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At the heart of the coral triangle in West Papua: an Indonesian-french scientific exploration of a white area with closed-circuit rebreathers (eCCR)

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The Bird's Head isthmus connecting the Bird's Head Peninsula with the rest of New Guinea is one of the last pristine areas remaining in Southeast Asia. Dominantly covered by lime- stone karsts, this vast region of West Papua (Indonesia) is still a terra incognita. At the heart of the coral triangle, the Kumawa and Lengguru limestone karst and reef slopes are today a major biodiversity reservoir with high levels of endemism. The French Indonesian 'Lengguru 2014' expedition was headed by IRD and P2O-LIPI, RCB-LIPI and POLTEK. Exploration and sampling effort were concentrated on several reef slopes from -100 m to the surface using closed-circuit rebreathers (eCCR) and open circuits. 'Lengguru 2014' expedition was the first French Oceanographic campaign organized by a national and academic research organization to use the rebreather. The scientific diving operations were made under the responsibility of the French research institute IRD. Nevertheless, the French regulation presently only allows the use of rebreather for recreational uses. The main author participates as an expert for the Ministry of Labor to reform the law with specific applications to scientific purposes. This scientific expedition was therefore permitted in phase advance.

The Lengguru 2014 expedition was organized in complete autonomy for 6 weeks. It required extensive preparation and logistics, as well as some strengthened safety procedures for scientific dives. Forty vertical transects have been performed from -100 meters depth to the surface, silently with great autonomy and optimized decompression. The exploration of flooded karsts by cave diving has been also possible with rebreather. It does not bubble and offers such autonomy. The use of eCCR offers together scientific benefits and enhanced diving safety.

The 'Lengguru 2014' Expedition provided a science-based assessment of functional, genetic and morphological diversity for several marine biotas (chondrichthyes, hard corals, gorgonians, mollusks) with primary importance for biodiversity conservation.

**PRINCIPLE OF THE CLOSED CIRCUIT REBREATHER (CCR)**

- A breathing loop to re-breathe the same gas
- Bubbling in water at eaque-pressure
- Elimination of CO₂ produced
- Use of air or gas mixtures

Different skills - pur oxygen rebreather, closed circuit rebreather (CCR) or semi-closed circuit rebreather (DCS), various gases mixtures for deep dives and many certified models. Consensus for multi-gas electrochemical closed circuit rebreather (eCCR).

**MATERIALS, METHODS AND ACTION STRATEGY**

The 30 m length vessel of POLTEK «Alhakr» and several 45m inflatable boats can easily accommodate 6 divers, 2 broadcasting and mixing systems, 2 bottles of 50 l medical oxygen and helium 350 kg of soda lime 2 compressors for breathing air + 2 oxygen boosters (redundancy) 1 rebreather for spare and training of indonesian scientists, Many spare equipments and consumables Many balistoc: carbon fibers 300 mm 11 L bottles SO2 for helium balloons, all oxygen compatible Secure equipments, communication equipments including mobile phones for divers, rebreather locator beacon, divers life and decompressing lines, etc. Several HD camera (photos and videos)

EQUIPMENTS for observation, measurement and sampling

Use of an unique model of electronic closed-circuit rebreathers (eCCR) - Villain or XP design from APODIV Markers for diving marks - gas mixtures for deep dives (4-10atm) and 1-4atm Mixtures and use of standard gases (air, Ar/TI50 or Tl75) + branded NeO2, N20 (10L) or O2 (15L) + Deeper 1A)

Team of 2 or 3 eCCR divers, with a multiplication of the decompression strategies.

**DIVING**

Expedition: the expedition was divided in 3 main phases: diving preparation, diving along the vertical transect from -96 m to 40 m including 40 min in twilight zone including 29 min beyond 70 m

**ADVANTAGES: ENHANCED DIVING SAFETY**

Significant improvement of the autonomy / Gas economy / Increased autonomy Constant oxygen partial pressure => Optimization of decompression

- Limitation of thermal losses (breathing of hot, humid air) => Decreased risk of decompression accident, no risk of heating in cold water diving

No bubbles / silence => Greater attention to teammates and underwater behavior

**AND SCIENTIFIC BENEFITS**

- Autonomy: significant increase of the intervention time - long interventions / reduction of the number of dives required / significant increase of the intervention time => decompression dives to secure (safety lines).

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**RESULTS & OUTCOMES**

- The use of re-breather in sciences exploration constitutes a new technological paradigm.

**CAVE DIVING**

- Exploration and sampling effort on several reef slopes (with 40 stations) including the twilight zone with vertical transects between 100 meters depth. The eCCR divers can dive deeper than 40 mn beyond 50 m.

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