slopes. These unknown environments will be explored vertically by teams of divers equipped with recycled systems down to depths of approximately 100m (330 ft.).



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### A ten million year-old massif

At the end of the Miocene (11-9 MY), the subduction of the Australian tectonic plate under the Pacific plate resulted in the Lengguru accretionary prism and its emergence above sea level. The alternance of mountainous wedges and isolated valleys (i.e. endohoreic) which is characteristic of Lengguru was completed 7 million years ago.

### First a link...

At the beginning of its genesis, the Lengguru massif acted as a terrestrial bridge between primitive New-Guinea and the Bird's Head Peninsula – a block of continental crust which separated from Australia more than 30 million years ago and moved closer under the impulse of tectonic movements – potentially enabling exchanges between their respective fauna. More to the East, new subduction occurrences further allowed the formation of the mountainous range dividing New-Guinea lengthwise, with more than 5,000 metre high summits (16,500 ft.).

### ... then a natural barrier

Later, rising by several centimetres each year, Lengguru probably acted quickly as an organisms dispersal barrier between the Bird's Head Peninsula and New-Guinea, on the one hand, and the Northern and Southern parts of New-Guinea on the other.

The significant rates of endemism that characterize the zoological populations of these three biogeographical regions could therefore be due to the origin or genesis of Lengguru and the great cordillera. The discovery of primitive species, isolated within the heart of Lengguru for over 10 million years, will allow to test this theory, and also to calibrate through time the biological diversification processes for all the analysed groups.



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## A sustainable scientific programme

### The stake: to understand the biological opulence of Lengguru

The South-East Asia karsts are considered as “islands within the islands” because they host an often significant part of the regional biodiversity. These high levels of diversity and endemism, which are typical of karst systems, can be explained by an outstanding palette of ecosystems, very fragmented terrains, contrasting local climate conditions, various levels of isolation and an often ancient geographical history going back several million years. The karsts cover nearly 10% of the immerged surface of South-East Asia, and they still are the less studied environments. They only represented 1% of the scientific publications reporting on the terrestrial and aquatic ecosystems studies between 1985 and 2004.

There is no zoological or botanical data available about Lengguru, although it is a region the size of Sardinia. Only a few peripheral areas were visited, in particular by the Australian ichthyologist G. Allen, who was the first to describe a few fish species.

The geological history of the Lengguru massif, of which we are today well aware, is an important basis for the understanding of the biological diversification processes responsible for the Lengguru fauna and flora.

### Target: tracing the Lengguru species genealogy

The purpose of the Lengguru programme is to study the processes and interactions between geodynamics – biodiversity – human societies within the karst systems of Western Papua.

The general methodology is to implement on-site missions covering a broad spectrum of ecosystems with contrasting characteristics: aquatic versus terrestrial. Surface versus underground, maritime versus continental, open versus fragmented.

The ecosystems studied were selected thanks to the preliminary data collected during the Lengguru 2010 Franco-Indonesian expedition.

Beyond an inventory of animal and vegetal communities, based notably on molecular bar-coding or traditional taxonomy techniques, biologists will be able to establish the phylogenetic relations between the species collected in Lengguru and those originating from peripheral areas.

### A federal approach

The confrontation between molecular, morphological, ecological, geological and paleontological approaches will allow to offer evaluative scenarios for all the groups analysed. This integrated approach will, in particular, allow to test the capacities of the Western Papua karst networks as a “reservoir of ancient lineages”, “endemism centres” or “biodiversity cradle”.

Extending the archaeological and anthropological researches will allow to pinpoint the role played by the Lengguru massif during the various human migrations between Asia and Australia since the end of the Pleistocene era (2.6 MY – 12,000 years). These researches will also allow to show more accurately the interactions between these societies and the contemporary fauna and flora communities in order to better understand their respective evolutions.



## Lengguru 2014 expedition

### Programme

The 2014 Lengguru scientific expedition is aiming at recording and studying the biodiversity within a broad spectrum of ecosystems, using an innovative approach focusing on the impact of environmental factors, and on the adaptation and evolution of species.

The expedition will work in three types of environments:

- **terrestrial**, including sampling from rivers, endohoreic lakes, poljes, lapiez, and several types of forests from the sea level to the top of the anticlines at 1,200m (4,000 ft.);
- **underground**, including the exploration and cartography of various caves, dolines and underground rivers;
- **maritime**, the exploration and cartography and bathymetry of the karst immersed parts.

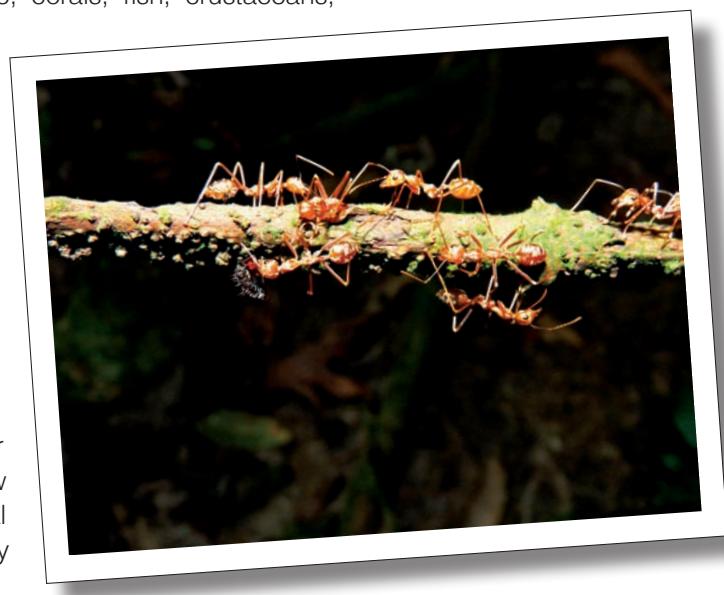
The terrain work will be carried out between 21st January and 6th March 2014, with a staff rota on 12th February.

The places visited will all be in the Kaimana region : Buruway (Karang Derdi –Nusa Ulan village), Arguni Atas (Wanoma et d'Urisa villages), Triton Bay (Lobo and Kamaka villages), Kayumerah Bay (Avona village and Tanjung Boi cape).

Mammals, amphibians, reptiles, birds, arachnids, algae, corals, fish, crustaceans, echinoderms, gastropods, orchids, palm trees, ginger,..., will be studied in relation with their molecular (barcoding and additional nuclear and mitochondrial markers) and morphological (meristic, biometry, osteology) specificities. Samples collected will consist in vouchers, pieces of fins, bits of muscle, feathers, blood samples, etc.

All samples of genomic DNA for plants and animals will be collected in the Cibinong LIPI zoological and botanical laboratories.

All collected material will be recorded in the Indonesian reference collections (MZB-Cibinong for zoology, BO-Bogor and Man-Manokwari for botany). When material from new species is involved, part of it will be stored in international reference collections, after agreement has been given by the Indonesian scientific authorities and the IRD.





## Teams

95 participants, divided into 8 thematic and 3 technical support teams, on several sites.



### Marine biology team / diving support team

The sampling methodology will consist in collecting manually corals, algae, gorgonians, invertebrates along vertical transects, from -100m (-330 ft.) to the surface. This approach will, in particular, allow to study the specific richness and the connectivity of communities depending on the depth, currents and turbidity.

For the continental part, the team will explore the immersed underground networks of the Seraran anticline (Jabuenggara Cave), and also the floor of Lake Kamaka. In the Jabuenggara Cave, where, in 2010, was discovered the first cavefish species of Indonesian Papua, the team is planning

to explore the deepest area of the network and search for potential new cavefish and crustaceans species. In Lake Kamaka, where the bathymetry will be carried out beforehand by the karstology-hydrology team, the focus will be on the deepest areas, which are suspected to have an underground connection with the Triton Bay. All organisms consistent with anchialine environments, darkness and greatest depths will be sampled.

All collected samples will be photographed, and their habitats mapped and recorded in detail (GPS coordinates, depth, salinity, water conductivity and hardness, temperature, turbidity, etc.).





## Herpetology team

The team is planning to explore several types of ecosystems at various altitudes. These environments include the forests (from litter to canopy), the lapiez, the lake and marsh shores, and more isolated environments such as the endhoreic valleys or other altitude areas.

Sampling will consist in observing and collecting amphibians and reptiles over different times at day and night along predetermined paths depending on altitude and the variety of biotopes the scientists come across. The chants of the frogs will be recorded, because they help identify the species. Since it is known that the herpetofauna endemism increases with altitude in New-Guinea, the team will develop protocols appropriate to study the turnovers of species communities proper to each altitude.

Each specimen collected will be photographed in vivo, euthanized, collected for molecular analysis and preserved in diluted formalin for further analysis of its morphological characteristics.

The physical features of the habitats will also be emphasised.

The biological collecting specialists in the canopy will train the Indonesian partners in such procedures, and will contribute to other teams (botany) to help them with their sampling (orchids and other epiphytes).



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© Philippe Gaucher

## Mammology team

This team, which focuses on the study of mammals, is divided into 2 group.

- The first group will concentrate on terrestrial mammals such as marsupials (kangaroos, couscous, etc.), bats and rodents. It will operate in various ecosystem types, and at various altitudes. It will collect its samples using nests or local hunters. Only one sample of each will be euthanized, the others only collected for genetic analysis.
- The second group will focus on the cetaceans met in the backrush or maritime waters, and will list the species encountered. It will work on the same sites as the marine team and will mainly concentrate on visual observations and counting techniques. Tissues will be collected using appropriate techniques and crossbows.



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### Ornithology team

The sampling strategy will consist in catching birds with appropriate invisible nets, fitted along paths within different ecosystems at various altitudes.

Each specimen will be weighed, blood sampled (molecular analysis), measured and photographed. Each individual will be banded and released. Their chants will also be recorded.

The molecular and morphological analysis (plumage and general shape) will enable, for each bird, to establish the indexes of diversity and demography, and to identify potential different populations depending on the altitude or level of ecological complexity.



© IRD / Laurent Pouyaud



© IRD / Laurent Pouyaud

### Ichthyology - oncology - malacology team

The ecosystems investigated include all aquatic environments, from brackish to fresh waters, whether in rivers, lakes or underground.

This team is assigned to collect the largest possible number of fish, crustacean and shellfish living in fresh or brackish waters, whether in surface or underground habitats.

The specimens, which will be collected using electro-fishing equipment or other appropriate fishing gear (nets, hoop nets, etc.), are destined to molecular analysis. The carcasses will be preserved for further morphological analysis and collections. Each specimen will be photographed according to the same protocols set for the other teams.

### Entomology team

The entomology surface team will explore several types of ecosystems at various altitudes. The team's interest is on the collection and study of various groups of insects and arachnids. It includes a group of scientists working in underground and soil environments, and another specialising in open air and overhead environments.

The underground group will concentrate on the diversity of collembola and arachnids, and will rely on the experience of the caving team to enter the caves and reach the oligotrophic, or conversely guano-rich microhabitats. The collecting methods are diverse, and include aspiration, trapping in cups, sieving or observation techniques. The micro fauna collected will be stored in alcohol solutions for further examination.

The surface group will assess the diversity of odonates, des hymenoptera and arachnids, from the litter to the canopy. Capture is ensured by light trapping, the use of nets, or the technique involving shaking branches into a white sheet.

All collected samples will be dried, and assembled in view of further analysis following the same protocol set up for other zoology teams.



## Botany team

The team is planning to explore several types of ecosystems at various altitudes. These environments include the forests (from litter to canopy), the lapiez, the lake and marsh shores, and more isolated environments such as the endhoreic valleys or other altitude areas.

The team will mainly focus on the groups of orchids, palm trees, ginger, magnolias and other angiosperm, conifers, bryophytes, pteridophytes. It will also focus on the vast variety of mushrooms. The canopy will be explored in cooperation with the herpetologists.

All samples collected will be kept in herbaria. The DNA samples will be collected directly on site, following appropriate protocols. Live orchids and other ornament flower plants will be brought back to the botanical garden to be cared for until the next blossom, hence allowing to supplement the species descriptions.

There will be three of each herbarium in order to supply various prestigious international collections.



## Karstology - hydrology team

One of the targets for the hydrologists will be to identify the hydrological regime of the Arguni Bay, a complex ecosystem on the fringes of the Lengguru karst, which hosts many endemic species. The second target will be to carry out the comprehensive bathymetry of the endhoreic Kamaka Lake in order to better understand the fluctuations of its fill levels, which can reach several tens of metres despite the alternating monsoons.

The main targets for the cavists, as far as they are concerned, are to explore the underground networks of the Berari massif and the springs and resurgences of high Lengguru. Beyond mapping and caving, these targets will also enable biologists to access these extreme environments.

Finally, researchers will be accompanied by a medical staff and a data management and statistics staff.





## An educational and cultural project

An extraordinary scientific and human adventure, the LENGGURU 2014 exploration is an opportunity to educate the general public, and young people in particular, about the role of research in the production of knowledge and the preservation of biodiversity. Through the many educational opportunities that will be held in France, Indonesia, and Papua, the IRD will offer many young people the opportunity to preview an unknown world.

### **Educational opportunities for young people**

#### ■ France

Two projects have been initiated in the Languedoc-Roussillon region:

- The first, intended for primary school students in the city of Montpellier and carried out in partnership with the City's Directorate for Landscape and Biodiversity, offers several activities: a comparison of karsts in Languedoc-Roussillon and Papua ; the creation of a travel diary; field trips with local specialists in limestone areas; following the exploration on the exploration's blog; and sessions presenting the exploration.
- The second will invite secondary school students to conduct their own research projects, to follow the exploration through its website, meet with researchers, and present their projects at various events scheduled at local institutions in 2014.

Additionally the City of Mende will host a research colloquium devoted to scientific and speleological explorations on 21 March 2014. Organised by the Émile Peytavin secondary school, in partnership with the *Société des lettres sciences et arts de la Lozère* (Society of Letters, Sciences, and Arts of the Lozère), the heritage department of the Ignon Fabre Museum, the IRD centre in Montpellier, and the Departmental Committee on Speleology, this colloquium will offer public conferences, round tables, poster sessions, etc.

#### ■ Indonesia and Papua

- French secondary school of Jakarta

Secondary school students will be invited to conferences/debates with the researchers before and after the exploration. One class plans to create an interactive exhibit on LENGGURU 2014 and follow the exploration through the online logbook.

- *Institut français d'Indonésie* (French Institute of Indonesia)

Three cultural centres in the Institut français d'Indonésie's network will present conferences/films on the exploration to the general public and in particular to students: Yogyakarta, Bandung, and Surabaya.

- Secondary schools in Papua

After conversations with the researchers at a conference before the exploration, two secondary schools from the city of Sorong will follow the exploration through its website.



**To allow groups of young people, teachers, and the mediators involved in the project follow the exploration, the website [www.lengguru.org](http://www.lengguru.org) will soon have an «educational area». It will specify the terms for the educational materials put in place and will offer documentary «resource» pages.**

## **Events and audio-visual productions for the general public**

### **■ Trilingual large-format photography exhibit**

At the end of the first half of 2014, the IRD and the City of Montpellier's Directorate for Landscape and Biodiversity will make a public presentation and exhibit of thirty large format photographs taken during the exploration. In three languages (French, English, and Indonesian), this exhibit will present the exceptional biodiversity of the Lengguru region as well as the fieldwork conducted by the scientists. Presented in Montpellier and Indonesia starting in the summer of 2014, it will then be available for loan in France and internationally.

### **■ Programs at the *Mare Nostrum* Aquarium of Montpellier Agglomeration.**

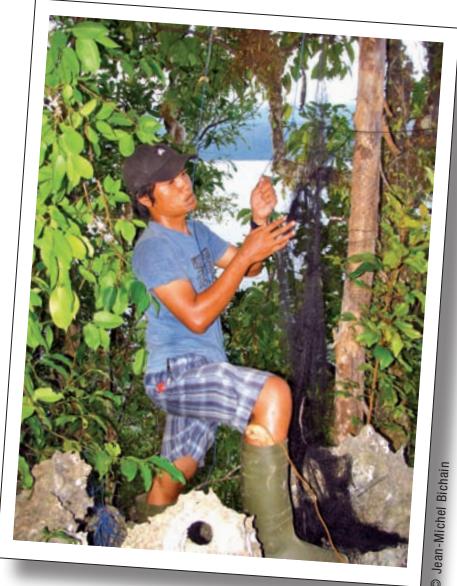
The IRD and the *Mare Nostrum* Aquarium will join together to allow the public to follow the progress of the exploration. On the program: school tours of the aquarium, near-live links with the scientists during the exploration, etc.

### **■ «LENGGURU, the Last Eden of Biodiversity»: A film event and a television series**

Mona Lisa Production will follow Laurent Pouyaud and all the scientists involved in the exploration to produce a program event: «LENGGURU, the Last Eden of Biodiversity». Primarily an adventure film, it will attempt to show six weeks of exploration by a team of «adventurer» scientists: the most exciting and dangerous moments, discoveries, etc. A blockbuster film, it will show the public the exceptional sites and misunderstood fauna of Lengguru through cinematic means (underwater and aerial images, animal cinematography, etc.). Produced at the heart of the scientific epic, this 90-minute program will be broadcast in prime time on ARTE in 2014.

Additionally, Mona Lisa is preparing a true scientific television series, of 4 52-minute episodes, with the goal of showing the researchers' discoveries, some of which have a global impact. Each episode will be devoted to a biotope and will show both «natural history» images filmed during the exploration and the process of analysing the samples collected and the species inventoried, filmed in the laboratories in Jakarta, Paris, and Milan.

The techniques used will be exceptional, such as for example electron microscopy (ESEM, under patent by Mona Lisa). It will be a co-production with the IRD and will be broadcast on ARTE at the end of 2014/beginning of 2015 and on the channels of Mona Lisa's partner broadcasters in Europe, the United States, and Asia.



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© Gilles Segura



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## Follow the exploration on the dedicated website: [www.lengguru.org](http://www.lengguru.org)

The role of the website [www.lengguru.org](http://www.lengguru.org), established by IRD, is to enable the general public, journalists, young people, and teachers to follow the exploration.

Richly illustrated, the website brings together all types of information about LENGGURU 2014: the context and objectives, a detailed scientific program, a presentation of the teams, the major stages of the exploration, scientific partners, and sponsors.

A logbook with regular contributions from the researchers during the exploration will help follow the progress of the exploration of the Papuan karsts.

Lastly, the site will summarise the results of the exploration conducted in 2010.



## Organizers, partners and sponsors

### Founding scientific institutions

The programme involves mutual cooperation between Indonesian and European scientists in scientific research and student training (masters and doctorates). These activities will be carried out within the framework of an agreement signed between the LIPI and the IRD in 2012. They also involve the Sorong Fishing Academy.



#### **The French *Institut de recherche pour le développement* (IRD)**

French organisation, co-founder of the project.

The IRD is a French research institute whose missions are to develop cooperation programmes with Southern Countries in matters of research, development and training. [www.ird.fr](http://www.ird.fr)

[www.ird.fr](http://www.ird.fr)



#### **The Cibinong Centre for Biology Research**

The Cibinong Centre for Biology Research (RCB-LIPI) is the Indonesian co-founder organisation at national level. The LIPI is the governmental organisation which is authoritative in Indonesia in matters of scientific research, and more particularly in the domain of biodiversity sciences.

[www.lipi.go.id/](http://www.lipi.go.id/)



#### **The Sorong Fishing Academy**

The Sorong Fishing Academy is the Indonesian co-founder organisation at local level. It is an educational institution under the authority of the Fishing & Maritime Affairs Indonesian Ministry. It allows young students to prepare, in particular, for a career in the merchant navy, in the fishing or aquaculture industry, or in the preservation of coastal areas and aquatic environments.

[www.kkp.go.id/](http://www.kkp.go.id/)



## Laboratory organizer



The Montpellier Evolution Sciences Institute is a combined research unit involving IRD, the French Centre national de la recherche scientifique and the French Université Montpellier 2.  
[www.isem.univ-montp2.fr](http://www.isem.univ-montp2.fr)

## Guest scientific institutions



**Pusat Penelitian Oseanografi, Lembaga Ilmu Pengetahuan Indonesia (RCO – LIPI)**



**Muséum national d'Histoire naturelle (MNHN-Paris), France**



**Centre national de la recherche scientifique (CNRS), France**



**Museo Nacional de Ciencias Naturales (MNCN-Madrid), Spain**



**Università degli Studi di Milano-Bicocca, Italy**



**Université Paul Sabatier (UPS - Toulouse), France**



**Cabinet d'expertise en Karstologie (CENOTE), France**



**Universidade dos Açores, Portugal**



## Associate business for development support



Dinas Perikanan dan Kelautan, Kabupaten Kaimana, Papua Barat, Indonesia



Universitas Negeri Papua (UNIPA, Manokwari), Papua Barat, Indonesia



Universitas Cendrawasih (UNCEN, Jayapura), Papousie, Indonésia



Università degli Studi di Milano-Bicocca, Italy

## Associate business for development support



**The Air-Kita foundation** based in Jakarta (Indonesia), and under the leadership of D. Perez, supports the expedition in its fund-raising and logistics. It also offers to carry out a feasibility analysis for the capture and supply of drinkable water to the village of Urira where the first known species of cavefish was discovered in 2010.

## Sponsors



**COLAS SA** and its Indonesian subsidiaries **-WASCO** and **ABS-** have set up a patronage partnership with the IRD since 2008. This support has allowed the Lengguru project to develop. COLAS shares the values and targets of the IRD, among which the ethical aspect of sustainable involvement towards our Indonesian partners.

## Soutien technique



**Scurion™**





## Revisiting the LENGUGURU-KAIMANA 2010 exploration

Organised by the IRD, the Indonesian Ministry of Maritime Affairs and Fisheries (KKP), the Indonesian Institute of Sciences (LIPI), in partnership with the Caracol association and the CENOTE engineering firm, the LENGGURU-KAIMANA 2010 exploration, conducted between 3 October and 19 November 2010, was the first phase of an interdisciplinary and multi-disciplinary project with the objective of understanding the evolutionary dynamic of the Lengguru mountains and their structuring role on biodiversity.

Combining archaeology, geology, biology, palaeontology, and karstology, this exploration required significant logistics: a thirty-metre ship from APSOR served as base camp for the forty members of the team; the research zones were reached by travelling up the major watercourses using inflatable rafts; lastly speleology and underground diving were necessary to reach caves and subterranean rivers.

### Multi-disciplinary discoveries

The scientists first identified at least fifteen new species of **fish**, including rainbow fish, gobies, and a de-pigmented cave-dwelling species with no eyes. New species of **mammals**, **insects**, and **amphibians** (in particular a frog that carries its offspring on its back) were also discovered. Attesting to the extreme biological wealth of the site, these discoveries were presented in many publications in 2011 and 2012.

In parallel, archaeologists discovered several sites with **cave paintings** and **sculptures** never before described in Papua. These discoveries appear to confirm one hypothesis of the researchers on the exploration: the Lengguru mountains were the site of significant migrations between Australia and Asia during major human population movements over the past 40,000 years. Lastly, geologists noted original **erosion phenomena in the karsts**.





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## Glossary

### Anchialine

An anchialine environment refers to a hydrological system with a subterranean connection to the ocean.

### Anticline

An anticline is a dome-shaped geological entity, as opposed to a synclinal, which is basin-shaped.

### Barcode

A barcode is a DNA sequence allowing to match a specimen with a species. Hence, molecular barcoding is a technique used to identify the species to which an individual belongs from a sample of blood, feather, etc.

### Bathymetry

Bathymetry is the measurement of ocean or lake depths in order to produce a chart of its floor.

### Biometry

Biometry is about measuring life. In other words, it refers to the quantitative study of the biological characteristics of living beings.

### Bryophyte

Bryophytes or mosses are terrestrial or fresh water plants, epitomized by the lack of vascular system, i.e. roots. They feature structures called rhizoids to adhere to the substrate.

### Collembola

Collembola are small arthropods which live on the surface and up to 12" underground.

### Doline

Dolines are circular excavations ranging from a few tens to hundreds of metres in diameter, issued from the erosion and collapse of karst lime stones.

### Echinoderm

Echinoderms are marine animals such as sea urchins or starfish, the body of which can be divided into five symmetrically from the centre.

### Endemism

Endemism refers to the characteristics of fauna and flora specific to a territory or geographical area. A species is called endemic when it cannot be found anywhere else in the world.

### Endorheism

Endorheism refers to regions where water drainage does not reach the sea. Endoreic watersheds, valleys or lakes are closed hydrological systems, as opposed to exorheic watersheds, which flow on the surface towards the ocean.

### Epiphyte

Epiphytes are plants that use other plants as a support to anchor their roots, such as algae, lichens, ferns, orchids, etc.

### Herpetofauna

Herpetofauna refers to all the species of reptiles and amphibians (frogs and other batrachians). Herpetology is the science to study herpetofauna.

### Hymenopter

Hymenoptera are a type of insects, significantly featuring mandibles and two pairs of membranous wings : it is, for instance, the group including bees, wasps, ants...

### Hypogeum

An hypogeum is an underground structure. "Hypogeum" species are those which have developed underground

### Ichthyology

Ichthyology is the study of fishes.

### Karst

Karsts are limestone rocks that have been worn and dissolved by the run-off of rainwater over millions of years, creating unique geological formations.

### Lapiez

Lapiez are geological formations on the surface of limestone rocks issued from their dissolution : the rocky plateau features numerous trenches, cracks and crevices.

### Meristic

An adjective referring to the count of a number of organs (fin rays, muscular segments of an eel, gill rakers on a gill arch, etc.).

### Mitochondria

The mitochondria is an element of the cell which converts the glucose into energy molecule. The mitochondrial markers are the DNA markers contained in the mitochondria. Contrary to the nuclear DNA, the mitochondrial DNA comes only from the mother of the individual.

### Odonate

Odonata refers to the dragon fly family. They are insects with an elongated body, featuring two pairs of membranous wings and compound, voluminous eyes.

### Oligotroph

An oligotrophic environment is, generally in an aquatic environment, one which is particularly poor in nutrients.

### Orogenesis

Orogenesis refers to all the formation mechanisms of mountains and varied relief.

### Osteology

Osteology is the study of bones and more generally the skeleton.

### Polje

Poljes are flat-floored depressions enclosed between steep slopes, and several kilometres wide, characteristic of karst environments.

### Accretionary prism

An accretionary prism is a rocky fold-and-thrust belt created by the accumulation and compression of oceanic sediments at underwater trench level as an effect of subduction.

### Pteridophyte

Pteridophytes are flowerless and seedless plants such as ferns and horsetails, which only reproduce via spores.

### Relic

A relict species is one of very ancient origin, nearly extinguished, which is concentrated within a very limited area, and most often features archaic characteristics.

### Subduction

Subduction is the process that takes place at convergent boundaries by which one tectonic plate moves under another plate.

### Uplift

Uplift is the process by which a portion of the lithosphere is lifted, creating the varied relief.

### Taxon

A taxon is a group of living beings descending from a common ancestor. Branches, classes, orders, families, species... are taxons. Taxonomy is the science classification science for organisms.



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