

**INVESTIGATIONS OF RECENT AND FOSSIL CORAL REEFS  
IN EASTERN INDONESIA (Snellius-II expedition) : A PRELIMINARY REPORT**

**RECHERCHES SUR LES ECOSYSTEMES CORALLIENS RECENTS  
ET FOSSILES DE LA PARTIE ORIENTALE  
DE L'ARCHIPEL INDONESIEN (expédition Snellius-II) :  
UN RAPPORT PRELIMINAIRE**

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**ABSTRACT**

Some fifty years after the Snellius I expedition (1929-1930) a Dutch-Indonesian joint expedition is carried out (1984-1985) in the Eastern Indonesian archipelago. Based on two months (September-October 1984) of research at nine different reef localities, a first report will be presented on the general morphology, composition and condition of recent and fossil reefs of these areas. The research areas that will be discussed are the following: Ambon: In the bay of Ambon fringing and patch reefs heavily damaged by silting up, caused by soil erosion on the island. North East Ambon an elevated reef from the old Pleistocene. Lucipara islands: Exposed very isolated atoll with some sand cays. Tukang Besi islands: Atoll reefs of Kaledupa. Binongko reef terraces; fossil cliffs modelled from massive Pleistocene reef limestone by coastal abrasion during tectonic uplift of the island; extensive reef terrace dating from the last interglacial; living reef not at the moment constructive. Sumba: East Sumba fringing reefs with influence of land and population. Young Pleistocene reef near Melolo, older terraces higher up. Komodo: Various fringing and patch reefs bordering the east side of the National Park of Komodo. Current swept reefs in the strait of Linta. Gililawa Laut and Tinandja lower Miocene reefs. Sumbawa: Fringing reefs in Telok Moti Toi and Sanggar bay near Tambora volcano (erupted in 1815). Coral growth in Bima bay. Pleistocene reef north east of Bima. Taka Bone Rate: Large pseudo atoll with small sand cay reefs (e.g. Tinandja) exposed reefs, coral banks and lagoons. Salayer: fringing reefs at west coast around islands Guang and Sahuluan. Pliocene reefs on both islands; Bahuluan with volcanic core. Sulawesi: Coral reef complex on the shallow shelf off South West Sulawesi, with three rows of reefs, most emerging as sand cay reefs. Because of young Holocene regression in front of Ujung Pandang. Influence of sedimentation and population. Apart from these investigations during the Snellius II expedition, a long term project has been carried out since 1979 in the last area mentioned. A continuation of reef research is planned there, in close cooperation with UnHas (University of Ujung Pandang). The presentation of results will be accompanied by maps and photographs.

**RESUME**

Près de cinquante années après l'expédition de Snellius I (1929-1930), une expédition commune des Pays-Bas et de l'Indonésie est réalisée (1984-1985) dans l'archipel est-indonésien. Basé sur des observations effectuées pendant 2 mois (Septembre-Octobre 1984), un premier rapport relatif à la morphologie générale, la composition et les conditions des récifs récents et fossiles de 9 localités différentes est présenté. Les localités étudiées sont les suivantes : Ambon: dans la baie d'Ambon, récifs frangeants et pâtés coralliens, gravement endommagés par la sédimentation terrigène; à 300m., récif émergé du Pléistocène inférieur. Iles de Lucipara: atoll très isolé avec quelques récifs à cayes. Iles de Tukang Besi : récifs d'atoll de Kaledupa, terrasses émergées de Binongko datant du Pléistocène, falaises de calcaire massif formé par érosion littorale, pendant la surélévation tectonique de l'île; ces récifs récents ne sont pas actuellement fonctionnels. Sumba : récifs frangeants à l'est de Sumba, soumis à l'influence terrigène et anthropique. Récif pléistocène terminal près de Melolo, présence de terrasses plus anciennes en altitude. Komodo : des récifs frangeants et bancs coralliens divers entourant la côte est du Parc National de Komodo. Récifs influencés par des courants extrêmement forts dans le détroit de Linta. A Gililawa Laut et Tinandja, récifs émergés du Miocène inférieur. Sumbawa : récifs frangeants dans Telok Moti Toi et la baie de Sanggar en face du volcan Tambora (éruption en 1815). Croissance de corail dans la baie de Bima. Récif pléistocène au nord-ouest de Bima. Taka Bone Rate : grand pseudo-atoll avec de nombreux récifs à cayes (par exemple Tinandja), des récifs exposés, des bancs coralliens et des lagons. Salayer : des récifs frangeants sur la côte ouest de Salayer autour des îles Guang et Bahuluang. des récifs émergés du Pliocène dans les 2 îles; à Bahuluang, avec un noyau volcanique. Sulawesi : complexe récifal étendu sur le plateau continental au sud-ouest de Sulawesi, avec 3 séries de récifs coralliens formés pendant la régression Holocène en face d'Ujung Pandang. Influences de la sédimentation et de la population. A côté des recherches réalisées sur les récifs coralliens pendant l'expédition Snellius II, un projet de longue durée est exécuté depuis 1979 dans le sud-ouest de Sulawesi (Buginesia). Une poursuite des recherches en milieu corallien a été programmée en coopération avec l'Université d'Ujung Pandang (UnHas). La présentation des résultats est accompagnée de plans et de photos.

## INTRODUCTION

In the Eastern Indonesian archipelago there exists a great number of widely different coral reefs. The many islands and coastlines are influenced by various physiographical conditions, volcanism and tectonic instability (Best, 1977).

In the framework of the Snellius-II expedition two trips with two ships, the Dutch "Tyro" (under leadership of Dr. J. van der Land) and the Indonesian "Samudera" (under leadership of Dr. Sukarno and Drs. Setiapermana), were dedicated to coral reef research. In all, about 45 scientists from Indonesian and Dutch institutes were involved in the expedition. We examined reefs in nine areas (fig. 1) and in each of these, some coral reefs and associated environments from the coast to the deeper parts of the slope, were studied with a transect method. Apart from the quantitative reef descriptions, a start was made with studies on primary production in seagrass fields and growth and degradation of the corals on the reef. Some attention was given to socio-economic aspects of fish populations and fishing methods. The geological history of the reefs and reef-builders was studied as well as reefs as indicators of sealevel and tectonic changes. Areal photographs have been taken of some localities for the general reef mapping. The results will be published by the Indonesian and Dutch scientific participants in the coming years. The present paper gives our observations of the recent and fossil reefs examined.

Along the north coast of Teluk Baguala there is a Daly-terrace, with many fossil *Fungia*'s up to about 1 m above sealevel with its adjoining abrasion platform (now coconut plantations). Fossil reefs from the older Pleistocene can be studied well at a height of about 300 m. along the road from Hunuk to Hitu Lama near Kampung Hulung (pl. I b).

### 2. Lucipara islands (Pulau pulau Maisel).

This atoll consists of four islands (sand cays) on a very exposed reef flat bordered by narrow ramparts and with steep coral covered seaward slopes (fig. 2). Three standard reef transects were described here. The reef slope shows a high coral cover (> 50%).

At the upper part of the drop off we find optimal coral growth with large branching *Acropora* and massive Faviidae. On the edge of the reef flat there is hardground with many *Heliopora* and *Millepora* colonies. The lagoon shows a rich lagoonal coral growth dominated by branching *Acropora formosa* and *Heliopora*. South of Mai the reef shows somewhat less variation, with a dominance of *Acropora bruggemanni* and fewer soft corals.

The condition of the reef was excellent. The few temporary inhabitants of the islands mainly live on fish and the capture of seaturtles.

### 3. Tukang Besi islands

This reef complex consists of atoll-like reefs and fringing reefs around limestone islands. (fig. 3). Karang Kaledupa is an exposed reef, without sandcays.

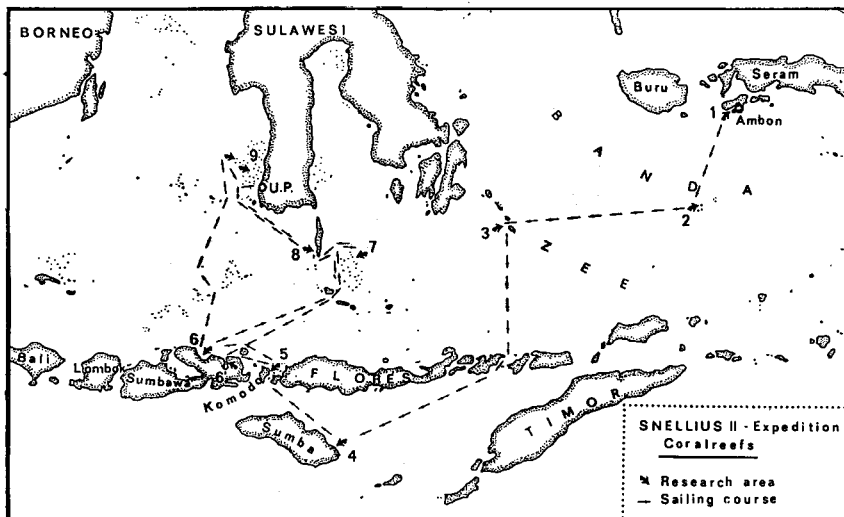


Fig. 1 Research area Snellius II expedition theme Coralreefs

## AREAS OF RESEARCH

### 1. Ambon

Some fringing- and patchreefs were examined in the bay of Ambon. The bay is strongly polluted and particularly coral growth suffers from the influx of sediment from the land (pl. I a). The number of coral species is still rather large (Randall et al, 1983) but the colonies are usually small. Only strong species that can handle sediment input (e.g. species with large polyps) are common: *Coniopora*, *Symphyllia*, *Lobophyllia*, *Fungia actiniformis*, *Plerogyra sinuosa* and *Euphyllia glabrescens*. *Porites* still forms large colonies with a diameter of up to 1 m. Other species remain small with larger colonies often half dead: horizontal surfaces are covered with mud, whereas vertical sides are still alive.

Strong currents occur in tidal inlets. In general coral cover is not high, there is much sand and rubble and many soft corals and sponges are present. Inside the reef there are extensive patches with high coral cover, consisting mainly of one or two species of *Acropora*. Two transect descriptions showed that there are many encrusting corals and small colonies of species that can withstand strong currents. Massive and stout species are abundant here.

At the Binongko coast there is an undisturbed reef terrace north of Taipabu, with much fish, mainly Octocorallian coral species, sponges and ascidians. Currents may be rather strong. The stony coral cover is low and bio-erosion is heavy. There is much *Porites*, but only rather small colonies. Near pulau Toméa, there is a nice reef flat with large coral colonies e.g. of *Mussidae*. At the back of the reef flat there is a lagoon inhabited by rather fragile species of coral such as *Galaxea fascicularis*.

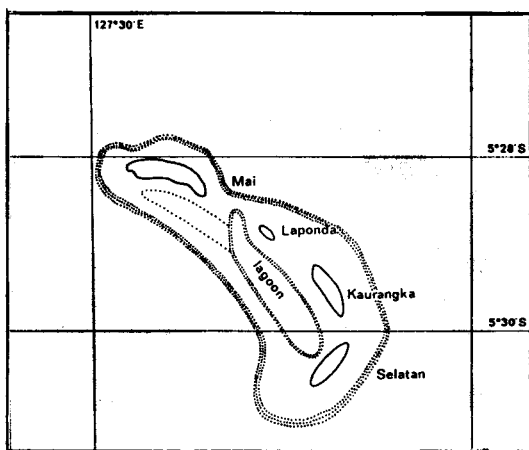


Fig. 2 Lucipara islands (Pulau Pulau Maisel)  
 The island of Binongko itself is a flat body, entirely consisting of coral limestone. Its sides carry at least 21 terraces, which were interpreted by Kuenen (1933) as many uplifted fringing coral reefs. This seems to hold true for the lowermost terrace, that is fairly wide (several hundreds of meters locally) and contains well-preserved still aragonitic coral heads (Pl. I c).  
 The narrow higher terraces are without exception wavecut abrasion platforms. The uppermost were severely degraded by Karst erosion, effecting horizontal surfaces only. The Karst topography has created landscape forms that were seen by Kuenen as "lagoons" and "boatchannels".  
 Tectonic activity has caused swarms of cracks in the Binongko coral limestone, and these have been widened by subsequent karstic dissolution. These cracks were also observed under water in the reef platform, proving that this too is largely abrasive in nature and that little Holocene reef growth has taken place.

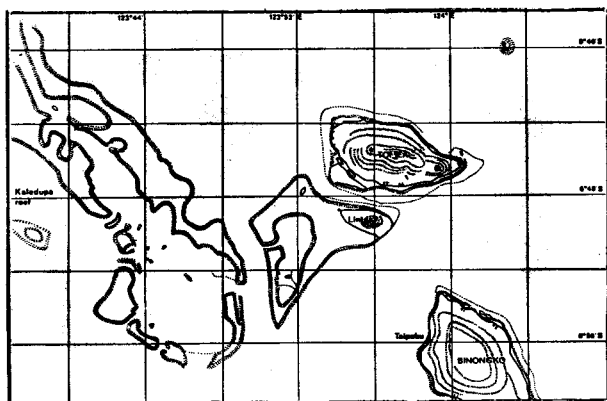


Fig. 3 Tukang Besi islands

#### 4. Sumba.

Off East Sumba, the coastal reef south-east of Melolo gradually slopes down to a depth of 25 m. There is much sediment and the visibility is poor. There are many fragile coral colonies of *Acropora* and *Seriatopora* species and coral species that can withstand sedimentation e.g. *Fungia actiniformis* and *Goniopora*. The transects indicate that the biotope is occasionally strongly disturbed by ocean swell. As a whole the reef condition was poor, probably also due to human activities.  
 The morphology of Sumba is dominated by a series of terraces, corresponding with Quaternary sealevel stands. The uppermost are erosive; the lower terraces are fossil reefs, covered by hard grounds and calcrete

that make detailed studies very difficult. Directly south of Melolo (Pl. I d) a quarry in the lowermost fossil reef zone offered a good opportunity. The reef covered by a hard ground, contained a large number of very well preserved fossil corals. Virtually all appear to belong to recent species; the age of this reef zone, elevated some 15 m. above present day sea level, must be young Pleistocene.

#### 5. North East Komodo

Intensive research took place during the ten days of investigations here (fig. 4). Because of the very variable geographical conditions along the capricious coast and the extremely strong currents (up to 12 knots) between the Flores sea and the Indian ocean, we are dealing with a series of different reef habitats along the Straits of Linta.

Transects in this last area could only be described during slack tides. These current swept reefs consist at places of an avalanche of coral fragments. Only sturdy encrusting or low arborescent species were recorded: *Seriatopora callendrum* and *Stylophora pistillata*.

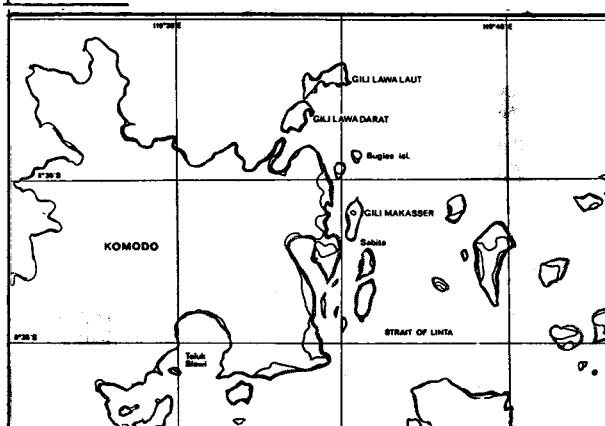


Fig. 4 Komodo

At the entrance of Slawi Bay there are strong currents and little coral growth. More protected inland slopes are dominated by various *Cycloseris*, *Heteropsammia* and *Heterocyathus*. *Trachyphyllia*, *Catalaphyllia* and *Goniopora*, are the other contributors to species richness. At the north-eastern cape of Komodo there is a beautiful coastal reef with a rich growth of many coral species: branching *Acropora*, *Hydnophora*, *Seriatopora*, *Caulastrea*, massive *Porites*, *Faviidae*, plate-like *Echinophyllia*, *Merulina*, *Pachyseris* and many *Fungiidae*. The discovery of *Zoopilus* is remarkable, because it was only known from Pacific waters (including north-eastern Maluku).

The reefs off Gili Lawa Laut show a great deal of variety. The southern bay is extremely sheltered with many fragile corals making up a high cover of over 75%. Large hardly attached whirls (fig. I e) of *Pachyseris*, *Echinopora*, *Mycedium*, *Echinophyllia*, and *Montipora* form large stands intermixed with loose thickets of *Acropora* species. In between these monospecific patches and at slightly greater depth, various rare coral species were collected: *Plerogyra taisnei*, *Alveopora catalai*, *Zoopilus echinatus*, *Halomitra* spec.

The northern reefs off Gili Lawa Laut clearly demonstrate the more exposed conditions at this side of the island. A spur and groove structure is present here. Low arborescent *Porites* species, *Seriatopora* and *Acropora* make up the main part of the Scleractinian cover. Soft corals of many species are also well represented.

Another area subjected to strong water movement is the south of Eastern Bugies Island. Strong currents pass this area and coral cover is less than in the sites discussed before. Fierce currents and whirlpools were seen near the reefs. Close to shore and the upper reef slope conditions are moderately exposed and the coral composition is therefore somewhat different. Arborescent Acropora species are well represented together with large colonies of Oxypora and Lobophyllia.

Reviewing the findings at Komodo, it appears that the sites themselves are not very rich in species, but that many different types with their own specific coral composition are found close together. This as a whole, makes Komodo an extremely interesting and diverse locality. Such a quality demands some form of marine conservation, the more since dynamite damage has been regular sighted in this area.

The small islands of Sabita and Gili Lawa Laut, off the eastern coast of Komodo, were found to consist partly of well stratified hard grey limestone with conglomerate levels and horizons rich in (sometimes rolled) fossil coral colonies. The genera Acanthastrea, Favites, Platygyra and Porites were common in these rich faunae; Acropora was conspicuous by its absence. Both faunae probably date from the mid-Tertiary. Very remarkable were six sclerosponge-like fossils from Sabita; four resemble stromatopores, two are alveolitic.

#### 6. Sumbawa.

To utilize the opportunity of studying the effects of reef destruction by volcanic eruptions in the past and the subsequent recolonization by corals, investigations were made in Sanggar Bay and Telok Moti Toi near the volcano Tambora (fig.5); which erupted in 1815. This was the largest eruption ever registered in historical times.

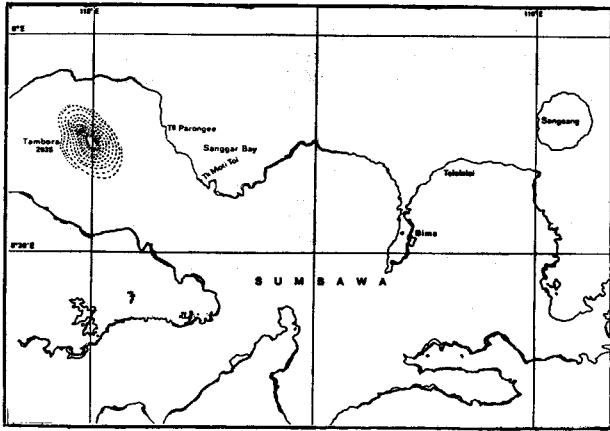


Fig. 5 Sumbawa

In the shallow coastal waters of the bay of Sanggar near the Tambora volcano there is still much volcanic sand, with Foraminifera. Both bays do not have well developed reefs. There are some young rapidly growing reefs mainly consisting of branching Acroporidae (>90%) and some small massive corals like Porites. The number of coral species is rather large. One transect in Sanggar Bay revealed a cover by short corals like Montipora stellata, Cycoloseris patelliformis, low arborescent Porites species and four Anacropora species. Near Tg. Parongee, off the east flank of the Tambora there are well developed reefs with a high diversity of coral species. There, Galaxea fascicularis forms enormous colonies of over 3 m. in diameter, at depths between 3 and 8 meters.

In all, coral reefs near the Tambora flourish and little or no effect of the 1815 eruption is found in the recent reef appearance. The only evidence is the presence of large patches of black volcanic sand in shallower water. It is possible that sectioning of a large coral head that apparently survived the 1815 cataclysm may produce traces of the short-lived oceanographical and climatological changes from that time.

The mouth of Bima Bay was surveyed for coral growth along both east and west coast. Visibility was mostly quite poor and beaches of coral sand are set amongst shores with volcanic deposits. Near open sea coral growth is well developed between 1 and 8 meters depth, with spurs going down to 15 meters. At these depths small fragile colonies of Cyphastrea, Leptoseris, Anacropora abound together with ahermatypic corals like Dendrophyllia, Balanophyllia and Tubastrea.

Murky shallow water supplied records of Oulastrea, Trachyphyllia and Lithophyllon, the first of which is restricted to such an environment.

Fossil reefs are well developed along the northern coast of Sumbawa east of Bima Bay. They were inspected near Tololalai. The upper surface of these reefs is covered by hard grounds; the sea side cliffs show diagenetically much altered and heavily karstified coral limestone, speckled with black volcanic grains. Only a few fossil corals were collected because of poor exposures.

Magnetite is less prone to weathering than volcanic silicate minerals. The beach at Tololalai consists of black magnetic grains, washed from the fossil reefs of presumably Upper Neogene age.

#### 7. Take Bone Rate.

This is the largest "pseudo" atoll in Eastern Indonesia, with a length of more than 40 miles. Only the northeastern part was investigated. In general the reefs are rich, but subjected to strong currents. The

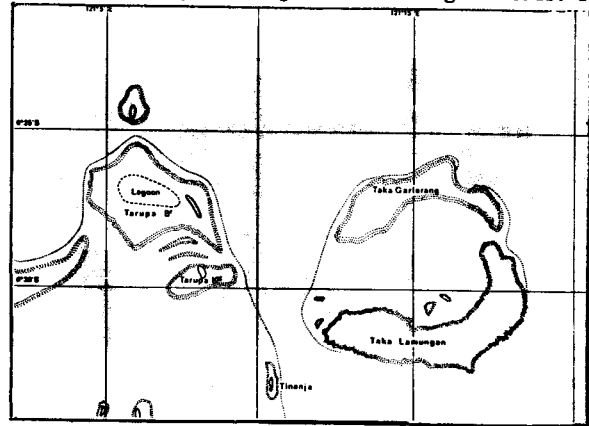


Fig. 6 Taka Bone Rate

area is very rich in fish. The reefs around the sandcays Tarupa Kecil and Tarupa Besar show many soft corals, sponges and Hydrozoa apart from the coral coverage of < 30% at about 10 meter depth. At the reef edge the cover may be up to 40%.

Pulau Tinanja provided a good locality to investigate the reefs at the four major compass angles around one and the same island. It is a sandcay with beachrock harnesses and an extensive reef flat, rich in fish. Reef constructions were very different at the four sites, mainly due to different influences of currents and winds (compare Moll, 1983).

An inventory was also made of the large lagoon west of Tarupa Besar. Here, more than 70 coral species were



RESEARCH IN PROGRESS

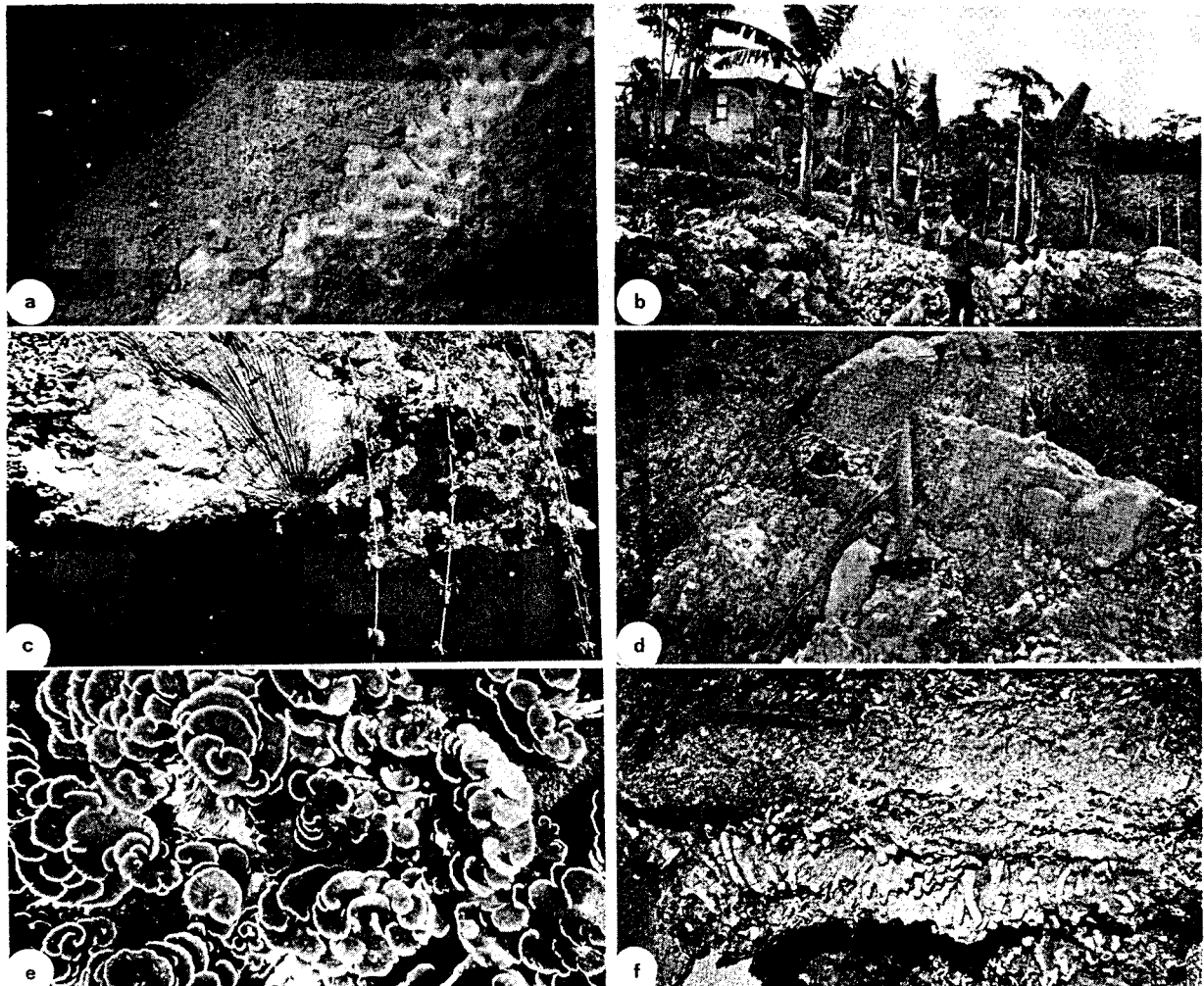
The work on material collected by the Snellius-II coral reef investigations can start only after the Snellius field work has been completed in July 1985. Now it is already clear that the close cooperation between Indonesian and Dutch during the Snellius-II effort, under leadership that keenly guided the workers through this fascinating part of the world, will produce many interesting results relevant to both science and reef management.

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PL. I a. Sediment influx on coral in Ambon bay  
 b. Older pleistocene reef in N.E. Ambon at 300 m.  
 c. Coral head in young reef terrace Binongko (Tukang Besi isl.)  
 d. Quarry in fossil reef zone near Melolo (Sumba)  
 e. *Montipora* colony of Gili Lawa Laut (Komodo)  
 f. Lower Miocene coral limestone, Gili Lawa Laut (Komodo)