LENGGURU 2014 EXPEDITION

KABUPATEN KAIMANA - PAPUA BARAT
INDONESIA

(October - November 2014)

FINAL REPORT

INSTITUT DE RECHERCHE POUR LE DEVELOPPEMENT
Expedition leader

LEMBAGA ILMU PENGETAHUAN INDONESIA
National counterpart & co-leader

POLITEKNIK KELAUTAN DAN PERIKANAN SORONG
Local counterpart & co-leader

RISTEK
304/SIP/FRP/SM/X/2014

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Final report

LENGGURU 2014 EXPEDITION

How Geodynamics promotes Biodiversity in Papuan Karsts?
(Kabupaten Kaimana – Papua Barat)

October –November 2014
RISTEK Authorization: 304/SIP/FRP/SM/X/2014

Joint Expedition of France and Indonesia Research Institutions

Expedition Leader: Institut de Recherche pour le Développement (IRD)
National Counterpart: Lembaga Ilmu Pengetahuan Indonesia (RCB - RCO - LIPI)
Local Counterpart: Politeknik Kelautan Dan Perikanan Sorong (Politeknik-KP-Sorong)

Funded by:

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Environment Department from the COLAS SA Company
&
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With the help of:

Bupati Kaimana Bapak Mathias MAIRUMA
&
Kaimana authorities

TABLE DES MATIERES

PART I: EXECUTIVE SUMMARY

Background - Since millions of years, Papuan limestone karsts have evolved through complex tectonic uplift movements. These sedimentary outcrops are characterized by a large array of ecological niches afforded by complex terrains and variable climatic conditions. Most form "islands within islands" and are biodiversity reservoirs with high levels of endemism. In Southeast Asia, karsts cover around 10% of the land area but surprisingly contribute just 1% of the regional biodiversity researches outputs from terrestrial and freshwater ecosystems. Beside this, most of Asian karsts are also threatened by large-scale mining (cement manufacturing) and by forestry logging. They are therefore considered as biodiversity hotspots for conservation priorities.

Previous research and results - We initiated in Oct.-Nov. 2010 a preliminary joint research program (i.e. Lengguru-Kaimana 2010; surat izin penelitian **RISTEK: 226/SIP/FRP/SM/X/2010**) for a first terrestrial biodiversity assessment in West Papuan Karsts (Kaimana Regency, Indonesia). Among others, this first expedition enabled the discovery of the first known cavefish in Indonesian Papua, 4 new species of rainbowfishes, 3 new species of gobies. These preliminary results were already published in international journals.

Research locations - Lengguru 2014 Expedition has started the assessment of the biological richness prevailing in several complex arrays of marine and terrestrial ecosystems with an original approach centered on understanding the role of environmental factors in driving biological diversification. All visited locations were in Kaimana Regency and belonged to several districts: Buruway (Karang Derdi – Nusa Ulan village), Arguni Atas (Wanoma and Urisa villages), Triton Bay (Lobo village).

Supporting agreement and expedition team - ***The Lengguru 2014 Expedition*** was based on a joint cooperation between Indonesian and European scientists and was covered by a MOU signed between LIPI and IRD in 2012. For the implementation of the project, both LoA and MTAs were signed. This scientific expedition was co-organized by IRD (French Institution), RCB-LIPI (National counterpart) and Politeknik-KP-Sorong (Local counterpart). It involved around 60 Indonesian researchers from LIPI (RCO and RCB) and several local institutions (i.e. Politeknik-KP-Sorong, Dinas Kelautan dan Perikanan Kaimana, UNIPA, UNCEN, UNMUS) and 27 foreigners from France (i.e. IRD, CNRS, MNHN, CENOTE, UPS-Toulouse) and Spain (MNCN-Madrid).

Aims of the project - The ***Lengguru 2014 Expedition*** initiated a sustainable and responsible partnership with the building of a long-term joint research venture prioritizing morphological and molecular analysis to be conducted in Indonesia through the joint IRD-LIPI molecular platform (RCB-Cibinong) for terrestrial material and through the RCO-Ancol genetic laboratory for marine samples. The program also supported several research activities of Indonesian scientists in Europe respectively at IMBE Marseille (molecular and morphological analysis of gorgonians and echinoderms), at UPS Toulouse (molecular analysis of birds), at MNHN Paris (molecular and morphological analysis of collembolans), and at Kew London (morphological analysis of orchids). The ***Lengguru 2014 Expedition*** partnership has also supported data management and sharing, co-authorship publications and scientific valorizations through a photo exhibition with caption and information boards (*Lengguru, a lost world*: 26 panels with caption and information boards, 180x120 and 90x60, Indonesian/English French/English versions) and a documentary TV film (*Lengguru, the lost world*: French-English-Indonesian versions, 90 min, coproduction ARTE France, IRD, Mona Lisa, 2016).

Research, methodology and depository of specimens - Mammals, amphibians, reptiles, birds, insects, arachnids, algae, seagrass, corals, gorgonians, fishes, crustaceans, echinoderms, gastropods, orchids, palms, gingers, and others will be inventoried through both molecular (DNA barcoding and/or additional nuclear and mitochondrial markers) and morphological (meristic, biometry, osteology) approaches. Samples collected consisted of voucher, fin clips, muscle, feather, and blood). All DNA extractions for both zoological and botanical materials were done in Indonesia (LIPI, Cibinong) and were supported by the expedition budget. All collected specimens (including holotype, part of paratypes, additional material) are stored in Indonesian reference collections (MZB-Cibinong for Zoology, BO-Bogor and MAN-Manokwari for Botany). Part of paratypes (in case of species descriptions) and part of additional material will be also deposited in international collections upon the approval of Indonesian scientific authority (RCB-LIPI). The general methodology for collecting material during the expedition was based on field survey conducted in a large array of ecosystems and displaying contrasted features under environmental gradients (aquatic versus terrestrial; surface vs. underground; depth vs. altitude; marine vs. inland; opened vs. fragmented). Each specimen was tagged with its GPS coordinates, photo, and environmental description of its habitat.

The expedition has been organized through 3 distinct sections:

- A terrestrial section including sampling in rivers, lakes, various forest types from the seashore to the top of some rugged ranges (1400 m),
- An underground section comprising exploration of caves, sinkholes, underground rivers,
- A submarine section with the exploration of submerged marine karsts, bottom of elevated and remote lakes (i.e. Danau Kamaka) and outer reef slopes.

In all visited areas, members of the expedition has asked for the help of locals for collecting and storing the specimens and for investigating all targeted areas. Based on the field experience obtained in 2010, the Lengguru 2014 Expedition has proposed an adapted logistic to all participants and assisted their safety with an experienced medical staff (i.e. Doctor Jean Chevallard – IRD).

Support from local government – On 9 to 17 July 2013, a preliminary survey (not research) was conducted in Kaimana to socialize the project. A presentation was done in front of Kaimana's Bupati, Bapak Matias Mairuma, and several Dinas representatives (Sekda, BAPEDA, Dinas Pariwisata, Dinas Perikanan, heads of respective districts in Kaimana). Socialization was also conducted with Polres, Kodim, local immigration and BKSDA (Sorong). Their approval of the oncoming Lengguru 2014 Expedition was presented in the Surat Dukungan signed by the Bupati on 15th July 2013.
On 20th November 2014, at the end of the expedition, preliminary results were presented in front of the Bupati and all of his staffs during a special event organized for that purpose.

Benefits of the project for Indonesia – Preliminary benefits for Kaimana Regency and locals were expected to be reach with the dissemination of all scientific results obtained during ***Lengguru 2014 Expedition*** and also since 2010. In accordance with Kaimana's Bupati, Bapak Matias Mairuma, and in cooperation with the Dinas Pariwisata, we plan to disseminate scientific and media supports for helping the improvement of tourism through organized surveys. This should be the photo exhibition and the film documentary but also a corpus of annotated photos. Benefits for Indonesian scientists include training overseas, involvement in data analysis, improvement in molecular laboratory equipment, improvements of the numbers of Indonesian scientific specimens/collections of flora and fauna in the herbarium Bogoriense (BO) and Museum Zoologicum Bogoriense (MZB).

Dissemination of the Project – In the coming years, dissemination of the project will include international and national publications, field guides, books and organization of an international Lengguru Biodiversity Congress. All kinds of data (photos, posters, videos, texts, etc.) will be given to local authorities in Kaimana for helping the promotion, the sustainable valorization and the conservation of Lengguru's biodiversity.

PART II: BACKGROUND

II-1 Expeditions Rainbowfishes 2007 – 2008 - 2009

The French Institute for Research and Development (IRD), the Akademi Perikanan Sorong (APSOR-KKP) and the Badan Penelitian dan Pengembangan Kelautan Perikanan (BALITBANGKP) initiated a scientific program on the evolutionary diversification and domestication of rainbowfishes. This program provided support for the Master (2008) and the PhD (2009-2012) of Kadarusman (APSOR) at University Paul Sabatier (UPS – Toulouse) and led to three joint sampling campaigns in West Papua in 2007, 2008 and 2009, respectively. The results obtained through this joint effort revealed unexpected cryptic species diversity with the discovery of 15 new species of rainbowfishes endemic from various karsts scattered in Western Papua. They also demonstrated that West Papua is the center of origin for the evolution of rainbowfishes with an origin dated at the end of Miocene Era (10 millions years ago). In the frame of the program, most of the newly discovered species were domesticated in the Depok Station in an attempt to diversify the ornamental international trade and help the ex-situ conservation of endangered species of rainbowfishes.

II-2 Expedition Lengguru-Kaimana 2010

Having clearly established the role of karst formation as promoter of rainbowfishes diversification, it was decided to carry out, for the first time, scientific investigations in the unexplored Lengguru karst. This geological formation, located at the crossroads of 3 distinct biogeographic provinces (i.e. the Northern and Southern New Guinea and the Bird's Head Peninsula) was expected to have played a major role in the evolution of rainbowfishes and likely to be home of many undiscovered species inhabiting its fragmented aquatic ecosystems (i.e. endorheic ecosystems). Exploring the Lengguru karst for completing our knowledge on rainbowfish systematic and evolution was therefore the main reason that determined the organization of an expedition in 2010. Because zoological records from the limestone karsts in Kaimana Regency were very scarce, we added value to the expedition by also conducting preliminary scans of other zoological groups through a multidisciplinary approach.

The Lengguru-Kaimana 2010 expedition was held in October and November 2010 in Kaimana Regency (Surat Izin Penelitian **RISTEK: 226/SIP/FRP/SM/X/2010**). It was jointly organized by the Pusat Penelitian Biologi (PUSLIT BIOLOGI – LIPI), the Balai Riset Budidaya Ikan Hias Depok (BRBIH – PRPB – BRKP – KKP), the Akademi Perikanan Sorong (APSOR – BPSDMKP – KKP), the Dinas Perikanan dan Kelahutan Kab. Kaimana and the Institut de Recherche pour le Développement (IRD).

The expedition focused on freshwater and terrestrial communities in both underground and surface ecosystems. It involved biologists, geologists, archeologists, speleologists, paleontologists and hydrologists from several Indonesian and French institutions. Besides of the preliminary karst exploration and species inventory, this expedition aimed to identify potential ecosystems and locations of interest for preparing a more complete and detailed expedition (namely Lengguru 2014). The main goal of Lengguru-Kaimana 2010 was to provide a first assessment of karst biodiversity in the area of Kaimana (Lengguru & Kumawa) by considering the interactions between geological processes and biological diversification and by testing karst capacities as reservoir of old lineages, speciation hotspots or arks of biodiversity. As limestone karst formations are also home of ancient human occupations, it was also proposed to develop an archeological component in our project.

With more than 250 species collected, a dozen of new species of insects, a new species of bats, several new species of frogs and 7 new species of fishes, our preliminary inventories confirmed important levels of endemism and species richness in both surface and underground-explored ecosystems. The most intriguing results were undoubtedly the discovery of the most ancient rainbowfish (i.e. *Melanotaenia mairasi*) in the endorheic lake of Kuweri and the first known cavefish (i.e. *Oxyeleotris colasi*) from Indonesian Papua living in the subterraneous system of Seraran Anticline (Urisa area). The discovery of *M. mairasi* therefore suggested directing future studies on isolated endorheic water drainage systems nested in the heart of Lengguru formation. As demonstrated by the discovery of *M. mairasi*, it was expected that these intriguing ecosystems that are isolated since several millions of years probably display specific and ancient zoological communities. This includes all freshwater organisms and terrestrial groups whose surrounding anticlines play the role of natural barriers to dispersion.

As hypothesized by Novotny *et al*., (2005), rapid tectonic uplift or geological subsidence in New Guinea have had major and direct effects on communities' diversification through spatial isolation and adaptive radiations in new and empty habitats. The discovery of *O. colasi* agrees with Novotny's hypothesis and indirectly proves the ancientness and ecologic stability of underground systems explored in Lengguru. Regarding to a local context of rapid tectonic uplift, we therefore considered of prime importance to focus on the diversity and

phylogenetic relationships of mountain communities belonging to distinct anticlines series. These research axes were scheduled for Lengguru 2014 and other ongoing expeditions and will concern essentially small mammals, birds, amphibians and reptiles whose endemicity is known to increase with altitudinal range in New Guinea.

II-3 Co-authored scientific publications and reports since 2010

Kadarusman, Sudarto, Paradis E. & L. Pouyaud. 2010. Description of *Melanotaenia fasinensis*, a new species of rainbowfish (Melanotaeniidae) from West Papua, Indonesia with comments on the rediscovery of M. ajamaruensis and the endangered status of *M. parva*. *Cybium*, 34(2): 207-215.

Kadarusman, Sudarto, Slembrouck J. & L. Pouyaud. 2011. Description of *Melanotaenia salawati*, a new species of rainbowfish (Melanotaeniidae) from Salawati Island, West Papua, Indonesia. *Cybium*, 35(3): 223-230.

Allen G.R. & R.K. Hadiaty. 2011. A new species of Rainbowfish (Melanotaeniidae) from Western New Guinea (West Papua Province, Indonesia). *Fishes of Sahul*, 25(1): 602-607.

Keith P., Allen G.R., Lord C. & R.K. Hadiaty. 2011. Five new species of *Sicyopterus* (Teleostei: Gobioidei: Sicydiinae) from Papua New Guinea and Papua. *Cybium*, 3 (4): 2-318.

Kadarusman. 2012. Rainbowfishes from West Papua (Melanotaeniidae): Evolution and Systematics. PhD, ED SEVAB, University Paul Sabatier, Toulouse 3, June 2012, 161 pp.

Kadarusman, Hadiaty R.K., Sudarto & L. Pouyaud. 2012. Expedition Lengguru-Kaimana 2010. Preliminary Assessment of Karst Biodiversity. Final Report, 146 pp.

Kadarusman, Hubert N., Hadiaty R.K., Sudarto, Paradis E. & L. Pouyaud. 2012. Cryptic diversity in Indo-Australian rainbowfishes revealed by DNA Barcoding: implications for conservation in a biodiversity hotspot candidate. *PLoSONE* 7(7): e40627.

Pouyaud L., Kadarusman, Hadiaty R.K., Slembrouck J., Lemauk N., Kusumah R.V. & P. Keith. 2012. *Oxyeleotris colasi* (Teleostei: Eleotridae), a new blind cave fish from Lengguru in West Papua, Indonesia. *Cybium*, 36(4): 521-529.

Kadarusman, Hadiaty R.K., Segura G., Setiawibawa G., Caruso D. & L. Pouyaud. 2012. Four new species of Rainbowfishes (Melanotaeniidae) from Arguni Bay, West Papua, Indonesia. *Cybium* 36(2): 369-382.

Keith P., Hadiaty R.K. & C. Lord. 2012. A new species of *Belobranchus* (Teleostei: Gobioidei: Eleotridae) from West Pacific Islands. *Cybium*, 36(3): 479-484.

Suroto H. 2012. Hunian Prasejarah Gua Karas Kaimana. In Papua TH. IV, No. 2/ November 2012, *Journal of Archaelogical Research of Papua and West Papua*. Pp: 1-114.

Fahmi M.R., Solihin D.D., Soewardi K., Pouyaud L., Shao Z., & P. Berrebi. 2013. A novel semi-multiplex PCR assay for identification of tropical eels of genus *Anguilla* in Indonesian waters. *Fisheries science*, *79*(2), 185-191.

Nugraha M.F.I., Pouyaud L., Carman O., Kadarusman, Widyastuti U. & J.C. Avarre. 2014. Development of twelve novel polymorphic microsatellite DNA markers for the Boeseman's rainbowfish (*Melanotaenia boesemani*) and tests for their cross-utility in 21 rainbowfish species from West Papua (Indonesia). *European Journal of Wildlife Research*, 60(6): 941-946.

Nugraha M.F.I. 2015. Genetic Diversity, Phylogeny and Conservation of Rainbowfish (*Melanotaeniidae*) in West Papua Indonesia and Its Prospects for New Ornamental Fish Commodity. PhD, ED GAIA, University Montpellier, November 2015, 812 pp.

Nugraha M.F.I., Kadarusman, Hubert N., Avarre J.C., Hadiaty R.K., Slembrouck J., Carman O., Sudarto, Ogistira R. & L. Pouyaud. 2015 Eight new species of Rainbowfishes (Melanotaeniidae) from the Birds Head Region, West Papua, Indonesia. *Cybium*, 39(2) : 99-130.

Fahmi M.R., Solihin D.D., Soewardi K., Pouyaud L. & P. Berrebi. 2015. Molecular phylogeny and genetic diversity of freshwater *Anguilla* eels in Indonesian waters based on mitochondrial sequences. *Vie et Milieu* (in press).

Fahmi M.R., Solihin D.D., Shao Z., Pouyaud L. & P. Berrebi. 2015. Population genetic structure of the tropical eel *Anguilla bicolor* in Indonesian waters based on microsatellite markers. *Folia Zoologica*, 64(2): 87-96.

Hubert N., Kadarusman, Wibowo A., Busson F., Caruso D., Sulandari S., Nafiqoh N., Rüber L., Pouyaud L., Avarre J.C., Herder F., Hanner R., Keith P. & R.K. Hadiaty. 2015. DNA barcoding Indonesian freshwater fishes: challenges and prospects. *DNA Barcodes*, 3: 144-169.

Nugraha M.F.I., Pouyaud L., Carman O., Widyastuti U., Zairin M., Kadarusman & J.C. Avarre. 2015. Genetic diversity of Boeseman's Rainbowfish (*Melanotaenia boesemani*) reared in Indonesian farms and comparison with the endangered natural populations. *Tropical Conservation Science Journal*, (in press).

Hartini S. & G. Takaku. 2015. Macrochelid Mites (Acari: Mesostigmata) from Kaimana, West Papua, Indonesia, and endemism of Macrochelid Mite fauna in New Guinea Island. *Treubia*, 42: 53-67.

Juswara L., Schuiteman A. & Droissart V. 2016. Four new orchid species from the Lengguru fold belt, West Papua, Indonesia. *PhytoKeys*, 61: 47-59.

Hocdé R., Menou, J-L., Pouyaud, L., Suruwaky, A.M. & I.B. Vimono. 2017. At the heart of the coral triangle in West Papua: an indonesian-french scientific exploration of a white area with closed-circuit rebreathers (eCCR). III European Conference on Scientific Diving. Mars 2017. Madeira – Portugal (DOI coming soon)

PART III: OUTLINE OF THE LENGGURU 2014 EXPEDITION

III-1 Project Term (on field)

16 October 2014 – 19 November 2014

III-2 Organizing Institutions

Institut de Recherche pour le Développement (IRD), France
Lembaga Ilmu Pengetahuan Indonesia (RCB – RCO - LIPI)
Politeknik Kelautan Dan Perikanan Sorong (Politeknik-KP-Sorong), Papua Barat, Indonesia

III-3 Collaborative Institutions / research units

III-3.a Institutions

Muséum national d'Histoire naturelle (MNHN-Paris), France
Centre national de la recherche scientifique (CNRS), France
Museo Nacional de Ciencias Naturales (MNCN-Madrid), Spain
University Paul Sabatier (UPS – Toulouse), France
Cabinet d'expertise en Karstologie (CENOTE), France
Dinas Perikanan dan Kelautan, Kabupaten Kaimana, Papua Barat, Indonesia
Universitas Negeri Papua (UNIPA, Manokwari), Papua Barat, Indonesia
Universitas Cendrawasih (UNCEN, Jayapura), Papua, Indonesia
Universitas Musamus (UNMUS, Merauke), Papua, Indonesia
Aix-Marseille University (AMU), France

III-3.b Research units

Institut des Sciences de l'Evolution de Montpellier (ISEM Montpellier), France
MARine Biodiversity, Exploitation and Conservation (MARBEC Montpellier) France
Institut Méditerranéen Biodiversité et Ecologie marine et continentale (IMBE-Marseille), France

III-4 Sponsors & partners

The Lengggguru 2014 expedition was:

- head by IRD, with RCB & RCO LIPI and Politeknik-KP-Sorong ;
- funded by the Incentive Funds from the Institut de Recherche pour le Développement (IRD) ;
- sponsored by the "Environment Department from the COLAS SA Company" and by the "TOTAL Foundation" ;
- with the guest scientific institutions : (field) UMR ISEM, UMR MARBEC INEE-CNRS, MNCN Madrid, Cenoteand (valorization) UMR IMBE
- and with the associated scientific institutions: Muséum national d'Histoire naturelle (MNHN-Paris), France Centre national de la recherche scientifique (CNRS), France, museo Nacional de Ciencias Naturales (MNCN-Madrid), Spain, University Paul Sabatier (UPS – Toulouse), France , Karstology expertise (CENOTE), France, Dinas Perikanan dan Kelautan, Kabupaten Kaimana, Papua Barat, Indonesia, Universitas Negeri Papua (UNIPA, Manokwari), Papua Barat, Indonesia ; Universitas Cendrawasih (UNCEN, Jayapura), Papua, Indonesia Universitas Musamus (UNMUS, Merauke), Papua, Indonesia,
- supported by (the additional technical supports of): ABS, Wasco, Veolia Eau, CNES, APDiving, Expé, Scubapro, Aventure Verticale AV, Innodive, Scurion, Bauer compresseurs, La Palanquée, Seacam, SDV, PETZL fondation.
- followed by the cultural partners: ARTE, Mona Lisa Production, Aquarium de la Porte Dorée, Aquarium Mare Nostrum, Agglomération Montpellier 3M et Ville de Montpellier

III-5 Project Management

Dr. L. Pouyaud,	IRD ISEM Project Leader (PI): France scientific coordination, laurent.pouyaud@ird.fr
Dr. G. Semiadi	RCB-LIPI : LIPI scientific coordination, semiadi@yahoo.com
Dr. Kadarusman	Politeknik-KP-Sorong, scientific coordination, kadarusman@kkp.go.id
Ir. R. Hocdé	IRD (MARBEC Co-PI), general coordination (technical, financial, administrative), diving team leader, data-manager, France, regis.hocde@ird.fr
Ir. J. Slembrouck	IRD ISEM, technical & administrative coordination, Indonesia, jacques.slembrouck@ird.fr
Dr. N. Hubert	IRD ISEM, DNA barcoding platform coordination, Indonesia, nicolas.hubert@ird.fr

III-6 Operating Coast

50,000 Euros in 2013 (preparation of the expedition, coordination meeting)

500,000 Euros in 2014 (preparation and execution of the expedition)

III-7 State of the art

In many areas of Southeast Asia, karst systems have formed “islands within islands” (Clements *et al.*, 2006). The high species diversity and endemism generally observed in karst landscapes is explained by a large array of ecosystems, complex and fragmented terrains, variable local climatic conditions, tectonic and eustatic histories, variable degrees of isolation, and incidence of random events. Karsts cover large sections of New Guinea but their exploration is the least advanced of any ecosystems in the Australasian region. In a review, Clements *et al*., (2006) stated that karsts contribute just 1% of the global and regional biodiversity research output from terrestrial and freshwater ecosystems conducted over a 20-years period (1985-2004). Given that karsts cover around 10% of the land area in Southeast Asia (Day & Urich, 2000) and given that they harbor significant proportions of surrounding region’s biodiversity and endemism (Yong *et al*., 2004), more studies need to be devoted to these ecosystems.

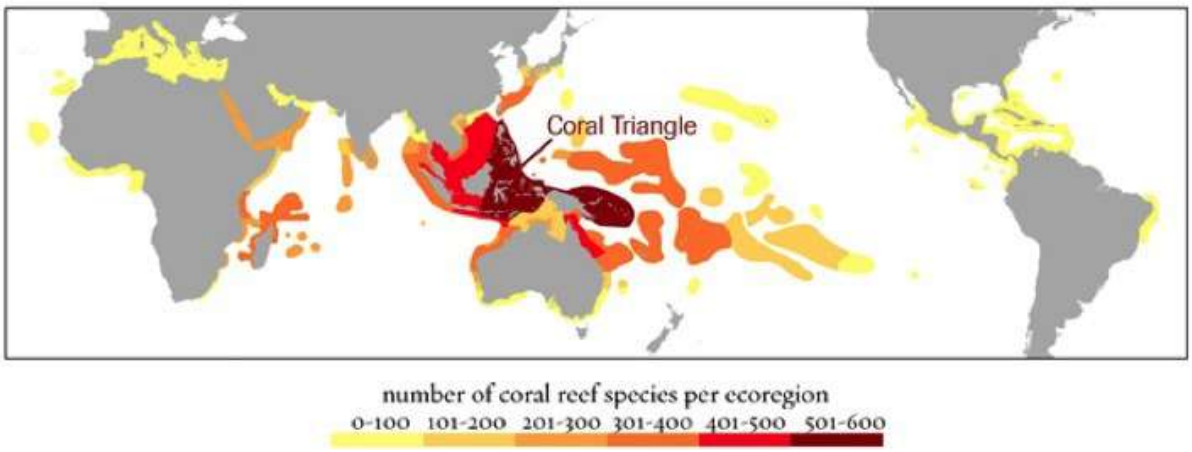
No data on inland organisms are available from the internal parts of Lengguru karsts. This is particularly true for reptiles, amphibians, insects, mammals, crustaceans and fishes. In Lengguru, only peripheral areas (i.e. Triton, Etna and Arguni Bays) were explored by Conservation International. The Australian ichthyologist G.R. Allen and colleagues were the first to inventory the freshwater fish diversity of these areas, respectively on the eastern and western edges of Lengguru. Among others, several new species of gobies and rainbowfishes were described (Polhemus & Allen, 2007). Despite a lack of biological data, the geological chronology and evolution of Lengguru is well known. An accurate knowledge of the tectonic events which gave rise to the formation of these karsts systems, some 10 millions years ago, constitutes therefore an important basis for the understanding of subsequent biological diversification processes.

Lengguru’s limestone karsts are forming a natural hilly isthmus of around 200km long and 100 km wide between the Birds Head peninsula and the rest of New Guinea. Located at the heart of the Coral Triangle and at the crossroads of Indian and Pacific Oceans, this underexplored region is home of the World’s richest marine biotas. Covering 5.7 million square kilometers of ocean waters, The Coral Triangle also called the “Amazon of the seas” extends on six countries of Southeast Asia and Pacific (Indonesia, Malaysia, Timor-Leste, Philippines, Papua New-Guinea, and Solomon). While only covering 1.6% of the Earth’s oceanic surface, the region displays 76% of all known coral species and 52% of Indo-Pacific reef fishes (37% of the world’s reef fishes). The Coral Triangle is the global center for marine biodiversity of not only corals and fish, but also many other marine organisms as gorgonians, mollusks, echinoderms, and crustaceans as well. It has also the greatest extent of mangrove forests in the world.

The Coral triangle epicenter is located on the surroundings of the Birds Head Peninsula between the Raja Ampat and the Moluccas. The marine biodiversity, which is the highest in Raja Ampat (circa 570 species of hard corals; 1400 species of reef fishes) decreases rapidly with geographic distance in any directions (i.e. 150 species of hard corals and 800 species of reef fishes in French Polynesia).

The biological resources of the Coral Triangle sustain the lives of over 120 million people and supply fisheries exports and coastal tourism. Facing overexploitation of its natural resources, habitats degradation from human activities and global warming, the region is considered a top priority for marine conservation and sustainable development.

Therefore contributing to the assessment of its biodiversity is a real challenge and a prerequisite to any management and conservation programs. The natural resources of the Coral Triangle are indeed still largely poorly understood in vast and remote areas.



III-8 Aims

The project **Lengguru 2014 Expedition** aims to study the processes and the interactions between geodynamics and biodiversity in Papuan limestone karsts.

The general methodology is based on field surveys conducted in a large array of ecosystems and displaying contrasted features under environmental gradients (aquatic *versus* terrestrial; surface vs. underground; depth vs. altitude; marine vs. inland; opened vs. fragmented). Specific ecosystems were selected according to the preliminary data obtained during the Franco-Indonesian expedition Lengguru 2010. Beside an inventory of organisms communities based on DNA barcoding and traditional taxonomy, biologists will infer the phylogenetic relationships of the taxa collected in Lengguru with those originating from the peripheral regions.

The confrontation between the chronology of geomorphologic processes, paleontological records and molecular clocks will enable to understand their diversification processes and will test karst capacities as reservoir of old lineages, speciation hotspots or arks of biodiversity.

III-9 Research Sites (see Figure 1 for geographic location)

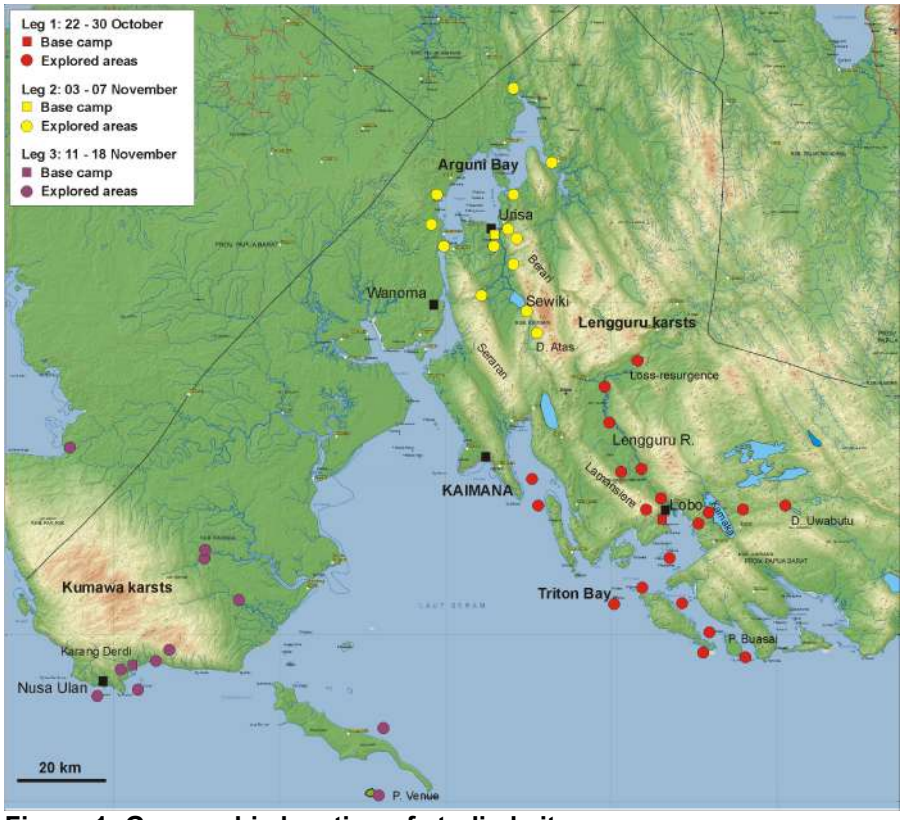


Figure 1: Geographic location of studied sites

The Lengguru Range is located in the Kaimana Regency (West Papua, Indonesia). It is characterized by series of parallels and oblique folds, with altitude ranging from 600 to 1500 m. These carbonate anticlines are separated by deep valleys sometimes closed and rifted with no outflow of collected water (i.e. endorheic). Lengguru's topography consists of limestone karsts shaped by uplift or subsidence geologic events and under the dissolving action of water on carbonate bedrocks since a dozen of millions years (cc. 10-12 Myr.). This rough and fragmented landscape displays unusual surface and subsurface features including sinkholes, vertical shafts, lapies, loss-resurgence streams, complex underground systems and caves. These sedimentary outcrops are therefore characterized by a large array of ecological niches afforded by complex terrains and variable climatic conditions.

Preliminary results obtained during Lengguru 2010 led us to identify and to explore four kinds of ecosystems with high scientific potentialities:

III-9-1 Underground rivers and caves

Goa Jabuenggara, Lengguru River, Gunung Berari

Caves biodiversity remains poorly documented for tropical karsts with vast geographic and taxonomic gaps. Relative stability and antiquity of subterranean ecosystems enable relict faunas to persist. Their discovery can therefore give new insight into the evolutionary history of surface groups. Several caves and underground rivers already discovered in 2010 were investigated in 2014 (i.e. Goa Jabuenggara). New areas were also explored such as in the loss-resurgence of Lengguru River.

III-9-2 Lapies and montane cloud forests

Tops of G. Lamansiere, G. Kumawa, G. Berari

Papuan biodiversity is known to increase with altitude. In Lengguru, the tops of anticlines are generally characterized by Lapies formations. Lapies are fissured limestone plateaus, which consist of natural labyrinths forming patchworks of habitats and forest types according to altitude, geological substratum, trade winds exposure, rainfall and remoteness from seashore. These extreme ecosystems, never studied nor visited, were explored for the first time in 2014 in several areas (tops of G. Lamansiere, G. Kumawa, G. Berari).

III-9-3 Endorheic lakes, fragmented rivers and isolated poljes

Danau Atas, D. Kamaka, D. Uwabutu

Endorheic basins are closed hydrologic systems (fragmented rivers, lakes, swamps) in contrast with exorheic basins, which flow to the ocean. Poljes are large elliptical depression, sometimes containing endorheic systems. The most ancient poljes located in the internal part of Lengguru Range were formed during the uplift of Lengguru's anticlines some 10 millions years ago. As a result of long-term isolation, these ecosystems probably host relict species and unexpected biodiversity. Our teams reached by walk the remote area of a small lake (i.e. Danau tas Sewiki) and make a rapid assessment of amphibians, orchids and birds prevailing there. We also reached the Uwabutu Lake located at 30km NE from Danau Kamaka.

III-9-4 Submerged karsts and outer reef slopes

Triton Bay, Karang Derdi, P. Venue, Jabuenggara Cave

Lengguru seafront consists of drowned karsts, which were geologically formed during successive marine regression since the end of the Miocene. Preliminary investigations performed in 2010, revealed an important richness of ecosystems, such as anchihaline caves, sea caves, submerged freshwater springs (Vruljas), drowned river canyon, stratified estuaries, coastal marine lakes, and reef slopes. We explored these areas of interest with the help of a diving team equipped with conventional scuba systems (using tanks and regulators) or with recycled-air scuba system (using some Closed Circuit Rebreathers – CCR). Main areas of investigation were at Karang Derdi (Kumawa) and P. Venue (Arguni Bay), at P. Buasai (Triton Bay). We also organized the dive exploration of Jabbuengara's underground system in karst aquifer near Urisa village where the first Papuan cavefish was discovered in 2010.

The topography of the underground system was conducted, in different directions, over a horizontal distance of 200 meters from the Jabbuengara entrance porch. The observations were made and samples were taken (fishes, shrimps, molluscs). The caves and the underground system are connected to the marsh and the estuary. They are under the influence of a mesotidal tidal regime.

PART IV: PRELIMINAR RESULTS – TERRESTRIAL TEAMS

IV-1 Team Cave Invertebrates

Arnaud Faille (ZSM), Cahyo Rahmadi (LIPI), Yayuk R. Suhardjono (LIPI), Louis Deharveng (MNHN).

IV-1-1 Sampling

The team collected various groups essentially belonging to arachnids, collembolans, cockroaches, and coleopterans. These groups consisted of troglobitic species (living exclusively in dark environment), edaphic species (living exclusively on soil), and epigeal species (living on outside vegetation).

Two sampling areas were considered:

Urisa area

Our sampling focused on Jabuenggara cave. The cavity is the type locality of the blindfish discovered in 2010 but nothing was known regarding the cave invertebrates. The biodiversity of the cavity is highly diverse. We found various spiders of the genus *Heteropoda* and some specimens of the family Schizomiidae (only reported once from the area of Fak Fak). We also found troglobitic species of Collembola (springtails), Amblypygi (whip spiders), and Blattodea (cockroaches). Guanobitic coleopterans (2 species of the families Leiodidae and Carabidae) were also caught in the cave.

Kumawa area

Following various valleys, canyons and thalwegs from sea level to 400m, we failed to find favorable caves for troglobitic species. The only small cavities and pits that we found were colonized by some groups already observed in Urisa and also known from other caves of South Eastern Asia, Orthoptera Rhaphidophoridae, *Heteropoda* sp. (giant spiders), and 1 exemplar of whip spider (Amblypygi).

Our view of the beetles biodiversity of the soil fauna is very preliminary due to the dryness of the litter and the lack of suitable caves in the investigated parts of the massif.

Our preliminary knowledge of the structuration of the karst, together with the observation reported by the team which explored the higher areas of the massif suggest that it will be necessary to explore the areas of the massif over 400m, where the caves and sinkholes seem to be present, in order to access to the troglobitic fauna of the massif.

IV-1-2 Taxonomy

Collembolans (8 new species)

The project financed a 5 weeks visit (October – November 2015) of Pr. Yayuk R. Suhardjono at MNHN Paris for finalizing with Pr. Louis Deharveng morphological observations and DNA barcoding of Collembolans samples.

Their collaborative work revealed the presence of various widespread species already known from the intertropical zone and some species displaying more confined geographic distribution and probably all endemic to PNG and 8 species new to Science.

Four new species of epigeal collembolans were found in Paronellidae and Entomobryidae (genus *Ascocyrtus*, Fig.2). Their description will be delayed because there is no specialist of these taxonomic groups.

Fig. 2: *Ascocyrtus* n. sp. Lengguru

Fig. 3: *Coecobrya* n. sp. Lengguru

Three new species of edaphic collembolans Neanurinae belonging to extremely diverse tropical genera in Asia (2 *Paleonura* n. sp. and 1 *Vitronura* n. sp.). Morphological descriptions of these species are in progress.

Only one species of troglomorphic collembolans was collected in Jabuenggara Cave. This species (*Coecobrya* n. sp.; 2 specimens; Fig. 3) is new and displays morphologic characters adapted to underground habitats (depigmentation, very long antennas, eyeless). Only three species displaying similar adaptive features were recently discovered in China. The COI barcode for this species indicates strong genetic divergence with all other species within the genus *Coecobrya* and a genetic affinity with a Javanese species. Its species description is in progress.

Coleopterans (1 new species)

Two species of guanobitic coleopterans were found in Jabbuengara Cave. These insects are coprophagous meaning that they feed on guano (excrements of bats colonies). The first species, a member of the Carabidae (*Altagonum misim*; Fig. 4) was already known from a mine site in Papua New Guinea, while the second belongs to the family Leiodidae (*Pseudonemadus* n. sp.; Fig. 5) seems to represent a species new to Science. We are waiting COI barcodes to confirm these taxonomic determinations and eventually to describe the Leiodidae species.

Fig. 4: *Altagonum misim* Lengguru

Fig. 5: *Pseudonemadus* n. sp. Lengguru

Amblypygids (1 new species)

This group belongs to arachnid and is also known as whip spiders. This is an evolutionary ancient lineage as fossilized amblypygids have been found dating back to the Carboniferous period (300 Mya). Dr. Cahyo Rahmadi and colleagues collected a few specimens of Amblypygi respectively in Jabbuengara Cave and in Kumawa. Preliminary morphological observations indicated that the specimen from Jabbuengara belongs to a new species compared to the own species known from Indonesian Papua (Raja Ampat). The species description is in progress.

Blattodea (1 new species)

Two hypogean specimens of cockroaches were caught in Jabbuengara Cave. Morphological thorough examination revealed that these specimens belong to family Nocticolidae (Fig. 6). This discovery is important for two reasons: (1) Nocticolidae is presently only known from Australia and Asia and not from New Guinea; (2) The species displays troglomorphic features. The team is collaborating with Dr. Lubomir Vidlicka (Slovaquia), the specialist of this group for describing the new species, which probably belongs to a new genus. The species is totally depigmented, eyeless and possesses very long antennas. These characters prove a long adaptation to underground environment, and confirm the uniqueness and ancientness of Jabuenggara Cave as it was previously suspected with the discovery of the new blind cavefish *Oxyeleotris colasi* (Pouyaud et al., 2012)[1]

Figure 6: Nocticolidae sp. n. Lengguru

[1] Pouyaud L., Kadarusman, Hadiaty R.K., Slembrouck J., Lemauk N., Kusumah R.V. & P. Keith. 2012. *Oxyeleotris colasi* (Teleostei: Eleotridae), a new blind cave fish from Lengguru in West Papua, Indonesia. Cybium, 36(4): 521-529.

IV-2 Team Surface Invertebrates – Insecta – Orthopteroid – Odonata - Lepidoptera

Tony Robillard (MNHN), Cahyo Rahmadi (LIPI), Yayuk Rahayuningsih Suhardjono (LIPI), Pungki Lupiyaningdyah (LIPI), Endang Cholik (LIPI).

IV-2-1 Sampling

The team collected three orders of orthopteroids, namely Orthoptera (crickets, grasshoppers), Dictyoptera (cockroaches, mantids), and Phasmatodea (stick insects, leaf insects). They also collected Odonata (dragonflies) and Lepidoptera (butterflies).

The sampling of orthopteroid insects had two main purposes: (1) to serve the general aim of inventory of insect fauna in West Papua, (2) to contribute to the in depth study of the crickets Eneopterinae, particularly diversified in Indonesia (Robillard 2010[2]; Robillard et al. 2014[3]), and having the particular adaptation of using high-frequency signals to communicate (Robillard et al. 2013[4]). A total of 650 specimens of Orthopteroid insects were collected during the field trip, by active collection during day and night. Each specimen was given a sampling number (TR1-TR650) and each is associated with information about habitat, activity and sometimes behavior (calling song, mating, foraging, etc.). This total includes stick insects (phasmids): 26 specimens (=15 species); Orthoptera: 532 specimens (see below for details), Blattodea (cockroaches): 83 specimens (=40 species); others (Dermaptera, Mantodea): 9 specimens (5 species). Among Orthopteran specimens, most major families are represented: Gryllacrididae: 12 specimens (= 10 species); Acrididae (25 specimens = 10 species); Tetrigidae: 23 specimens (=10 species); Rhaphidophoridae: 5 specimens (= 3 species); Tettigoniida: 25 specimens (= 18 species) and Grylloidea (true crickets), including Gryllidae: 338 specimens (= 40 species), Mogoplistidae: 21 specimens (= 8 species), Phalangopsidae (31 specimens (= 5 species), Trigonidiidae : 52 specimens (= 12 species). Within Gryllinae, several subfamilies of crickets are represented (Podoscirtinae, Gryylinae, Landrevinae, Eneopterinae). We thus estimate that we sampled about 170 species of Orthopteroids, to be confirmed by additional analysis of the material.

More than 100 specimens of dragonflies and more than 200 specimens of butterflies were collected during the expedition. Their analysis and determination is still in progress at the present time.

IV-2-2 Taxonomy

Most of orthopetroids species from the area were collected and described at the end of XIX century, it is therefore important to increase and to complete the collections by adequate sampling for DNA analysis and behavior data (calling song recording). For the moment, the team focused on the crickets Eneopterinae taxonomy, which represent the major part of the samples.

Cardiodactylus (2 new species)

Six species (94 specimens) were collected, including 4 species known from other localities (Fig. 7) in PNG but never observed in Lengguru (i.e. *C. novaeguineae*, *C. guatei*, *C. muiri*, *C. pictus*), and 2 species new to Science. Species descriptions are under process.

Figure 7: *Cardiodactylus pictus*, male, Lengguru *Cardiodactylus pictus*, female, Lengguru

[2] Robillard T. 2010. New species of the genus *Lebinthus* (Orthoptera, Grylloidea, Eneopterinae, Lebinthini) from Indonesia and the Solomon Islands *Zootaxa*, 2386, 25-48.

[3] Robillard T., Gorochov A.V., Poulain S. & Suhardjono, Y.R. 2014. Revision of the cricket genus *Cardiodactylus* (Orthoptera, Eneopterinae, Lebinthini): the species from both sides of the Wallace line, with description of 25 new species. *Zootaxa*, 3854 (1): 001–104 [monograph].

[4] Robillard T., Montealegre Z.F., Desutter-Grandcolas L., Grandcolas P. & D. Robert D. 2013. Mechanisms of high frequency song generation in brachypterous crickets and the role of ghost frequencies. *Journal of Experimental Biology*. 216: 2001-2011.

Lebinthini (2 new genera, 4 new species)

We collected around 180 specimens of Lebinthini, respectively in Kaimana, Urisa, Lobo and Kumawa. The results revealed the presence of 2 new genera and at least 4 new species (Figs. 8 & 9).

The *Lebinthus* species was extensively recorded and the songs are entirely ultrasonic (25 kHz). The new genera correspond to large brachypterous species and represent a local radiation of at least four different species (Kumawa and Urisa are clearly different, others need to be confirmed), with a musical song having a frequency of 10 kHz.

Figure 8: *Lebinthus* sp., male, Lengguru

Figure 9: Lebinthini new genus, male, Lengguru

The discovery of these new taxa within the tribe Lebinthini is very important, in particular for identifying the evolutionary origin for this interesting group, which developed specific high-frequency signals to communicate.

IV-3 Team Herpetology – Amphibians – Reptiles

Antoine Fouquet (CNRS), Evy Arida (LIPI), Amir Hamidy (LIPI), Wahyu Trilaksono (LIPI), Philippe Gaucher (CNRS).

IV-3-1 Sampling

Given the almost complete lack of available information on the herpetofauna of this part of New Guinea, the objective of this herpetological survey was rather simple; to document the species communities of amphibians and reptiles by collecting specimens, tissue samples and call recordings for as many species as possible. This has been undertaken using diurnal and nocturnal active searches, trapping and automatic recording. Recording the calls of frogs is very useful because their frequencies are often diagnostic characters between distinct species even between cryptic species (species morphologically similar but reproductively isolated). Three areas, (i.e Lobo, Urisa, and Nusa Ulan) were sampled by 4 people. The efficiency of such survey is highly dependent on weather conditions, which were not optimal for all the sites. The entire sampling totalizes 35 amphibian and 54 squamate species. We summarize below some of our results for each collecting site.

Lobo

We spent 8 days collecting at sea level as well as 300m and 1100m elevations along the slope of the Mt. Lamansiere. Our collecting trip was done during the drier period in Lobo, i.e October 21st-28th. Therefore, only a few amphibians were reproductively active and calling. Nevertheless, a total of 20 amphibian and 37 squamate species were collected. The total number of specimens for amphibians is 88 and for squamates 108. Small skinks were abundant in this area. We also collected 9 snake species.

Urisa

Our stay in this area was shorter than in Lobo (5 days). We collected at sea level as well as at 350m elevations along the slope of Mt. Berari near lake Sewiki. We found a combination of dry and wet periods during our collecting trip in this area from November 2nd to November 7th. The first half of our stay in Urisa was hot and dry and the rain started to fall by November 5th. A total of 18 amphibians and 14 squamate species were collected in Urisa (84 specimens: 54 amphibians and 30 squamates).

Nusa Ulan

We stayed for 7 days in this area from November 11th to November 17th. We sampled the herpetofauna at sea level as well as at 400m and 1100m elevation along the slope of the Kumawa massif. We collected 21 species of amphibians and 24 species of squamates. A total of 105 specimens were collected during our stay. Fifty-five specimens are amphibians and 50 are squamates. Sights of varanids were more frequent than in the first two sites but snakes were scarce (5 species).

IV-3-2 Taxonomy (possibly 10 new species)

The number and identifications of the species collected may change, as identifications require improvement from field data processing, the analysis of genetic data, and available literature. For that purpose, 205 specimens (including 6 specimens from Lengguru 2010) of amphibian, 170 specimens of lizard, and 23 specimens of snakes were DNA extracted at MZB Laboratory and were sent for DNA sequencing at the Canadian Centre for DNA Barcoding. We are now awaiting the sequences results for confirming the species determination and performing the species description.

However, we can already estimate that around **10 undescribed taxa of amphibian** were collected at mid and high elevation regarding to calls recording and morphological observations. It appears that many cases of cryptic species seem to occur, and especially at different altitude at the same area, or at the same altitude between distinct areas (i.e. Lengguru and Kumawa), where couple of taxa, apparently similar in morphology, can display very distinct songs characteristics in terms of frequencies periods (Figure 10). For snakes, **4 taxa are still undetermined** (*Boiga* sp., *Stegonotus* sp., *Rhabdophis* sp., and *Typhlopidae* sp.), while for lizards a **minimum of 10 taxa** belonging to 7 genera remains undetermined (*Cyrtodactylus* sp., *Sphenomorphus* sp. 1-4, *Nactus* sp., *Lepidodactylus* sp., *Hypsilurus* sp., *Gehyra* sp., and *Enoia* sp.).

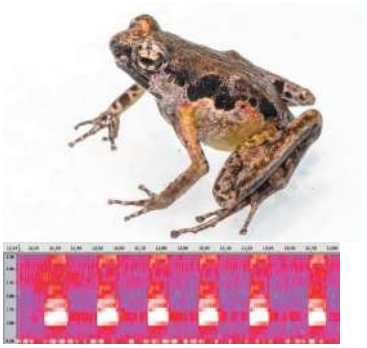
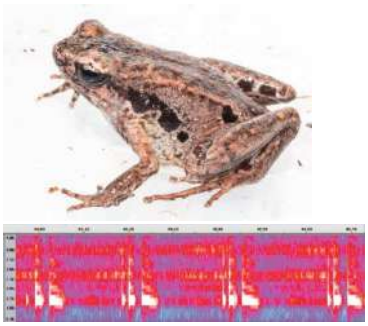


Fig 10: *Hylophorbus* sp.1 (Lengguru 300m)

***Hylophorbus* sp.2 (Kumawa, 300m)**



***Hylophorbus* sp.3 (Kumawa, 1100m)**

We were not able to collect a few amphibian species calling high in the trees. Moreover, the limited time on each site and the difficult terrains associated with logistical supports, particularly for collecting in the highest elevation make this inventory largely incomplete. Completing this inventory as well as gathering data from adjacent areas such as Fakfak, Arfak, Tambrau, Wondiwoi, Weyland will undoubtedly allow us to answer important biogeographic and phylogeographic questions along with clarifying some taxonomic issues.

IV-4 Team Ornithology

Hidayat Ashari (RCB-LIPI), Borja Milà (MNCN-CSIC, Madrid), Suparno (RCB-LIPI), Herman Warmetan (UNIPA), Christophe Thébaud (Univ. Toulouse, France)

IV-4-1 Sampling

Several cases of secondary contact zones between closely related taxa (subspecies or species) appear to exist in the Lengguru area between populations from the Vogelkop and the main body of New Guinea that may have been separated in the past (Mack and Dumbacher 2007[5]). In addition, the Kumawa Mts are amongst the least known areas of Papua in regards to biodiversity even though the value of the area for biodiversity is considered outstanding, with many undescribed bird taxa in the mid-mountain and cloud forests based on the work of previous scientific teams (Diamond 1985[6]). Thus, our main objective was to search for

[5] Mack, A.L. & J. Dumbacher. 2007. The Birds of Papua. Pgs 654-688 In: Marshall, A.J. and B. M. Beehler (eds.). The Ecology of Papua.
[6] Diamond, J.M. 1985. New distributional records and taxa from the outlying mountain ranges of New Guinea. *Emu*, 85(2) : 65-91.

cryptic population structure that may result from geographic isolation or ecological complexity across space in both Lengguru and Kumawa areas and to collect new specimens from undescribed taxa in Kumawa Mts.

Our sampling strategy consisted in collecting birds in geographically separate localities and through elevation gradients in three areas (Lobo and Urisa in the Lengguru area, Nusa Ulan in the Kumawa area). The team worked closely with the herpetological and botanical teams so that through a common spatial sampling scheme it might be possible to analyze similarities and differences in the patterns of species assemblages across different taxa.

Birds were captured using standard mist nets, targeting primarily understory birds. Individuals were aged using plumage characteristics, and the degree of skull ossification. They were weighed and marked permanently with Indonesian metal rings to avoid resampling the same individuals. Wing rulers and dial calipers were used to acquire on each individual a set of standard morphometric measurements. Approximately 10 microliters of blood were collected by venipuncture from each bird and immediately conserved in 90° alcohol for further genetic analyses. Every captured bird has been photographed from various angles according to a standard procedure. Species were identified by eye in the field based on the team's expertise, the new field guide "Birds of New Guinea" published by Drs Pratt and Beehler, and unpublished documents kindly provided by Dr Beehler.

Sampling took place on 16 days over three main periods between October 22 and November 17, 2014. A total of 181 birds were captured, out of which 160 were collected for voucher specimens after RCB-LIPI members of the team considered them of high museological value. Tissue or blood samples were obtained in a total of 180 birds, representing 54 species belonging to 23 families, including 1 endemic family to the island of New Guinea (Melanocharitidae).

Sampling in the Lobo area was carried out October 22-28, 2014, at three mist-netting stations, one (Lobo 1) at low elevation (S 3,76674, E 134,09644, 13m), and two on Lamansiere Mountain at mid elevation (S 3,70496, E 134,06984, 218 m), and high elevation (S 3,72907, E 134,06161, 972 m). We sampled 93 individuals of 35 species.

Sampling in the Urisa area took place on November 4-6, 2014 at a single mist-netting station located at 133 m above the lakeshore at the eastern extremity of Sewiki Lake (S 3,34088, E 133,82571). We sampled 24 individuals of 19 species.

Sampling at Kumawa took place November 12-17, 2014, at three sites, one at sea level and two above 1000m. The Kumawa 1100 station was at 1100 m altitude (S 4,01462, E 133,08696), and Kumawa 1200 at 1200 m altitude (S 4,01134, E 133,08751), both in a habitat that can be described as cloud forest. We sampled 64 individuals from 24 species.

IV-4-2 Taxonomy

Melanocharis berrypecker (1 new species)

During the expedition Lengguru 2014, the ornithological team captured at 1100m in the Kumawa Mountains a male bird that belongs to the berrypecker genus *Melanocharis* (Melanocharitidae; endemic to New Guinea) but appears to be an undescribed taxon.

The examination of the bird in the field quickly revealed that it shared similarities with *M. longicauda*. However, it became also quite clear that this bird belongs to a population that may represent a distinct taxon, be it a different subspecies of longicauda or even an undescribed species of *Melanocharis*: while tail pattern and upperparts were like nominate longicauda, its underparts were shiny white with lemon wash on throat, breast, and flanks (Figure 11). A specimen was collected and deposited at the MZB. Comparisons between this specimen and other *Melanocharis* specimens revealed further differences, the most obvious being a difference in body size, the Kumawa individual being larger than any other *Melanocharis* in the MZB collection.

Figure 11: _Melanocharis_ n. sp. Kumawa

***Melanocharis longicauda* New Guinea**

Altogether, the substantial differences between the Kumawa berrypecker and other berrypeckers are pointing towards a putatively undescribed species. If so, this would be the first species to be described for the whole of New Guinea in the last 10 yrs. (not accounting for the many cases of splitting up one species with several subspecies into multiple species (see Beehler and Pratt, in press).

New Guinea berrypeckers belong to the Melanocharitidae, a very interesting family of passerines endemic to New Guinea which consists into three very distinct lineages that have been recently elevated to the subfamily rank (Schodde and Christidis, 2014). This family is of uncertain phylogenetic position and is considered as a transitional taxon in a grade leading to the crown Passerida but it could also be part of the core Corvoidea. The resolution of the relationships between Melanocharitidae and other families such as Petroicidae, Cnemophilidae, and Picarthatidae would clearly help clarify the evolutionary sequence which took place in the region of transition between the ancestrally Australasian crow-like birds (core Corvoidea), and the primarily extra-Australasian Passerida, one of the major event that triggered the evolutionary diversification of passerine birds at the global level.

We have proposed, as a top priority for the immediate follow-up research work to the Lengguru Expedition 2014, to undertake a multidisciplinary approach in which we will combine genetic, phenotypic, and phylogenetic analyses to address two main scientific issues:

- To investigate inter- and intraspecific variation within the Melanocharitinae subfamily (comprising the genera *Melanocharis* and *Rhamphocharis*) using a geographically explicit context; this will allow us to produce the first ever phylogenetic hypothesis for this subfamily and to determine whether the undescribed Kumawa population represents a new species or a subspecies of *Melanocharis longicauda*.
- To improve the phylogenetic placement of the Melanocharitidae within the oscine Passerines by increased sampling of representatives of this family (following a recommendation by Barker, 2014).

To tackle this important issues for the fundamental knowledge of Papuan biodiversity as well as the systematics of an important part of the evolution of passerine diversity, our research strategy consist in using a recently developed pipeline for obtaining mitochondrial genomes for both freshly collected samples and museum specimens, including very old specimens (Besnard et al. 2015).

For that purpose, the project financed a 4 weeks visit (July 2015) of Hidayat Ashari (RCB-LIPI) at Paul Sabatier University (Toulouse, France).

Their collaborative work revealed the presence of various widespread species already known from the intertropical zone and some species displaying more confined geographic distribution and probably all endemic to PNG and 8 species new to Science.

We have, together with our LIPI partner, extracted DNA from all *Melanocharis* blood or tissue samples that were collected during the expedition. In addition, to this, we also successfully extracted DNA from toe-pads sampled on museum samples from MZB of *M. longicauda* and *M. versteri*.

We are now in the process of examining DNA variation at 4 mitochondrial genes (ND2, ND3, ATP6, ATP8) and three nuclear introns (MUSK, ACO1, FIB5) and constructing libraries for assembling the mitochondrial genomes of one sample per taxon using high-throughput sequencing (Hiseq 3000; Génopole Toulouse).

Further clarification of the taxonomic status of the Kumawa individual will **absolutely require additional fieldwork so that the female can be described**, other diagnostic traits (vocalizations, ecology) be obtained, and sampling increased so that the uniqueness and conservation value of the Kumawa population be assessed rigorously. Also, the Kumawa bird closely resembles the description given by David Gibbs (BBOC, 1994) of an unidentified *Melanocharis* observed in the Fakfak Mountains; another outlying mountain range of New Guinea, which like Kumawa still remains uncharted for its biodiversity.

***Goura* pigeons**

We are currently investigating phylogenetic and population divergence in New Guinea crowned pigeons (*Goura*), a genus composed of several species with abutting distribution ranges, to test hypotheses about the process and timing of speciation in this bird group in relation to historical scenarios on the evolution of New Guinea lowland forests.

A striking distribution pattern in many New Guinea taxa is that lowland forest forms tend to be widespread but confined largely to one of the three main lowland zones (northern and southern watersheds separated by the Central Cordillera, and the lowlands of the far west comprising the Vogelkop and Bird's Neck). Such pattern is unexpected since lowland forest form a continuous ring around the island and it has long been assumed this habitat did not provide much opportunities for allopatric speciation in stark contrast with montane habitats (Mack and Dumbacher 2007 in Marshall and Beehler, The Ecology of Papua). However, it is also easy to imagine that the Central Cordillera and the Bird's Neck may have facilitated population splitting into separate allopatric forms at some point in time, although this hypothesis has never been formally tested. Interestingly, lowland sister-species often meet and hybridize on the eastern part of the Bird's Neck where the Central Cordillera ends to the west, in line with the idea that previously geographically separate

populations came into contact after an allopatric phase. The three-part pattern observed in lowland forest taxa is found in bird genera such as *Talegalla*, *Paradisaea*, *Psittaculirostris*, *Chalcopsitta*, but it is most remarkable in the genus *Goura* (Beehler 2007 in Marshall and Beehler, The Ecology of Papua). In crowned pigeons, *Goura cristata* occupies the lowlands of the Vogelkop (including Raja Ampat Islands) and Bird's Neck; *Goura victoria* inhabits the lowlands of the northern side of the main body of New Guinea while *Goura scheepmakeri* inhabits the southern lowlands (Figure 12). *Goura cristata* and *G. scheepmakeri* may meet at Etna Bay although there is currently a dearth of data from Etna Bay to Mimika, located further east. *G. cristata* and *G. victoria* meet at Siriwo River where they hybridize (Rand and Gilliard 1967 Handbook of the Birds of New Guinea).

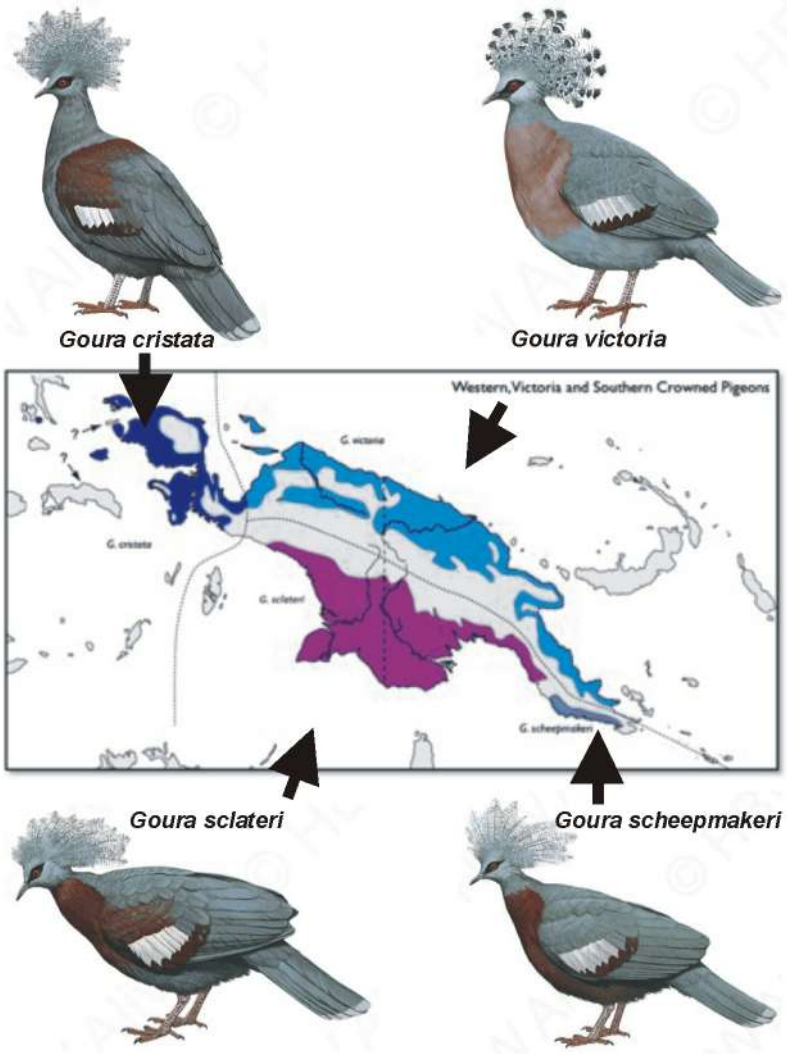


Figure 12: The four *Goura* pigeons and their known distributions

The distribution of the *Goura* makes it an interesting group for investigating the timing and the possible causes of the three-part pattern commonly observed in New Guinea lowland forest forms. Since present-day distributions are strongly influenced by historical factors, including a complex tectonic history, Plio-Pleistocene water-level changes and potentially complicated patterns of dispersal between accreted terrane components of New Guinea (Polhemus 2007 in Marshall and Beehler, The Ecology of Papua), we use a combination of molecular and phenotypic approaches to analyze divergence between *Goura* species and to address questions pertaining to the systematic relationships, historical biogeography and population history of this charismatic bird group.

Specifically, we are constructing the first molecular phylogeny for all members of *Goura* using mitochondrial (and possibly nuclear) markers; we have used so far museum specimens to which, we were given access by the Natural History Museum, London, and the American Museum of Natural History. Though our collaboration with LIPI partners, we have now added to our study the two samples that were obtained during the Lengguru Expedition 2014 (feathers, tissue) and also some of the MZB specimens to increase our sampling within Papua.

We use the pipeline we have recently developed for obtaining mitochondrial genomes for both freshly collected samples and museum specimens, including very old specimens (Besnard et al. 2015). Altogether, like in the *Melanocharis* study, with museum samples from MZB as well as the two samples collected during Lengguru 2014, we now have the best possible resources to produce some excellent data sets that will no doubt lead to joint publications in scientific journals.

Based on the observations we made during Lengurru 2014, one particular line of research we would like to undertake in the short term concerns a rigorous assessment of habitat requirements and ecology of Crowned Pigeons. Among the four recognized species of crowned pigeons, *G. cristata* and *G. scheepmakeri* are evaluated as Vulnerable, and *G. sclaterii* and *G. victoria* are known as Near Threatened by the IUCN. Populations estimates of these species are not known but are suspected to have decreased, because of hunting (for meat or feathers), capture for trade (despite their CITES rating in appendix II), and deforestation. We suspect that the biology of *Goura* pigeons is highly unusual with very low fecundity and high survival of the adults in the absence of direct predation by humans or animals like dogs introduced by humans, which put all these species at high risk of extinction in all areas where human populations are established. Between 1972 and 2002, 14% of lowland forests in New Guinea have been cleared, and 7% has been degraded (12% and 17% respectively if we consider only accessible forest), representing nearly 5 million ha (Shearman et al. 2009). If current trends continue, it is estimated that 83% of the 1972 accessible forest area will have been cleared or degraded in 2021 (Shearman et al, 2008), which would put a large fraction of the lowland forest biodiversity at risk, especially the *Goura* pigeons.

Thus, we propose to acquire better knowledge of habitat requirements and the basic biology and ecology of *Goura cristata* in the Kumawa area so that we can derive applications to the conservation of all Crowned Pigeons. *Goura* pigeons are still common and unaffected by hunting or deforestation in the lowlands of Kumawa, which make this area ideal for undertaking such a study. The study could involve obtaining biological data often only known from captive birds: size, weight, and existence of sex or age dimorphism. We could also use blood samples to conduct DNA analyses to better understand populations' structure. We currently know that *Goura* spp. live in little groups (2 to 10 individuals) but we don't know if they are family groups or not and to what extent group structure makes the species more vulnerable to disturbance or not.

Montane avifauna

The mountains of New Guinea consist of the Central Range plus a number of smaller outlying ranges. Seven of these outlying ranges have been recognized in western Papua (Papua Barat), including Kumawa Mts but excluding the remote karst mountains of the Lengguru area. A number of montane bird species or superspecies are distributed across these mountain ranges and available data suggest that population differentiation has occurred between the populations inhabiting the different ranges (Diamond 1985; Beehler and Pratt, in press). We propose to assess the hypothesis that outlying ranges provide exceptional opportunities for population divergence and speciation in mountain forest passerines. We also propose to identify the relationship between the Kumawa Mts populations and populations from other mountain ranges since they are some indication in the taxonomic literature that in some species these populations may be more closely related to populations from the Wandammen, van Rees, and Foja than to populations from the Arfak/Tambrau system. Also, it will be interesting to see where populations from the Lengguru Mts fit in since their status has never been examined before.

To this aim, we have started comparing samples obtained in the highlands of Lobo and the Kumawa mountains to those from other mountainous regions of New Guinea. Target taxa, with sample sizes from the Lengguru expedition in parentheses, include the following: *Heteromyas albispecularis* (n = 3), *Tregellasia leucops* (n = 6), *Phylloscopus poliocephalus* (n = 6), *Peneothello bimaculata* (n = 2), *Crateroscelis murina* (n = 7), *Sericornis beccari* (n = 6), *Sericornis spilodera* (n = 2), and *Meliphaga orientalis* (n = 2).

To us, this is perhaps the most promising research avenue that could be developed based on further exploration of the Kumawa, Fakfak, and also Tambrau mountains. The montane avifaunas living in these two mountain ranges clearly offer excellent material for studying numerous problems of evolution, colonization, biogeography, and ecology. However, prerequisite to such studies are better sampling of the bird communities living in these mountains. Lengguru 2014 has led to very exciting development in the Kumawa areas, but intensive fieldwork is still required before we understand the role of these mountains as cradles for bird biodiversity and are able to assess their conservation value.

IV-5 Team Botany ARECACEAE (Palms, rattans)

Jean-Christophe Pintaud (IRD), Lina S. Juswara (LIPI), Charlie D. Heatubun (UNIPA).

With the tragic loss of Dr. J.C. Pintaud in August 2015, the team has postponed the research activities on the Lengguru's collected material.

IV-5-1 Sampling

Arecaceae is an important and diverse group of plants in Papua, significant for ecosystem structure and functioning, as well as for the numerous uses, palms have in rural areas. The aim of the survey conducted during Lengguru 2014 expedition was to record, collect and document plants of the Arecaceae family and understand how they are associated to different forest ecosystems, from 0 to 500 m elevation, which is the range corresponding to the highest diversity of palms.

In each locality (Lobo, Urisa, Nusa Ulan), a list of all palms found, with their ecological context, was established, and collections made for species uncommon or needing further study. Collecting consisted in making herbarium specimens including representative organs (leaves, inflorescences, fruits) with up to seven duplicates, with additional spirit collection of fragile organs (flowers, mature fruits) in 70° ethanol, and preserve a fragment of young leaf tissue dried in silica gel for posterior DNA extraction. Detailed field notes where taken on the morphological characters, ecology and when possible, uses of the species.

IV-5-2 Taxonomy (possibly 1-3 new species)

In total, 35 Arecaceae species where recorded in 5 ecosystems, and 20 collections made. The most diverse group was the rattans, with 8 species of *Calamus* found. The most ubiquitous species were *Arenga microcarpa*, *Caryota rumphiana*, *Areca macrocalyx*, *Calamus aruensis* and *Hydriastele papuana*. The richest ecosystems were the lowland alluvial forest and the lowland rain forest on clay, each with 17 species, followed by the lowland rain forest on limestone (13 species), and finally the tidal forest with 5 species, including the extensive nipah swamps (*Nypa fruticans*) of the Arguni bay.

Collections made document range extension for some species, in particular *Ptychosperma propinquum*, initially known from Raja Ampat and Kei Islands, and include 1-3 species possibly new to science in the genera *Licuala* and *Calamus*, pending further genetic analysis.

Finally, agro-systems revealed an important diversity of palms used by local inhabitants (11 species), among which the coconut palm (*Cocos nucifera*), the sago palm (*Metroxylon sagu*), the sugar palm (*Arenga pinnata*), the salak (*Salacca zalacca*), the betel nut palm (*Areca catechu*) and the rattans *Calamus aruensis* and *C. heterancanthus*, extensively used for canes, basketry and ties.

The palm flora documented therefore appear to be rich, important from an ecosystemic as well as utilitary points of view, with a significant contribution to biodiversity inventory, taxonomy, and distribution records.

IV-6 Team Botany: Epiphytes

Lina Juswara (LIPI), Vincent Droissart (IRD), Ismail Apandi (LIPI)

IV-6-1 Sampling

Our main objective was to make a rapid but large botanical survey of epiphytic plant (mainly the Orchid family) in the Kaimana area. The ultimate goals are to generate a checklist of species for this poorly sampled area, and incorporate these data into a regional database to analyse plant distribution patterns at different scales (local, national, regional).

Field works were done in three main localities (Lobo village, Triton Bay; Urisa village, Arguni Bay; Nusa Ulan, Kumawa Forest Reserve), and at various altitudes. During our fieldwork, we collected herbarium specimens (pressed/dried + in 70° ethanol) with associated field data, leaf tissue samples in silica gel for DNA studies and high-resolution digital pictures. Since most of epiphytic orchids encountered in the field are sterile and therefore nearly impossible to identify to species, we also collected living plants for non-flowering specimens. These living specimens will be cultivated and monitored by local botanists until flowering in Bogor Botanical Garden (Java) and in Wamena Botanical Garden (West Papua).

During the 2014 Lengguru expedition, we sampled 22 different stations (primarily swamp forests, mature lowland forests and montane/mist forests) in the three main localities, from the shore to the top of anticlines at around 1200 m altitude. We gathered a total 95 fertile / flowering specimens (62 orchids, 19 ferns, 14 other; see Fig. 13) and associated material (pictures, silica-gel samples): 38 from Lobo area, 31 from Urisa area and 26 from Nusa Ulan area. We also collected 474 living orchid's specimens (Fig. 14).

Fig 13. Overview of orchid species diversity collected during the 2014 Lengguru expedition.

Fig 14. Living orchid samples collected during fieldworks. All cultivated plants are tagged to allow association with the original location, habitat, and other field information.

IV-6-2 Taxonomy (4 new species)

The project financed a 4 weeks visit (June 2015) of Dr. Lina Juswara at the Kew Royal Botanic Gardens (London, Great Britain) for pursuing with Dr. A. Schuiteman and Dr. V. Droissart, morphological observations and species identifications of part of collected orchids during Lengguru 2014. They compared their material with reference specimens available in Kew's collection herbarium. Their collaborative work revealed the presence of four new species belonging to genera *Bulbophyllum*, *Dendrobium* and *Taeniophyllum*, with 3 species present on Lamansiere Mt. and 1 species from Kumawa Mt. (Fig. 15).

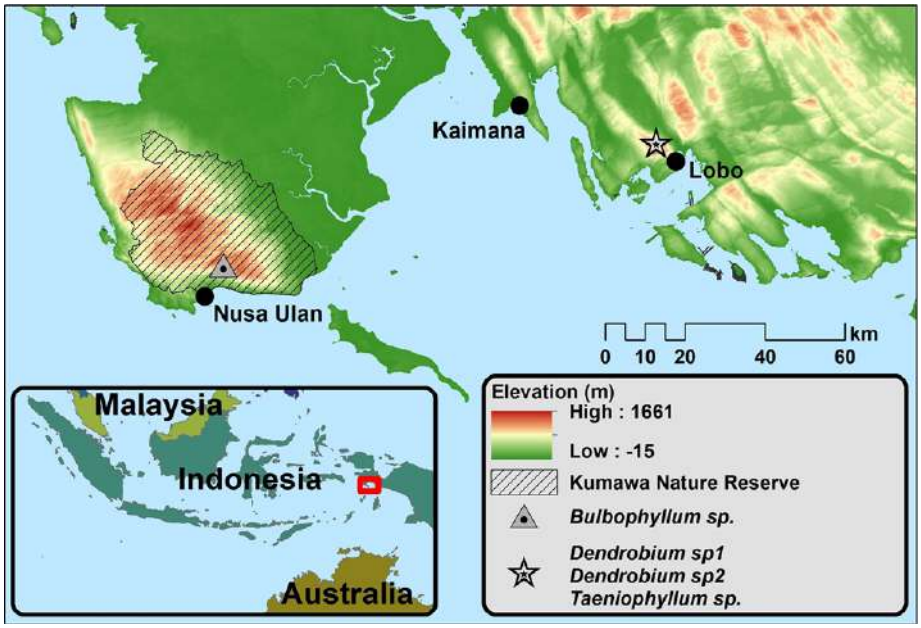


Figure 15: Geographic localization of the four new orchid species.

These new species were drawn and compared with closely related species by using a Wild Heerbrugg Switzerland Type 308700 stereomicroscope. Descriptions were made from the information of measurements and drawings of vegetative and reproductive parts made on liquid preserved specimens. Additional data such as colour, habitat or ecology are mainly derived from field notes and high-resolution pictures taken during the expedition.

Species descriptions were published in PhytoKeys in 2016[7] Type specimens are deposited in Bogor herbarium, while duplicates are deposited in Manokwari, Kew, MNHN, and Leiden herbariums. Habitats and morphological species are presented respectively on Figs. 16 & 17.

Figure 16: Photographs of living type specimens and habitats. *Bulbophyllum leucoglossum*: A habitat and habit; B flower, side view; C flower, front view; D flower close-up, showing details of the column and the labellum. *Dendrobium centrosepalum*: E habitat and habit; F, G plant and inflorescence; H inflorescence and flowers close-up.

[7] Juswara L., Schuiteman A. & Droissart V. 2016. Four new orchid species from the Lengguru fold belt, West Papua, Indonesia. *PhytoKeys*, 61: 47-59.

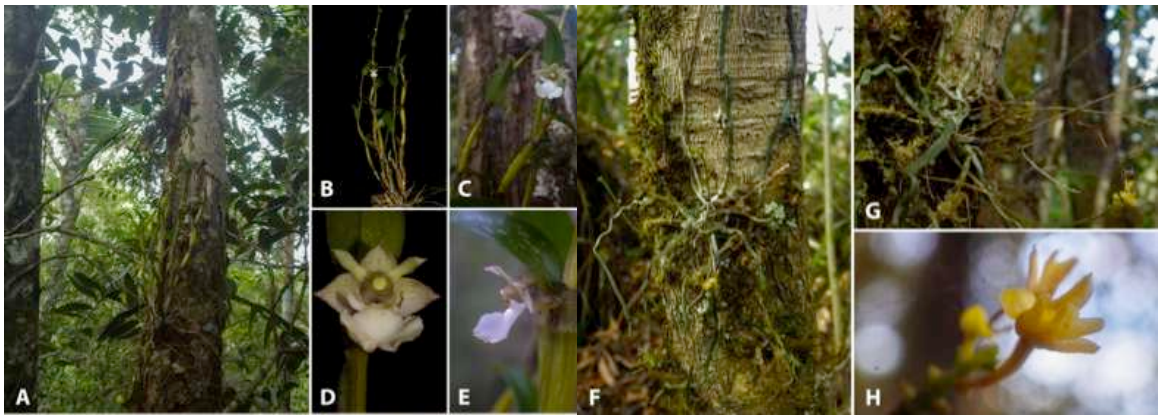


Figure 17: Photographs of living type specimens and habitats. *Dendrobium taeniocaule*: A habitat and habit; B plant; C flower and part of pseudobulb; D flower, front view; E flower, side view. *Taeniophyllum pyriforme*: F habitat and habit; G plant and inflorescence; H inflorescence and flowers close-up.

IV-7 Team Ichthyology

Kadarusman (Politeknik-KP-Sorong), H.L. Ohee (UNCEN), E. Melmambessy (UNMUS), M. Legendre (IRD), C. Cochet (IRD), S. Sauri (LIPI), Saidin (Politeknik-KP), R. Hocdé (IRD), A. Salamuk (Dinas Perikanan Kaimana), L. Pouyaud (IRD).

IV-7-1 Sampling

Our main objective was to pursue the ichthyological survey of freshwater fishes in the Kaimana area already started during Lengguru 2010 with an assessment of Melanotaeniidae (rainbowfishes), Eleotridae and Sicydiinae diversity. It was decided for Lengguru 2014 to extend the sampling to all fishes groups distributed in freshwater habitats and to investigate new localities never explored before. The ultimate goals are to generate a checklist of species for this poorly sampled area, and to quantify endemicity rates of the Lengguru ichthyofauna compared to neighbouring regions of the Birds Head and Papua.

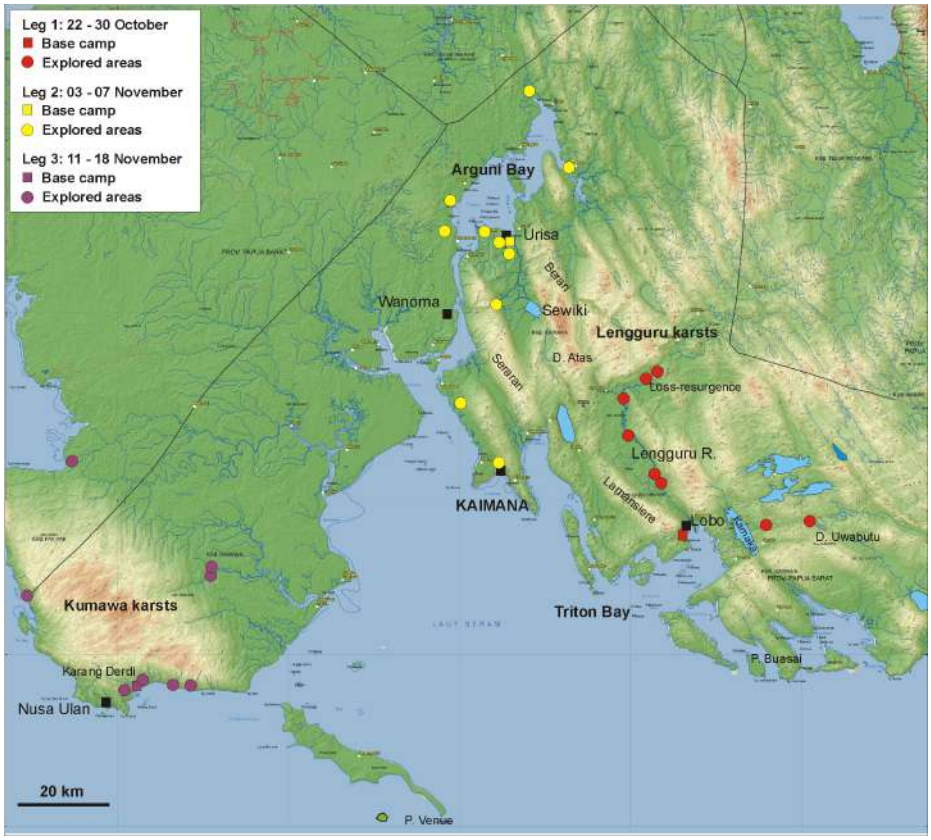


Figure 18: Sample sites covered during the ichthyological survey

Field works (Figure 18) were done in three main areas (Triton Bay, Arguni Bay, and Kumawa):
- Triton Bay (22-30 October), with several tributaries of the Lengguru River, and some remote localities east of Kamaka Lake (i.e. Uwabutu Lake, Ubecara River).
- Arguni Bay (03-07 November), comprising several rivers scattered all around the bay, the Sewiki Lake and surroundings (Wababoko underground drainage), and also the vicinity of Kaimana Town.
- Kumawa (11-18 November), including the upstream parts of Buruway and Karuta rivers.

Fishes were caught by scoop-net and seine-net, each specimen was photographed and labeled. Caudal-fin clips were taken for molecular analysis, while the carcasses were conserved on formaldehyde 20%.

A total of 366 specimens belonging to 14 families (i.e. Anguillidae, Apogonidae, Eleotridae, Gobiidae, Kuhliidae, Leiognathidae, Melanotaeniidae, Pseudomugilidae, Rhyacichthyidae, Soleidae, Syngnathidae, Terapontidae, Toxotidae, and Zenarchopteridae) were caught at 26 localities. All the specimens were registered and are stored at LIPI-MZB.

IV-7-2 Taxonomy

The preliminary species inventory made from Lengguru 2010 revealed the presence of 5 new species in Melanotaeniidae (Allen & Hadiaty, 2011[8]; Kadarusman et al. 2012[9]), one new species of cavefish (Pouyaud et al. 2012[10]), one new species of Sicydiinae gobies (Keith et al. 2011[11]), and one new species of Eleotridae (Keith et al. 2012[12]).

All the specimens collected during the expedition Lengguru 2014 were extracted at the MZB-IRD barcoding platform, and DNA aliquots were sent for DNA sequencing at the Canadian Centre for DNA Barcoding. We are now awaiting the sequences results for confirming the species determination and performing the species description.

Melanotaeniidae (6 new species)

Awaiting confirmation with COI sequences, first morphological observations made on Melanotaeniidae seem to reveal the presence of 6 new species at the heart of Lengguru and on the foothills of Kumawa (Figure 19). Their phylogenetic relatedness with already known species in the area will enable to argument the role of Lengguru as a center of diversification for this family.

Figure 19: New species of Melanotaeniidae (Lengguru 2014)

[8] Allen G.R. & R.K. Hadiaty. 2011. A new species of Rainbowfish (Melanotaeniidae) from Western New Guinea (West Papua Province, Indonesia). *Fishes of Sahul*, 25(1): 602-607.
[9] Kadarusman, Hadiaty R.K., Segura G., Setiawibawa G., Caruso D. & L. Pouyaud. 2012. Four new species of Rainbowfishes (Melanotaeniidae) from Arguni Bay, West Papua, Indonesia. *Cybium* 36(2): 369-382.
[10] Pouyaud L., Kadarusman, Hadiaty R.K., Slembrouck J., Lemauk N., Kusumah R.V. & P. Keith. 2012. *Oxyeleotris colasi* (Teleostei: Eleotridae), a new blind cave fish from Lengguru in West Papua, Indonesia. *Cybium*, 36(4): 521-529.
[11] Keith P., Allen G.R., Lord C. & R.K. Hadiaty. 2011. Five new species of *Sicyopterus* (Teleostei: Gobioidei: Sicydiinae) from Papua New Guinea and Papua. *Cybium*, 3 (4): 2-318.
[12] Keith P., Hadiaty R.K. & C. Lord. 2012. A new species of *Belobranchus* (Teleostei: Gobioidei: Eleotridae) from West Pacific Islands. *Cybium*, 36(3): 479-484.

IV-8 Team Mammalogy

G. Semiadi (LIPI), N. Supriatna (LIPI), Apandi (LIPI), A. M. Yohanita (UNIPA)

IV-8-1 Sampling

Lobo (Triton Bay) is an area with great variation on its topography, ranging from tower karsts type at the seashore to hilly forests on the slope of Lamansiere Mountain. The area is marked by a road construction of 40km long in the Lengguru valley. This development has resulted in many points by logging, burns and conversion of primary forests to cultivated parcels. Collection of mammals were conducted using live traps and snap traps for rodents, mist nets and harp nets for bats and specific requests of any large mammals to local hunters. Sampling schemes focused along river edges for both rodents and bats. Traps (25 to 40) and mist nets (1-2) were placed in transect lines perpendicular to the riverbanks and according to topography. Three small dry cave systems were also visited for sampling bats, large mammals and rodents. At least 11 species of bats were temporarily identified, comprising 59 specimen collected and 22 specimens released. The majority of bats were frugivorous with only two specimens of insectivores. The low numbers of bats being trapped were attributed to the summer weather conditions with less density of insects in the forest. Only 7 species of rodents (14 specimens) were collected including several species of *Rattus* and an exemplar of an undetermined *Melomys*. We noticed slight abundance of soil bandicoot rats in secondary forests. The catching of bandicoot rats was the most successful by using snare traps done by local hunters. Several specimens of marsupials were also caught, including a striped possum (*Dactylopsila trivirgata*), two cuscus (*Phalanger gymnotis*), a black-tailed Dasyure (*Murexia melanurus*), and two common spiny bandicoots (*Echymipera kalubu*).

Urisa (Arguni Bay) is an area characterised by important river systems, thus making more difficult for displacement due to limited boat availability to reach ideal spots for mammals collection. Thus collection was mostly conducted in secondary forests just behind the Urisa village and in the Sewiki area in Jabuenggara Cave and its vicinity. Bats collection was concentrated at the cave entrance and inside the cave. The interesting finding from Urisa was the presence of at least 6 different species in the same cave system. Such high species diversity in a small cave system is interesting to be studied and seems to have never been observed elsewhere in other Indonesian karst areas. At least 7 species of bats were temporarily identified, with 19 specimen collected and almost 70 specimens released. The presence of rodents was noticed in a very low number either in Jabbuengara cave or in low land forested areas. Only four specimens were collected and identification is in process after skull extractions. Big mammals only consisted of the observation of important densities of deer.

Kumawa is a protected area and the region is dominated by hilly topography surrounded by several river systems. Flat areas occur only at the lower part of the hilly region, and mostly along the coastal line. Large mammals that were easily spotted were forest wallabies (2 specimens), wild boars and deer. Several sighting of nocturnal cuscus occur mainly at the hilly areas with big trees. Small mammals were captured (2 species of *Rattus* sp., 1 species of *Melomys* sp.) along riverbanks and along the coastal line. We also noticed a low diversity in bats in the lowlands of Kumawa. Only 7 bats species were collected (27 specimens collected and 15 specimens released) and one species of flying fox.

IV-8-2 Taxonomy

It is not possible to estimate the number of possible new species for mammals prior to the acquisition of molecular data. For that purpose, all the specimens collected plus additional material previously collected from other areas in Papua, were DNA extracted and were sent for sequencing to the Canadian Centre for DNA Barcoding.

Nevertheless, previous morphological observations show 3 underdetermined species of Chiropters (*Rhinolophus* sp. in Lobo; *Nyctimene* sp. in Nusa Ulan; *Hipposideros* sp. in Urisa). For the rodents, we were not able to determine the two specimens of *Melomys* sp. and several specimens of *Rattus* sp. caught respectively in Kumawa and Lobo.

For the marsupials, it will be interesting to test the species determination already done from the morphological observations with the use of molecular data and subsequent phylogenetic relatedness with other taxa from New Guinea.

It will be particularly interesting to compare the COI sequences of the two specimens of the forest wallaby (*Dorcopsis muelleri*) caught in Kumawa, with other populations from West Papua and Papua in order to test possible geographic isolation. Kumawa's lowland habitats are indeed surrounded by steep mountain slopes, which probably hamper their dispersion.

PART V: PRELIMINAR RESULTS – MARINE TEAMS

Lengguru's limestone karsts extend in the Seram Sea until lowest levels known of Quaternary marine regressions (-120m). Submerged anticlines form complex islands networks, rias and shallow rocky banks. For example in Triton Bay, faults and rocks collapses are numerous and represent original submarine landscape similar to natural labyrinths with high potentialities for exploring various assemblages of organisms. On the contrary, the southwest extremity of Kumawa is exposed to the strong Torres' east-west surface current, and consists of a sharp slope plunging to the abyssal pit of the Seram Sea and facing a permanent upwelling.

Our preliminary explorations on the Lengguru's coastline show the followings:

- Presence of a large sedimentary cone (terrigenous inputs from continental erosion) in the Arguni Bay and extending until the south cape of Pulau Adi; accumulation of deep and unstable submarine dunes alternating with numerous scattered coral reefs,

- A mesotidal regime characterized by asymmetric tides (2,6 m maximal range), tidal propagation extending far upstream (up to 100 km) in Arguni Bay (Sewiki Lake) and sometime forming tidal bore (observed on Lengguru River in October 2014),

- An important hydrodynamic regime with a westward-flowing current particularly strong on exposed capes (south extremity of Nusa Ulan Cape) with the presence of submarine hydraulic sand dunes with depths ranging between -20 and -50 m,

- A rugged and tormented geomorphology at south extremity of Nusa Ulan Cape with absence of fouling and presence of scarce benthic fauna on substrate exposed to current until 90-100 m depths,

- A disjoint abundance for many organisms compared to other areas in Indonesia with generally abundant species becoming rare in Lengguru and conversely rare species elsewhere becoming more abundant in the area,

- An important species diversity within each studied group but characterized by low intraspecific abundance at a given locality,

- A spectacular species diversity of soft corals and associated organisms in Triton Bay,

- A stratification of species assemblages according to depth with some species characterized by an unusually shallow occurrence (20-40 m) that are generally confined to depths below about 50-100m at most locations in the Indo-Pacific; an ascent of deep species probably explained by the permanent turbidity of the surface section of the water-column.

Exploration of outer reef slopes were made at 6 locations (Figure 20): (1) inner part of Triton Bay; (2) eastern part of Pulau Buasai; (3) outer part of Triton Bay; (4) Bitsyari Bay; (5) Pulau Venue; (6) southern part of Nusa Ulan.

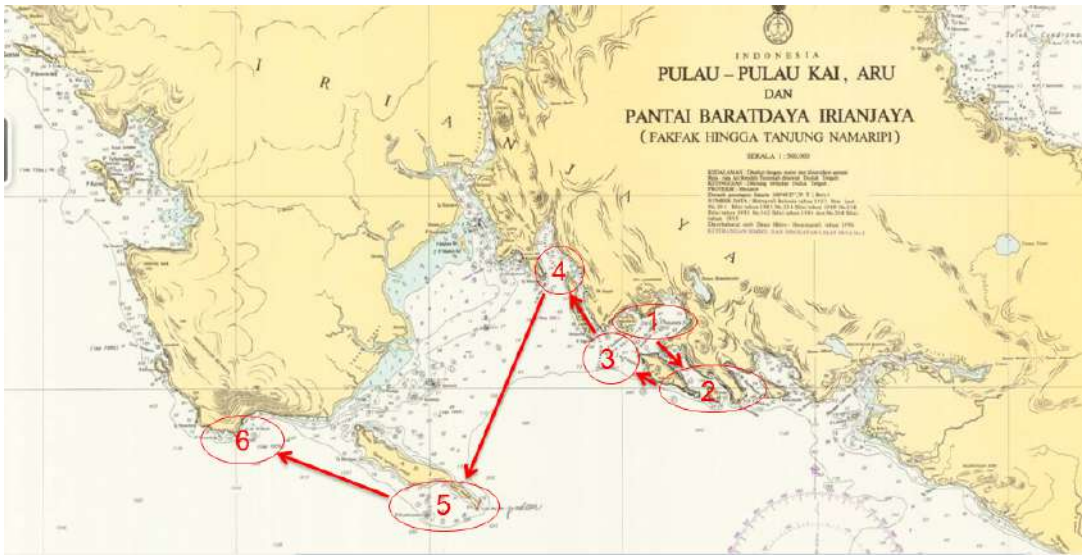


Figure 20: Localities explored by diving teams

Areas and depths of intervention were organized according to capacity and level of experience of each diver. Deep dives (up to -100m) were investigated by 5 divers (R. Hocdé, J.L. Menou, A. Gerbault, E. Bahuet, G. Di Raimondo) with electronical- closed circuit rebreathers (e-CCR), while conventional dives (up to 40m) were organized by other members (Y. Tuti, M. Abrar, I.B. Vimono, A. Irawan, U. Arbi, A. Suruwaki, Gofir).

Beside an intensive dives campaign performed along Lengguru's reef slopes, 2 CCR divers explored during 2 consecutive days the underground submarine network of Wababoko Cave in Berari anticline (near Jabbuengara). This exploration revealed the existence of an important underground system, which was not mapped because of the importance of the area and insufficient logistic. No hypogean organisms but only organisms originating from outside were observed during the dives (a turtle of the genus Elseya and some species of Gobiidae).

The sampling methodology for the marine biotas consisted to collect by hand hard and soft corals, seagrass, algae, and invertebrates (mollusks, echinoderms) along vertical transect from -100m to the surface and by the way to precise their distribution according to depth. Each collected sample was photographed and labeled with a precise description of its habitat (GPS coordinates, depth, salinity, etc.). Nature of the samples consisted of vouchers (Museums collections) and tissues for subsequent DNA barcoding analysis.

More than 600 specimens were collected (hard corals, gorgonians, echinoderms, mollusks, algae, seagrass) in favor of 321 cumulated dives at 48 stations. The results for each studied groups are presented below.

V-1 Team Echinoderms

I.B. Vimono (LIPI), R. Hocdé (IRD), J-L. Menou (IRD), A. Gerbault (IRD), G. Di Raimondo (IRD), A.M. Suruwaki (Politeknik-KP-Sorong), Gofir (Politeknik-KP), A. Chenuil (IMBE)

V-1-1 Sampling

A total of 332 specimens were collected during 20 diving operations. These specimens belong to 4 classes: Asteroidea (sea stars, 184 specimens), Holothuroidea (sea cucumbers, 76 specimens), Ophiuroidea (brittle stars, 14 specimens), and Echinoidea (sea urchins, 58 specimens). The class Crinoidea was not sampled due to its difficulty for preservation.

V-1-2 Taxonomy

Preliminary morphological observations revealed the presence of 22 species of sea stars (6 undetermined species), 22 species of sea cucumbers (8 species not identified), 9 species of brittle stars (7 species undetermined), and 11 species of sea urchins (1 species not identified).

Part of the material collected (68 taxa) was DNA extracted at Ancol's molecular laboratory during a two weeks working session organized in October-November 2015.

With the financial support of Expedition Lengguru 2014, Dr. A. Chenuil has invited I.B. Vimono (RCO) at IMBE Marseille during 2 weeks (December 2015), for a molecular training aiming to optimize the PCR conditions and protocols for amplifying the extracted taxa. Near than 90% of the specimens were successfully amplified for the 5' part of the COI gene (730 base pairs). The material was sent for sequencing and data acquisition are ongoing. It is scheduled a new visit of I.B. Vimono on the coming months according to its availability for pursuing the sequences data analysis and performing additional DNA extractions and PCR amplifications.

Asteroidea (possibly 2 new species)

The species collected and preliminary determined on a morphological basis are: *Acanthaster planci* (11), *Choriaster granulatus* (4), *Culcita novaeguineae* (5), *Echinaster callosus* (2), *Echinaster luzonicus* (27), *Fromia millepora* (15), *Fromia indica* (1), *Fromia monilis* (9), *Gomophia egeriae* (4), *Halityle regularis* (1), *Iconaster longimanus* (1), *Linckia laevigata* (22), *Linckia multiflora* (34), *Nardoa novaecaledoniae* (13), *Neoferdina cumingi* (1) and *Protoreaster nodosus* (16). Most of these species are widespread in the Indo-Pacific except 3 rare species, which were sampled during the expedition (i.e. *Echinaster callosus*, *Halityle regularis*, *Protoreaster nodosus*; Figure 21).

Figure 21 (from left to right): *E. callosus* 20m; *H. regularis* 25m; *P. nodosus* 18-25m

Indra B. Vimono despite hundreds of dives never observed *Halityle regularis* elsewhere in Indonesia. On the same manner, the horned sea star *Protoreaster nodosus*, which is known to be extinct from many touristic areas in the Indo-Pacific, is relatively abundant in Lengguru.

One specimen of *Gomophia egeriae* (Figure 22) was collected at 70m (Triton Bay) and presented only 4 arms. This morphologic characteristic is very rare in the genus and argues to confirm its taxonomic status with genetic analysis. The species *G. egeriae* is generally considered as a synonym of the species *G. agyptiaca*, which is distributed to the Red Sea and Western Indian Ocean. Nevertheless, the other species *G. watsoni* is known from Australia and was already barcoded. Further molecular data on our material will therefore help for its identification.

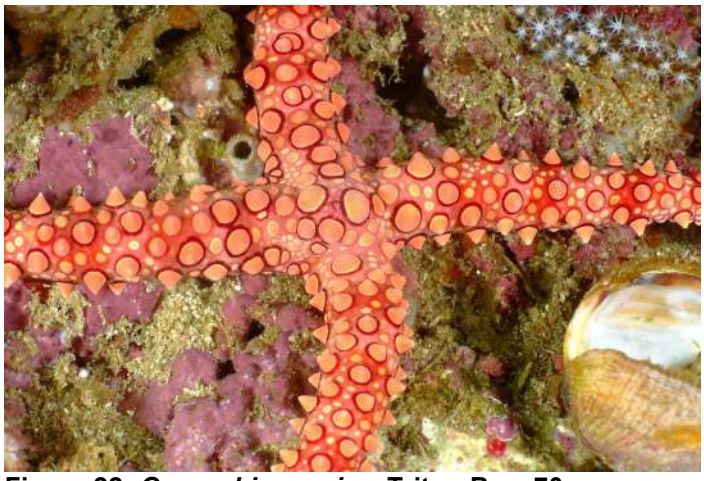


Figure 22: *Gomophia egeriae*, Triton Bay, 70m

The crown of thorns starfish *Acanthaster planci*, a voracious predator of corals, was observed in important densities in the Pulau Venue Marine Protected Area near anciently bombed reefs. This results address serious concerns for the area in terms of potentially major management problem of coral reefs.

The six species not yet determined until additional molecular analysis and morphological observation are: one species with an unknown genus (Asteroidea 1, Triton Bay), one deep species of *Nepanthia* sp. (Asteroidea 2, 100m depth, Triton Bay, figure 23), one species of *Echinaster*, two species of *Astropecten*, and one species of *Linckia* displaying some differences with *L. guldingii*.

Figure 23: *Nepanthia* sp., 100m, Triton Bay

Holothuroidea (possibly one new species)

The species collected and preliminary determined on a morphological basis are: *Actinophyga albonigra* (6), *Actinophyga lecanora* (1), *Bohadschia argus* (2), *Holothuria atra* (1), *Holothuria coluber* (1), *Holothuria edulis* (12), *Holothuria fuscogilva* (1), *Holothuria fuscopunctata* (3), *Neothyonidium magnum* (1), *Pearsonothuria graffaei* (8), *Stichopus noctivagus* (1), *Thelenota ananas* (1), *Thelenota anax* (8), and *Thelenota rubrolineata* (1).

The eight species not determined include a species close to *H. edulis* (5 specimens), 3 species within Synaptidae (14), 2 species within genera *Synaptula* (9) and *Penctata* (5), a species of genus *Bohadschia* (1), and a species with no identified genus (2 specimens).

Ophiuroidea

Within the 9 taxa of brittle stars, only two species were identified. These species are respectively *Ophiolepis superba* (2) and *Ophiotrix purpurea* (5). The identification of the remaining 7 species will be performed from the DNA barcoding results and with the help of a specialist for this group, not contacted at the moment.

Echinoidea (possibly 2 new species)

All the collected species were identified from their morphologic characters, excepting for one taxon of *Phyllacanthus*. The identified species are respectively: *Asthenosoma varium* (1), *Diadema savignyi* (10), *Diadema setosum* (1), *Echinostrephus aciculatus* (31), *Echinostrephus luzonicus* (2), *Echinothrix calamaris* (3), *Eucidaris metularia* (1), *Mespilia globulus* (1), *Prionocidaris baculosa* (2), and *Tripneustes gratilla* (5).

All of these species are common and widespread in the Indo-Pacific excepting the rare species *Prionocidaris baculosa* (Figure 24), which is normally distributed in the Western Indian Ocean. This taxon collected at 70m depths can potentially represent a new species after confirmation with molecular data.

Figure 24: *Prionocidaris baculosa*, 70m, Lengguru

The species belonging to the genus *Phyllacanthus* seems closely related to the species *P. imperialis* known from the Indo-Pacific (Figure 25). Nevertheless, some obvious morphologic differences can be seen: the Lengguru specimen has larger spikes diameter with distinct pattern of coloration. Several specimens from Lizard Island (Australia) were already barcoded making easy further determination of our specimens.

Figure 25: *P.* cf. *imperialis*, Lengguru (left); *P. imperialis*, Lizard Island (Australian Museum)

V-2 Team Gorgonians

Y. Tuti (LIPI), R. Hocdé (IRD), J-L. Menou (IRD), A. Gerbault (IRD), G. Di Raimondo (IRD), A.M. Suruwaki (Politeknik-KP-Sorong), L. Pouyaud (IRD), D. Aurelle (IMBE), S. Sartoretto (IFREMER)

V-2-1 Sampling

Around 179 specimens of gorgonians were collected during 30 diving operations at night and during daylight between the surface and 94m depths. Each specimen was photographed in situ and in the wet lab. The carcass was then preserved in ethanol 70 for subsequent morphologic analysis. A piece of tissue was stored in absolute ethanol for further molecular analysis.

V-2-2 Taxonomy (possibly 8 new species)

The gorgonians examined on a morphologic basis belong to 8 families: Acanthogorgiidae, Briaeidae, Ellisellidae, Gorgoniidae, Melithaeidae, Plexauridae, Primnoidae and Subergorgidae. Most of the taxa are included in Plexauridae and Ellisellidae. From the different identified genera, some are widespread and commonly observed in the Indo-Pacific (i.e. *Ellisella*, *Melithae*, *Astrogorgia*, *Menella*) with a priori well-known species diversity (Grasshoff & Bargibant, 2001[13]). Nevertheless, the present work could significantly increase the species richness of these genera with the description of several new species in the coming months.

With 11 described species, the genus *Trimuricea* is widely distributed in the Indo-Pacific and was recently extended to the Persian Gulf. Members of this genus has been rarely observed nor photographed in situ (Samini-Namin K. & L.P. Ofwegen, 2016[14]). The sample of Plexauridae (L003LY17) from Triton Bay was morphologically assigned to *Trimuricea* cf. *inermis* and probably belongs to a new species (Figure 26). Our sample is indeed related to *T. inermis* (described from East Timor), but displays several distinct morphological characters with the latter. It is also very different from *T. bicolor*, a species of the genus known from Sulawesi. The present discovery therefore highlights our knowledge on Plexauridae by extending the family's distribution in West Papua and by increasing its species diversity and data on its biology.

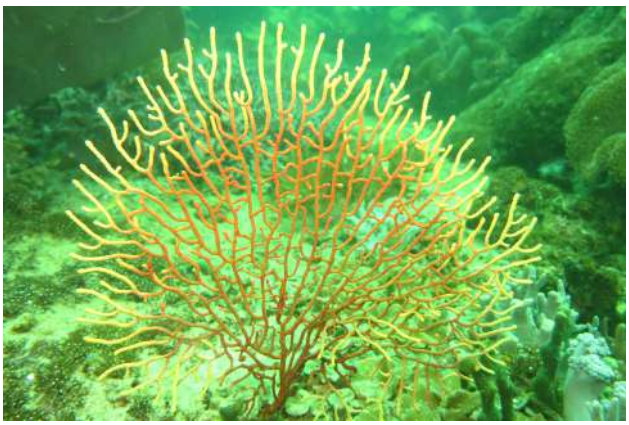


Figure 26: *Trimuricea* cf. *inermis* (Plexauridae), Triton Bay

[13] Grasshoff, M., Bargibant, G., 2001. Les gorgones des récifs coralliens de Nouvelle-Calédonie. IRD éditions, Paris, 336 pp.
[14] Samimi-Namin K. & L.P. Ofwegen. 2016. A revision of Trimuricea Gordon, 1926 (Cnidaria : Octocorallia : Plexauridae) with the description of six new species. *Zootaxa*, 4105(1) : 1-44.

Lengguru 2014 was the opportunity to explore for the first time in West Papua, “the twilight zone”. This part of coral reef is comprised between 50 and 100m depths and cannot be explored with conventional diving technologies, nor with remotely operated vehicle (ROV) because of rough topography and strong current. The use of closed circuit mixed gas rebreathers gives therefore this opportunity under safe condition and with enough time for sampling activities.

Two samples of Primnoidae (L007LYA9 and L019LYJLM1) were collected in this depth range (50-100m) in Triton Bay. Primnoidae is a very diverse gorgonian family widely distributed geographically and bathymetrically (until 6000m depths) (Cairns, 2009[15]). They are also known as abyssal soft corals.

The two samples of Primnoidae belong to the genus *Pterostenella*. The sample L007LYA9 (Figure 27) is closely related to *Pterostenella anatole*, while L019LYJLM1 (Figure 28) seems to share similarities with *Pterostenella plumatilis*. Nevertheless, close examination of our material revealed sufficient morphological differences with these two species, suggesting the possible presence of two new species.

Figure 27: *Pterostenella* cf. *anatole* (L007LYA9, Triton Bay)

Figure 28: *Pterostenella* cf. *plumatilis* (L019LYJLM1, Triton Bay)

Part of the samples (i.e. L001LY103, L004LY108, L014LY116, L023LY123, L048LY156) collected between 30 and 70m depths were assigned to *Nicella* (Figure 29). Following the literature, this genus is rarely observed above 50m (Fabricius & Alderslade, 2001[16]). Morphological analysis of our material suggests that they probably belong to unknown species.

[15] Cairns S.D. & Bayer F.M. 2009. A generic revision and phylogenetic analysis of the Primnoidae (Cnidaria : Octocorallia. *Smithonian contributions to zoology*, 69 : 79-80.
[16] Fabricius K. & Alderslade P. 2001. Soft Corals and Sea Fans – *A comprehensive guide to the tropical shallow-water genera of the Central-West Pacific, the Indian Ocean and the Red Sea*. Australian Institute of Marine Science, 264 pp.

Figure 29: *Nicella spp*. (Triton Bay and Nusa Ulan)

The unusually shallow occurrence of several *Nicella* gorgonians was also observed for other families such as Parisididae. This observation is of prime importance if confirmed by subsequent species assignation with molecular analyses because it could suggest that specific Lengguru's karst environment coupled with particular turbidity conditions promote original species assemblage including taxa known to be deeper species in other Indo-pacific areas.

Gorgonians play a prominent role for other organisms. They are hosts for snails, crabs and fish. The best example is that of the pigmy seahorse, which developed intricate relationships with species of the gorgonian genus *Muricella* by mimicking its general aspect to shelter against predators and optimizing preys capture. Some pigmy seahorses were observed and photographed during the Lengguru survey (Figure 30).

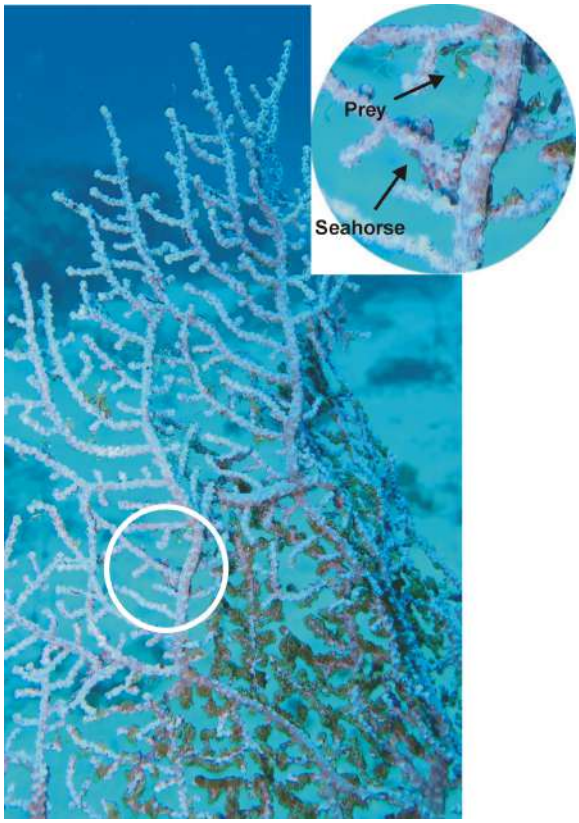


Figure 30: A pigmy seahorse on a *Muricella*

Part of the material collected (81 taxa) was DNA extracted at Ancol's molecular laboratory during a two weeks working session organized in October-November 2015.

With the financial support of Expedition Lengguru 2014, Dr. D. Aurelle has invited Y. Tuti (RCO) at IMBE Marseille during 2 weeks (December 2015), for a molecular training aiming to optimize the PCR conditions and protocols for amplifying the extracted taxa.

The molecular analyses were performed on two mitochondrial genes (COI-Igr and MutS). These two genes are the most used in gorgonians phylogenies (McFadden et al. 2011[17]). They are also developed in genetic barcode for species identification but with lower performing on gorgonians compared to other

[17] McFadden C., Benayahu Y., Pante E. et al. 2011. Limitations of mitochondrial gene barcoding in Octocorallia. *Molecular Ecology Resources*, 11, 19-31

Metazoans due to the low interspecific variation of the mitochondrial DNA (Calderon et al. 2006[18]; Pante et al. 2015[19]; McFadden et al. 2011). It is therefore necessary to perform an integrative taxonomic approach coupling molecular analyses with accurate morphological studies.

We obtained the DNA sequences of 62 taxa for the COI gene and 54 taxa for the mtMutS. We present a preliminary phylogenetic tree (maximum parsimony) obtained with mtMuts data (Figure 31).

The phylogenetic tree shows that Lengguru material encompasses a wide diversity within Octocorallia, with several divergent groups. Most represented groups are related to genera *Menella* and *Echinogorgia*, or to *Acanthogorgia*. Some specimens seem to be very divergent from already known genera (Leng107) and an accurate analysis of their morphologic characteristics is a prerequisite to confirm their taxonomic status.

We are presently completing morphological characterization of all samples. The next step will consist to complete DNA extraction and PCR amplifications of the remaining material DNA. A new visit of Y. Tuti at IMBE Marseille is scheduled during the coming months according to its availability for pursuing the molecular data acquisition and analysis, and for starting new species description.

[18] Calderon I., Garrabou J., Aurelle D. 2006. Evaluation of the utility of COI and ITS markers as tools for population genetic studies of temperate gorgonians. *Journal of Experimental Marine Biology and Ecology*, 336, 184-197.
[19] Pante E., Abdelkrim J., Viricel A. et al. 2015. Use of RAD sequencing for delimiting species. *Heredity*, 114, 450-459.

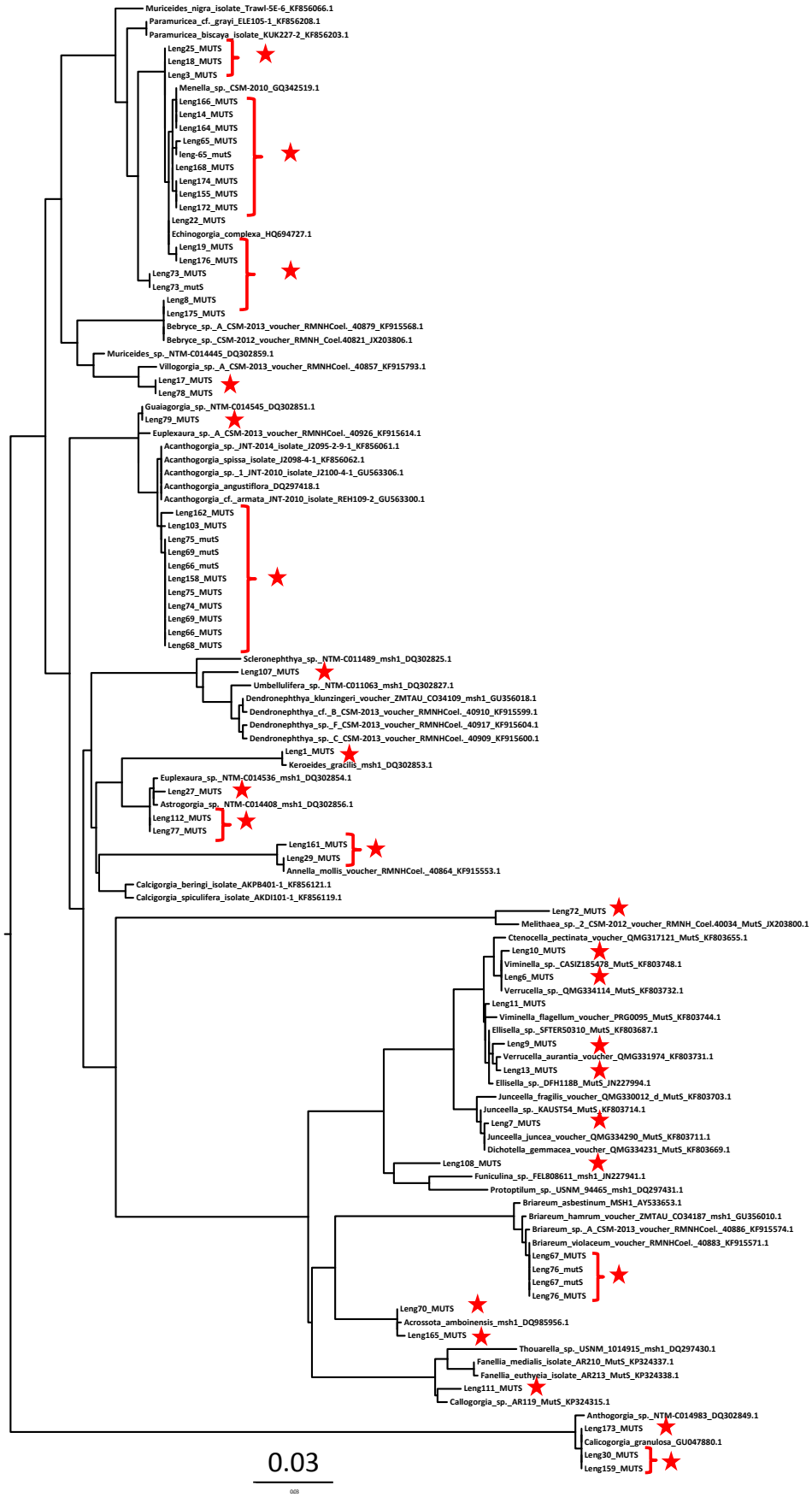


Figure 30: Gorgonians MP phylogenetic tree from mtMutS. Lengguru taxa are indicated (red stars) and closest known taxa (blast in genbank) are mentioned.

V-3 Team Hard Corals

M. Abrar (LIPI), R. Hocdé (IRD), J-L. Menou (IRD), A. Gerbault (IRD), G. Di Raimondo (IRD), E. Bahuet (IRD) ,A.M. Suruwaki (Politeknik-KP), D. Aurelle (IMBE)

V-3-1 Sampling

Our main objective is to make an inventory of hard coral in Lengguru by using molecular identification. Because Lengguru 2014 was a preliminary survey for this complex group, we decided to collect only specimens of uncommon species or displaying original features (morphology, coloration). Near one hundred samples were collected from 33 genera distributed in 15 families (Figure 31): Acroporidae (*Acropora* spp., *Alveopora* spp., *Montipora* spp.), Agariciidae (*Gardinoseris* spp., *Leptoseris* spp., *Pachyseris* spp., *Pavoma* spp.), Caryophylliidae (*Plerogyra* sp.), Dendrophylliidae (*Dendrophyllia* spp., *Heteropsammia* spp., *Tubastrea* spp., *Turbinaria* spp.), Euphylliidae (*Catalophyllia* spp., *Euphyllia* spp.), Faviidae (*Favia* spp.), Fungiidae (*Cycloseris* spp., *Diaseris* spp., *Fungia* spp., *Polyphyllia* spp., *Sandalolitha* spp.), Lobophylliidae (*Lobophyllia* spp., *Oxypora* spp.), Merulinidae (*Cyphastrea* spp., *Pectinia* spp., *Platygyra* spp., *Trachyphyllia* spp.), Montastraeidae (*Montastraea* spp.), Mussidae (*Scolymia* spp.), Oculinidae (*Galaxea* spp.), Pocilloporidae (*Pocillopora* spp., *Stylophora* spp.), Poritidae (*Goniopora* spp.), and Psammocoridae (*Psammocora* spp.).

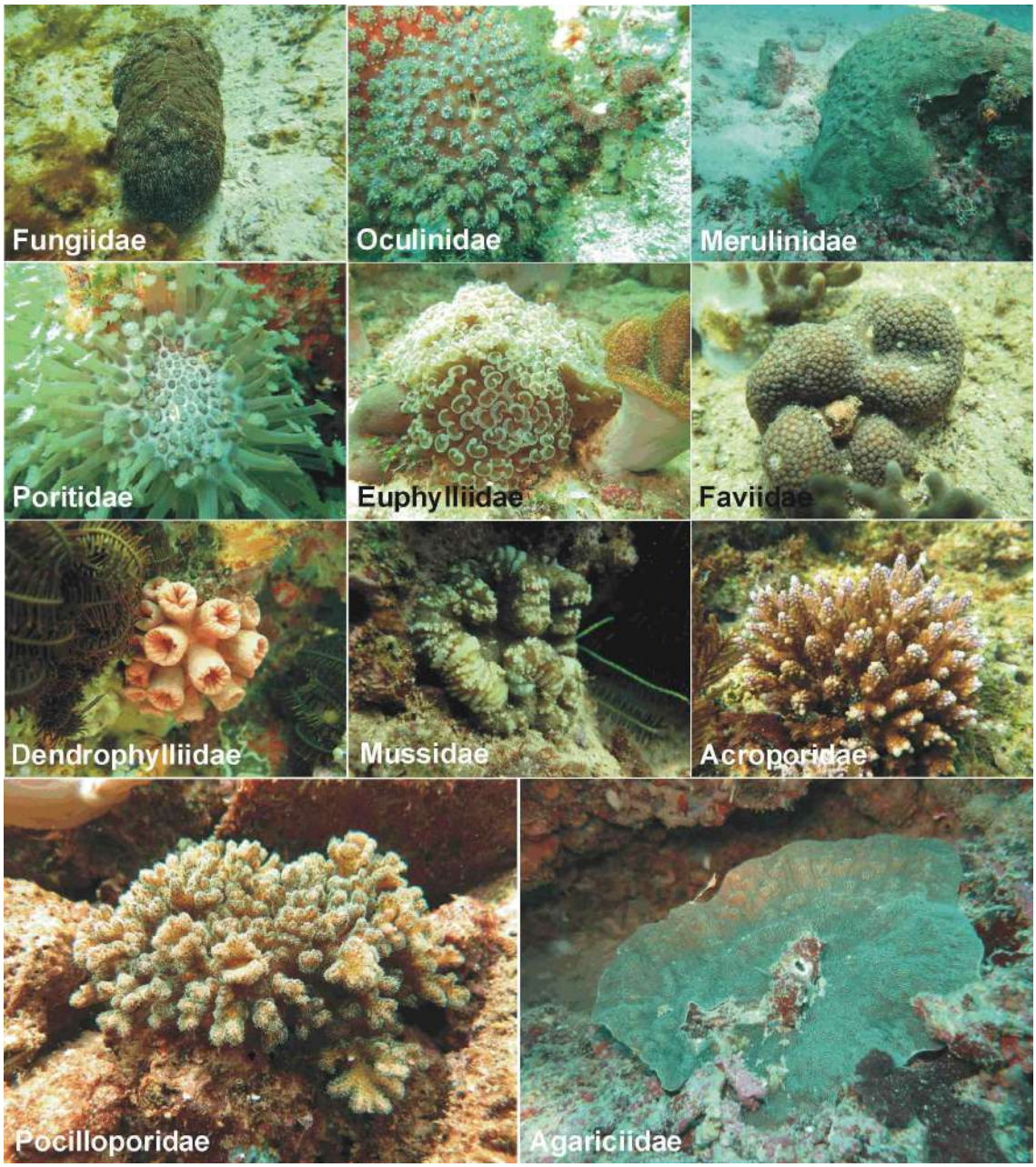


Figure 31: Some families of hard corals collected in Lengguru

V-3-2 Taxonomy

During a molecular training session organized by the Lengguru team at RCO-LIPI, M. Abrar and D. Aurelle tried to extract DNA from 15 samples of hard corals by using a standard protocol with the Qiagen Dneasy kit. Tests on DNA quantity and quality demonstrated that the DNA was already degraded because of long exposition of the samples to UV and ambient temperature.

Hard corals DNA is generally present in very low quantity in the skeleton structure and is exposed to rapid degradation in contact with DNAses from various sources. It is therefore necessary to store immediately the collected sample in appropriate conditions (sufficient quantity of absolute ethanol, obscurity, and under a very cold temperature).

The dry specimens were all registered in the LIPI collection awaiting further accurate identifications. The next step will consist to perform new DNA sampling in favor of a next field expedition.

V-4 Team Mollusks

U.Y. Arbi (LIPI), R. Hocdé (IRD), J-L. Menou (IRD), A. Gerbault (IRD), G. Di Raimondo (IRD), A.M. Suruwaki (Politeknik-KP), L. Pouyaud (IRD), A. Chenuil (IMBE)

V-4-1 Sampling

Near 900 specimens of mollusks were collected with 30% corresponding to dead shells. These specimens belong to 4 classes: Gastropoda (797 specimens), Bivalvia (85 specimens), Polyplacophora (6 specimens), and Scaphopoda (7 specimens).

The class Gastropoda includes 43 families: Architectonicidae (3 specimens), Buccinidae (34), Bullidae (2), Bursidae (7), Cassidae (8), Cerithiidae (16), Colubrariidae (6), Columbellidae (3), Conidae (188), Coralliophyllidae (5), Costellariidae (23), Cymatiidae (7), Cypraeidae (95), Epitoniidae (3), Eulimidae (1), Fasciollariidae (5), Ficidae (2), Fissurellidae (1), Haliotidae (4), Harpidae (5), Mitridae (15), Muricidae (31), Nassariidae (11), Naticidae (11), Neritidae (5), Olividae (16), Ovulidae (13), Patellariidae (1), Potamididae (2), Ranellidae (13), Schapandridae (3), Strombidae (60), Terebridae (46), Tonnidae (24), Triviidae (1), Trochidae (29), Turbinellidae (5), Turbinidae (15), Turridae (26), Turritellidae (24), Volutidae (4), and Xenophoridae (1). We also collected several taxa of sea slugs (Cephalaspidea, Sacoglossa) and Nudibranchia (45).

The class Bivalvia includes 15 families: Arcidae (7), Cardiidae (4), Limidae (5), Maleidae (4), Mytillidae (1), Ostreidae (6), Pectinidae (6), Pinnidae (3), Psammobiidae (1), Pteriidae (11), Solenidae (3), Spondylidae (8), Tellinidae (7), Tridacnidae (3), and Veneridae (12).

The class Polyplacophora is represented by Chitonidae (6) and the class Scaphopoda is represented by Dentaliidae (7).

Tissues were collected for DNA analysis on most families belonging to Gastropoda (202) and Bivalvia (29) for subsequent species assignation.

V-4-2 Taxonomy (possibly 7 new species)

Molecular analyses are still not performed on mollusks. Only 32 specimens of cone snails (Conidae) and cowries (Cypraeidae) were DNA extracted at Ancol's molecular laboratory during a two weeks working session organized in October-November 2015. It is expected to continue this work for the coming months depending on the availability of U. Arbi.

Preliminary morphological observations were done on Conidae with the determination of 16 taxa including 13 known species (i.e. *Conus amiralis*, *C. arenatus*, *C. bandanus*, *C. capitaneus*, *C. circumcisus*, *C. generalis*, *C. leopardus*, *C. lividus*, *C. marmoreus*, *C. miles*, *C. moluccensis*, *C. textile*, *C. virgo*), and 3 undetermined species (*Conus cf. aurisiacus*, fig. 32; *Conus cf. vitulinus*, fig. 34; *Conus* indet., fig. 36). Within these undetermined species, 2 species seems respectively related to *C. aurisiacus* (Figure 33) and *C. vitulinus* (Figure 35) with some differences for their coloration pattern. We did not find any related species for the third undetermined species (Figure 36). It is premature to give any conclusion on their taxonomic status prior molecular data, as the *Conus* genus comprises more than 500 species.

Figure 32: *Conus cf. aurisiacus* (Lengguru)

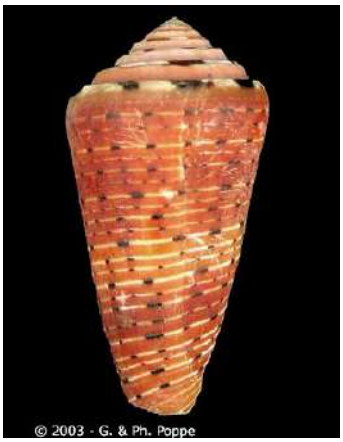


Figure 33: *Conus aurisiacus*

Figure 34: *Conus cf. vitulinus* (Lengguru)

Figure 35: *Conus vitulinus*

Figure 36: *Conus sp.* undetermined (Lengguru)

There are about 3000 described species of opisthobranchs and at least 40% of these have been found exclusively in the Coral Triangle. We observed that this group is largely represented in Lengguru in terms of abundance and species diversity. Sea slugs and nudibranchs (opisthobranchs) were identified according to the species determination guide publishes by Gosliner et al. (2015)[20].

We identified 42 species of nudibranchs distributed in 16 genera namely, *Ardeadoris* (2 species), *Atagema* (1), *Ceratosoma* (1), *Chromodoris* (2), *Dendrodoris* (1), *Dorisprismatica* (1), *Goniobranchus* (5), *Halgerda* (1), *Hypselodoris* (6), *Nembrotha* (3), *Phyllidia* (8), *Phyllidiella* (2), *Phyllidiopsis* (1), *Pteraeolidia* (4), *Reticulidia* (2), and *Thecacera* (2). Among these, 6 taxa are undetermined in genera *Dorisprismatica* (1 species), Halgerda (1), *Pteraeolidia* (3), and *Thecacera* (1).

These unknown taxa are presented below (Figure 37).

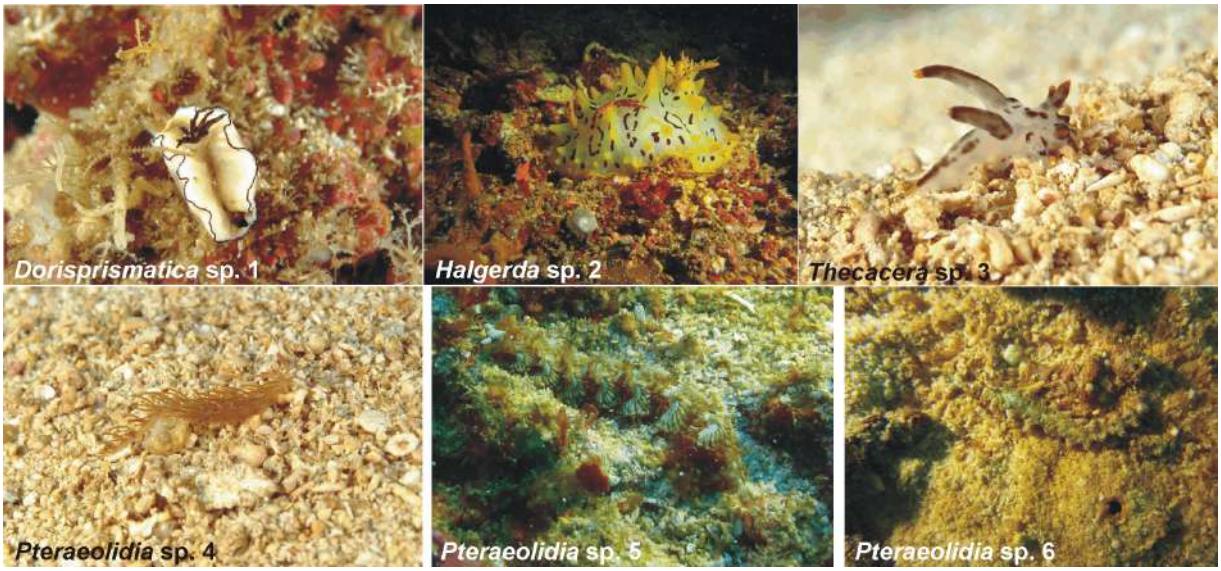


Figure 37: Undetermined species of nudibranchs

Concerning the sea slugs, we determined 4 species in Cephalaspidea (genus *Chelidonura*, fig. 38), 3 species in Pleurobranchoidea (genus *Pleurobranchus*, fig. 39), and 1 species in Sacoglossa (*Thuridilla lineolata*, fig. 40).

Figure 38: *Chelidonura livida* Lengguru

Figure 39: *Pleurobranchus cf. grandis*

Figure 40: *Thuridilla lineolata* Lengguru

[20] Gosliner T.M., Valdes A. & Behrens D.W. 2015. *Nudibranch and Sea Slugs Identification – Indo-Pacific*. New World Publications, Inc. Jacksonville, Florida USA, 408pp.

V-5 Team Algae and Seagrass

A. Irawan (LIPI), M. Sekar (LIPI), R. Hocdé (IRD), C. Payri (IRD)

V-5-1 Sampling

Seagrass and algae samples were collected by hand during snorkeling or diving sessions. A total of 28 specimens of algae and 65 specimens of seagrass were collected during the expedition. All specimens were dried on silica gel and a piece of tissue was preserved in absolute ethanol for further molecular analyses.

Globally, seagrass are abundant on the Lengguru's seafront with many localities displaying favorable conditions (shallow waters on muddy-sandy substrates).

V-5-2 Taxonomy

First morphological investigations on algae revealed the presence of 7 genera (i.e. *Codium* spp., *Halimeda* spp., *Halimenia* spp., *Lobophora* spp., *Padina* spp., *Porphira* spp., and *Sargassum* spp.). It was not possible to validate their species status pending further molecular analysis in collaboration with Dr. C. Payri.

Morphological observations on seagrass confirm the presence of 2 families and 6 species (Cymodoceaceae: *Cymodocea rotundata*, *Halodule pinifolia*, *Halodule universis* and Hydrocharitaceae: *Enhalus acoroides*, *Halophila ovalis*, *Thalassia hemprichii*). The species *C. rotundata* and *H. ovalis* (Figure 41), and the species *E. acoroides* were the most abundant (Figure 42).

The diversity of seagrass in Lengguru is important (6 species) referring to Indonesian's diversity (13 species). The karst context and subsequent soil runoffs probably explain this observation in favoring continuous sediment deposit and persistence of important seagrass populations.

Figure 41: *Cymodocea rotundata* (long) and *Halophila ovalis* (oval)

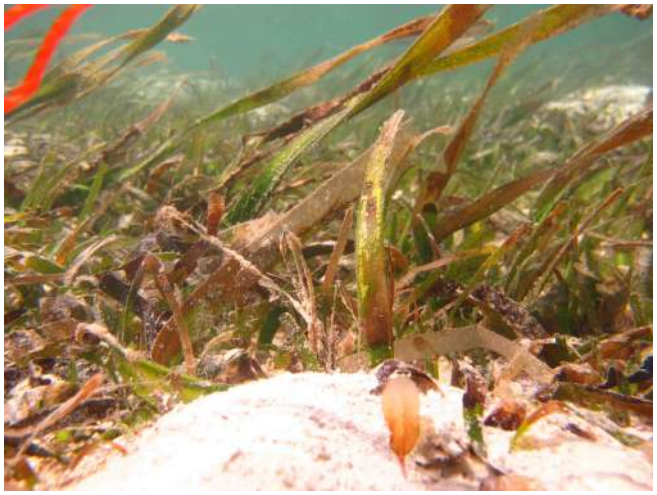


Figure 42: *Enhalus acoroides*

V-6 Team Cetaceans and Whale Sharks

M. Sekar (LIPI), R. Hocdé (IRD), L. Pouyaud (IRD), S. Quérouil (IRD)

V-6-1 Sampling

For cetaceans, observations were made onboard the Airaha 2 vessel either during cruise or when anchored. Whenever possible, observations were confirmed by getting closer to the animal using an inflatable boat. In addition, on few occasions, an inflatable boat equipped with a 25 or 40hp engine was used to actively search for cetaceans, following random routes. In total, 34.4 hours were spent actively searching for cetaceans, along a journey of 286.6 nautical miles. Searching effort was performed under good weather and visibility conditions, with Beaufort not exceeding 3, by one to five observers (median of 3). Cetaceans were spotted on 41 occasions, either during active search or incidentally, by any passenger or crewmembers. Tissues from two dolphins were sampled with adequate non-invasive method for molecular analyses.

Whale sharks are commonly observed in Bitsyari Bay (Kaimana), where they are attracted to the presence of lift net Bagan platforms that target anchovies. Bagans are large stationary anchored outrigger boats that deploy nets at night. These nets are lowered to 20m and strong electric are switched on to attract anchovies. In the early morning, lights are switched off and the nets are lifted with the trapped fish. The unused fish that is discarded in turn attracts the whale sharks. The question asked by the Fisheries Department from Kaimana was to test if these whale sharks are a resident population or if their presence is only transient? The whale shark (*Rhincodon typus*) is normally considered as a cosmopolitan tropical species in constant moving. We sampled small pieces of muscle tissue on 2 specimens to answer this question by appropriate molecular analyses.

V-6-2 Taxonomy

Cetacean Sightings mainly consisted in dolphins, with two predominating species: the usual form and the dwarf form of spinner dolphins (*Stenella longirostris longirostris* and *Stenella longirostris roseiventris*), with groups ranging from 3 to over 300 individuals, and the Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), with groups ranging from 1 to 45 individuals. These two species are typical of coastal habitats and were repeatedly sighted in the same areas, suggesting that they might be at least seasonally resident in Triton Bay and Kumawa. Common bottlenose dolphins (*Tursiops truncatus*) and pantropical spotted dolphin (*Stenella attenuata*) were also seen occasionally. Finally, an undetermined species of dolphin was observed in Arguni Bay. Preliminary sightings suggested a species belonging to the humpback dolphin from the genus *Sousa*.

Regarding whales, large whales of the genus *Balaenoptera* (probably Bryde's whales, *Balaenoptera brydei*) and melon-headed whales (*Peponocephala electra*) were seen on respectively 3 and 1 occasions. A distant sighting was most probably a group of humpback whales (*Megaptera novaeangliae*).

M. Sekar and S. Quérouil extracted DNA from one specimen of *Stenella longirostris* and one specimen of the humpback dolphin *Sousa* sp. in March 2015 at the LIPI-IRD barcoding platform. Mitochondrial control region and cytochrome b were amplified and sequenced. The results revealed that the mitochondrial haplotype of the spinner dolphin *Stenella longirostris* sampled in Kumawa (Figure 43) is the same than one of haplotypes diversity described in the large population of the dwarf spinner dolphin *Stenella longirostris roseiventris* distributed in Oceania. These results therefore demonstrated for the first time the presence of the dwarf spinner dolphin in West Papua and probably suggest an extension of Oceania population until Indonesia.

The mitochondrial haplotype of the humpback dolphin sampled in Arguni Bay (Figure 44) is identical to one of the haplotypes of the Australian humpback dolphin *Sousa sahulensis* described in 2014 (Jefferson & Rosenbaum, 2014[21]). This species was only known from northern Australia. The specimen from Lengguru probably belongs to a distinct population characterized by a different coloration pattern. These results are important for the conservation management of this endangered species by extending its natural distribution. A paper presenting these results is in progress.

Genetic analyses made at LIPI on the 2 specimens of whale sharks consisted to PCR amplification and sequencing of complete mitochondrial control region. The results revealed that both Lengguru specimens shared their haplotype respectively with one specimen caught from Indian Ocean and with one specimen from Pacific Ocean according to the work done by Castro et al. (2007)[22]. Lengguru specimens (Figure 45) therefore

[21] Jefferson T.A. & Rosenbaum H.C. 2014. Taxonomic revision of the humpback dolphins (*Sousa spp.*), and description of a new species from Australia. *Marine Mammal Science*, 30(4) : 1494-1541.
[22] Castro A.L.F., Stewart B.C., et al. 2007. Population genetic structure of Earth's largest fish, the whale shark (*Rhincodon typus*). *Molecular Ecology*, 16, 5183-5192.

belong to the cosmopolite large population from the Indo-Pacific. In conclusion, the presence of whale sharks in Bitsyari Bay is transient or only seasonal.

Figure 43: *Stenella longirostris roseiventris* Kumawa

Figure 44: *Sousa sahulensis* Arguni Bay Lengguru

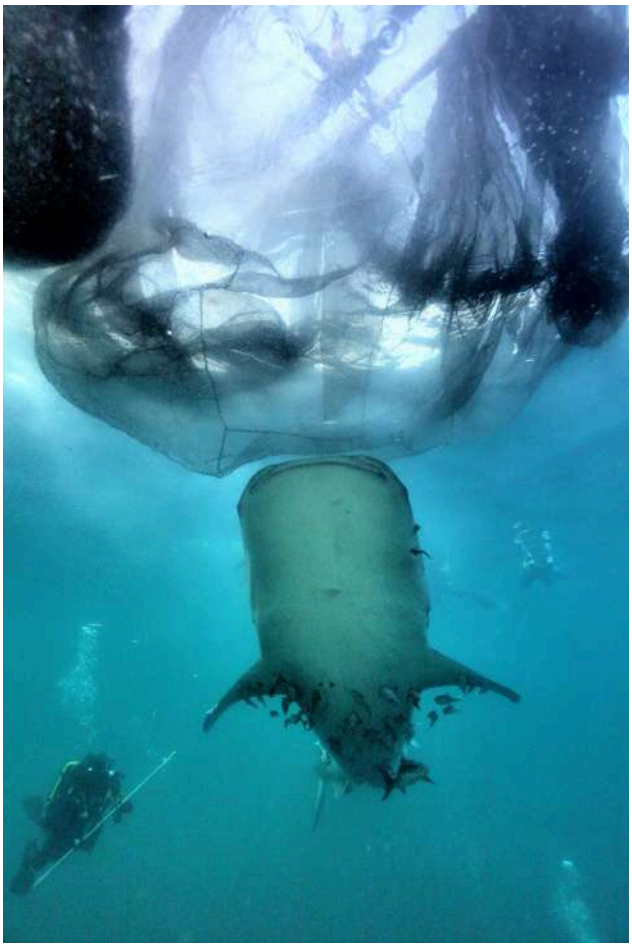


Figure 45: *Rhincodon typus* Bitsyari Bay Lengguru

PART VI: SCHEDULE FOR LENGGURU 2014

	Date	Terrestrial Team	Marine Team
We	01/10/14	organisation team: flight France - Jakarta	
Th	02/10/14	organisation team: arrival in Jakarta	
Fr	03/10/14	Jakarta: administrative and organisational preparation	
Sa	04/10/14	Jakarta: administrative and organisational preparation	
Su	05/10/14	Jakarta: arrival of european participants	
Mo	06/10/14	Jakarta: administrative and organisational preparation	
Tu	07/10/14	Jakarta: administrative and organisational preparation	
We	08/10/14	Jakarta: administrative and organisational preparation	
Th	09/10/14	Jakarta: administrative and organisational preparation	
Fr	10/10/14	Flight Jakarta - Sorong	
Sa	11/10/14	Flight Jakarta - Sorong & logistical and administrative preparation	
Su	12/10/14	Sorong: logistical and administrative preparation	
Mo	13/10/14	Sorong: logistical and administrative preparation	
Tu	14/10/14	Sorong: logistical and administrative preparation	
We	15/10/14	Sorong: logistical and administrative preparation	
Th	16/10/14	Sorong: logistical and administrative preparation	
Fr	17/10/14	Maritime transit Sorong - Kaimana (Airaha2 vessel & rent wooden boat)	
Sa	18/10/14	Maritime transit Sorong - Kaimana (Airaha2 vessel & rent wooden boat)	
Su	19/10/14	Maritime transit Sorong - Kaimana (Airaha2 vessel & rent wooden boat)	
Mo	20/10/14	Kaimana: logistical and administrative preparation	
Tu	21/10/14	Transit Kaimana - Lobo & Lobo: arrival and basecamp installation	
We	22/10/14	Lobo	Triton bay (night in Lobo)
Th	23/10/14	Lobo	Selat Iris
Fr	24/10/14	Lobo	Pulau Aiduma
Sa	25/10/14	Lobo	Pulau Aiduma
Su	26/10/14	Lobo	Pulau Aiduma
Mo	27/10/14	Lobo	Pulau Dramai (night in Lobo)
Tu	28/10/14	Lobo	Pulau Lauzara (offshore Triton Bay)
We	29/10/14	Lobo	Teluk Bitsyari, Pulau Namatote
Th	30/10/14	Lobo	Pulau Sokkos (night in Lobo)
Fr	31/10/14	Lobo: basecamp chekout, transit Lobo - Kaimana	
Sa	01/11/14	Transit Lobo - Kaimana with stop Teluk Bitsyari	
Su	02/11/14	Transit Kaimana -Wanoma - Urisa	Transit Kaimana - Wanoma - Pulau Adi
Mo	03/11/14	Urisa	Pulau Adi
Tu	04/11/14	Urisa	Pulau Tumbu-Tumbu (Venue)
We	05/11/14	Urisa	Transit Venue - Kaimana - Urisa
Th	06/11/14	Urisa	Wababoko cave
Fr	07/11/14	Urisa	Wababoko cave
Sa	08/11/14	Kaimana: logistic	
Su	09/11/14	Day off (waiting Airaha captain)	
Mo	10/11/14	Transfert Kaimana - Nusa Ulan	
Tu	11/11/14	Nusa Ulan (Dinas base camp)	Pulau Karang Derdi
We	12/11/14	Nusa Ulan (Dinas base camp)	Pulau Nusa Ulan
Th	13/11/14	Nusa Ulan (Dinas base camp)	Pulau Nusa Ulan
Fr	14/11/14	Nusa Ulan (Dinas base camp)	Pulau Nusa Ulan
Sa	15/11/14	Nusa Ulan (Dinas base camp)	Pulau Nusa Ulan
Su	16/11/14	Nusa Ulan (Dinas base camp)	Pulau Karang Derdi
Mo	17/11/14	Nusa Ulan (Dinas base camp)	Pulau Tumbutumbu
Tu	18/11/14	Nusa Ulan (Dinas base camp)	Pulau Nusa Ulan
We	19/11/14	Transit Nusa Ulan - Kaimana	
Th	20/11/14	Kaimana: bupati meeting - vessel preparation - departure to Sorong	
Fr	21/11/14	Way Kaimana - Sorong	
Sa	22/11/14	Way Kaimana - Sorong	
Su	23/11/14	Sorong: material checking	
Mo	24/11/14	Sorong: uploading container	
Tu	25/11/14	Flight: Sorong - Jakarta	
We	26/11/14	Jakarta: Return part of the team to Europe and New-Caledonia	
Th	27/11/14	Jakarta: Return part of the team to Europe	
Fr	28/11/14	Press conference in LIPI Central - Preliminary report Menristek	
Sa	29/11/14	Jakarta	
Su	30/11/14	Organisation team: Flight to France	
Mo	01/12/14	Organisation team: Arrival in Montpellier (France)	

PART VII: RESEARCH FELLOWSHIP

Below are summarized the different events organized during the post-Lengguru Expedition for promoting research acquisition and valorization and for strengthening researchers capacities.

Indonesian scientist	Topic	Organism	European team	Period
Lina Juswara RCB	Species description	Orchids	KEW London	June 2015 (4 weeks)
Hidayat Ashari RCB	NGS sequencing	Birds	UPS Toulouse	July 2015 (2 weeks)
Yosephine Tuti P2O	PCR & sequencing	Gorgonians	IMBE Marseille	December 2015 (2 weeks)
Indra B Vimono P2O	PCR & sequencing	Echinoderms	IMBE Marseille	December 2015 (2 weeks)
Yayuk R Suhardjono P20	Morphology	Collembolan	MNHN Paris	November 2015 (5 weeks)

Scientists	Topic	Organism	Location	Period
S. Quérouil (IRD) and M. Sekar (LIPI)	DNA extraction and PCR	Cetaceans	RCB/IRD Barcoding platform Cibinong	March 2015 (1 week)
Kadarusman (Politeknik-KP-Sorong)	DNA extraction	Fish	RCB/IRD Barcoding platform Cibinong	November 2015 (1 week)
D. Aurelle (IMBE) L. Pouyaud (IRD) R. Hocdé (IRD) I.B. Vimono (LIPI) M. Sekar (LIPI) Y. Tuti (LIPI) M. Abrar (LIPI) U.Y. Arbi (LIPI) A. Irawan (LIPI) Kadarusman (Politeknik) A. Suruwaki (Politeknik)	Molecular training session: DNA extraction PCR DNA	Gorgonians Hard corals Echinoderms Mollusks	LIPI-RCO Molecular Laboratory Ancol	October – November 2015 (2 weeks)

PART VIII: CONCLUSIONS AND PERSPECTIVES

The main objective of the ***Lengguru 2014 Expedition*** was to start and impulse an interdisciplinary international scientific cooperation on terrestrial and marine biodiversity domains at the heart of the Coral Triangle in West Papua (Indonesia). The Indonesian Institute of Sciences (LIPI) with the Research Centre for Biology (RCB) for terrestrial biodiversity and the Research Centre for Oceanology (RCO) for marine biodiversity heads this program together with the Sorong Polytechnic School (Politeknik-KP-Sorong) and the French Research Institute for Development (IRD).

All the field objectives were fulfilled in terms of visited ecosystems panel, material collected, and international cooperation. The own concern was the short number of working days (22) for this two months survey because of multiple but necessary administrative procedures and complex logistical aspects. We are conscious that involving near 100 participants (including locals) is a real challenge but enabling such diversity of scientific teams to participate to the same expedition was a scientific necessity for assessing an integrative approach on biodiversity studies in Lengguru limestone karsts.

The sample collection totalize near 4000 specimens with orthopteroid insects (ca. 650), amphibians (ca. 200), reptiles (ca. 200), birds (ca. 180), mammals (ca. 150), plants (ca. 500), freshwater fish (ca. 370), echinoderms (ca. 330), gorgonians (ca. 180), hard corals (ca. 100), mollusks (ca. 900), and algae-seagrass (ca. 100). This amount can significantly rise if we totalize hundreds of collected collembolan specimens.

Preliminary results obtained from morphological observation and DNA barcoding totalize near 59 species possibly new to Science. This includes collembolans (8), arachnids (1), insects (8), amphibians (10), birds (1), plants (5), fish (6), echinoderms (5), gorgonians (8), and mollusks (7). This amount is subject to fluctuate and most probably to rise with oncoming DNA barcoding results.

The Lengguru team will continue in the coming months to acquire and to valorize jointly the results. In that frame, it is expected to pursue the organization and support of research fellowships for Indonesian counterparts. This includes international midterm visits but also PhD degrees, which must be increased.

We aim to maintain and to strengthen this fruitful collaboration with the organization in October-November 2017 of a new expedition in Lengguru focusing on marine biodiversity and mountain avifauna.