CROSSING MARINE LINES AT TERNATE

Capacity building of junior scientists in Indonesia for marine biodiversity assessments

Preliminary results of the Ternate Expedition (2009)

Part of Ekspedisi Widya Nusantara (E-Win), Indonesian Institute of Sciences (LIPI)

2nd Edition, May 2010

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LIPI

. naturalis

PROGRESS REPORT

Preliminary results of the LIPI – Naturalis expedition to Ternate, Halmahera, Indonesia
23 October - 18 November 2009.

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Group photo at the Ternate field station.

Acknowledgements

The fieldwork around Ternate, West off Halmhera (23 October - 18 November 2009) was undertaken under the umbrella of Expedisi Widya Nusantara (E-Win) of the Indonesian Institute of Sciences (LIPI). Prof. Dr Suharsono, director of the Research Centre for Oceanography (RCO-LIPI), is acknowledged for his support. The research permit was issued by the State Ministry of Research and Technology RISTEK in Jakarta. Dr Bert W. Hoeksema (Naturalis) and Ir Yosphine Tuti (RCO-LIPI) acted as expedition leaders. Logistic support was given by Mr. Fasmi Ahmad and his staff of the field research station of LIPI at Ternate, and by Mr. Samar and Mr. Dodi of Universitas Khairun at Ternate. Last but not least, we want to thank the Governor of North Moluccas for his encouragement.

Contents

Introduction

Marine biogeographic boundaries at a crossroads in the Indo-Pacific convergence: impacts of plate tectonics, sea-level fluctuations and inter-oceanic currents.

Locality: Ternate, off Halmahera (*Maluku Utara*)
Period: October 23 – November 18, 2009

Many coral reef species show widespread ranges that are entirely Indo-West Pacific. The ranges of these species and many others overlap in the Coral Triangle (CT), the centre of maximum marine species diversity in the Indo-Pacific convergence). The centre's boundaries are not exactly known because the range limits of species that occur partly inside and outside the CT have not been determined. Furthermore, species that are not well-known may show disjunctive or fragmented distribution ranges, which may be a result of incomplete sampling. It may also depend on restricted habitat availability of the species concerned. Therefore, in order to get more insight in the position of the CT, it is proposed to use model species groups for which taxonomic revisions area available. By using model taxa, reliable data sets can be obtained on species presence and absence, which is based on the use of species richness estimators that indicate the reliability of species absence records.

Preliminary data on mushroom corals (Fungiidae) indicate that various West Pacific species have their westernmost range along the east coast of Borneo. A few others have records from West Papua (Waigeo) but not more westward, whereas some species known from western Indonesia and the Makassar Strait appear to be absent here. The low sea level stand during the Last Glacial Maximum (LGM) and the direction of inter-oceanic currents from the Pacific to the Indian Ocean are considered important factors for the ranges of reef coral species. East Kalimantan (Berau) and West Papua (Raja Ampat) appear to be richest in species, but since their species compositions differ it is expected that there is a maximum concentration of species in the middle, at Halmahera.

Scientific Objectives

Most species that have ranges more or less congruent with the Coral Triangle are strictly West Pacific. These are species that cannot be found on reefs with terrigenous influence. During the LGM, they most likely survived around Pacific islands where coral reef communities must have followed the slopes downward to the lowest sea level stand. From there they could recolonize other areas by larval transport in currents after the sea level started to rise to its present stand. Hence, the species that determine the present CT boundaries, appear to be offshore species that survived in oceanic conditions and may not easily settle on shelf-based reefs nearshore. Considering the present ranges based on presence/absence data and the oceanic current directions, West Pacific islands most likely acted as species reservoirs during the LGM.

The westernmost range boundaries of some species at West Papua suggest that plate tectonics (Fig. 5) also play a role in the species diversity of coral reefs. This concerns species that are endemic to the Pacific Plate. It is expected that they cannot be found around Ternate, west of Halmahera. In case they can be found at Ternate, not Pacific plate endemism but restricted range dispersal is a determining factor in the distribution of these species.

Symbiotic species (parasites or commensals) may have more restricted distributions than their hosts, especially if they lay eggs in or on the host and the larvae show limited dispersal. Therefore symbionts of corals are also included in the study.

Methodology

During four weeks in the field at Ternate, off Halmahera (Propinsi Maluku Utara; Figs 7-8), inventories of reef corals will reveal which factors play a role in the marine diversity between northern Sulawesi and West Papua. With the help of SCUBA, a total of 41 sites (expedition stations) were surveyed during which species presence was recorded, photographs made, voucher specimens and DNA samples collected. Species records will be used in a species richness estimation analysis for species presence-absence comparisons. With the help of DNA samples, per species the position of individuals at Ternate can be compared with that of individuals at North Sulawesi and West Papua, for phylogeographic studies on connectivity within the populations. In this way the role of currents can be determined. The sites will be selected with the help of nautical maps, satellite images, and GPS.

Capacity Building

Like during previous expeditions, collaboration between Indonesian and Dutch participants was an important objective. Indonesian scientists and supporting staff members of RCO-LIPI were involved in the research and the logistics. Besides, also two students of the university at Ternate (Universitas Khairun) were participating in the field work. Prof. Farnis Boneka (Universitas Sam Ratulangi) from Manado, North Sulawesi was invited to participate for the promotion of networking among Indonesian marine scientists. He was the lead scientist for molluscs, since the Netherlands team did not have all-round malacologists in their team. Since the Naturalis team could not assist in all disciplines, Prof. David Lane of the University of Brunei was also invited to participate. He supervised the research on echinoderms (mainly sea stars and sea cucumbers).

Mrs. Yosephine Tuti (Jakarta) was coordinator for the RCO-LIPI team. Mr. Fasmi Ahmad was head of the research station in Ternate. Mr. Sumadijo was responsible for SCUBA gear maintenance (filling dive tanks). Indonesian senior staff assisted in the supervision of junior scientists when no Dutch supervisor was available. In total there were six junior scientists of RCO-LIPI and two MSc students of Universitas Khairun. A total of 11 local participants were involved in laboratory assistance (logistics and technical support) and as boat crew.

Research team & methodology

Expedition leaders: Dr Bert W. Hoeksema (NCB Naturalis) and Mrs. Ir. Yosephine Tuti (RCO-LIPI).

<u>Scientific team of Indonesia</u>

- Ir M.I. Yosephine Tuti H. (RCO-LIPI, Jakarta) - *soft corals*
- Farnis Boneka, MSc (Universitas Sam Ratulangi, Manado) - *molluscs*
- Ucu Yanuardi (RCO-LIPI, Bitung) – *molluscs*
- Udhi Eko Hernawan (RCO-LIPI, Tual) - molluscs
- Bambang Hermanto (RCO-LIPI, Bitung) - *corals*
- Supono SSi (RCO-LIPI, Bitung) – *echinoderms*
- Indra Bayu Vimono, SSi (RCO-LIPI, Jakarta) – *echinoderms*
- Pipin Kusumawati SPi (RCO-LIPI, Bitung) - *sponges*
- Samar Ishah (Universitas Khairun, Ternate) - *fish*
- Dodi (Universitas Khairun, Ternate) - *corals*

<u>Logistic support in Ternate</u>

- Fasmi Ahmad SPi (RCO-LIPI, Ternate) - *logistics*
- Sumadijo (RCO-LIPI, Jakarta) - *logistics diving*
- Sarjan (RCO-LIPI, Ternate) - *logistics diving*
- Rani Abdulatif (RCO-LIPI, Ternate) - *logistics*
- Milda Hamid (RCO-LIP, Ternate) - *logistics*
- Said Koda (RCO-LIPI, Ternate) - *logistics*
- Mohamad Akhmad (RCO-LIPI, Ternate) - *logistics*
- Iqbal (RCO-LIPI, Ternate) - *captain*
- Zaimudin (RCO-LIPI, Ternate) - *boat crew*
- Samsir (RCO-LIPI, Ternate) - *boat crew*
- Ismet (RCO-LIPI, Ternate) - *boat crew*
- Taswin (RCO-LIPI, Ternate) - *boat crew*

<u>Scientific team of the Netherlands</u>

- Dr Bert W. Hoeksema (NCB Naturalis) - *stony corals, associated organisms*
- Dr Stefano G.A. Draisma (Nationaal Herbarium Nederland) - *macro algae*
- Dr Charles H.J.M. Fransen (NCB Naturalis) - *crustaceans*
- Dr Arjan Gittenberger (NCB Naturalis) - *tunicates*
- Dr Ronald Vonk (Zoölogisch Museum Amsterdam) - *amphipods*
- Dr Nicole J. de Voogd (NCB Naturalis) - *sponges*
- Sancia E.T. van der Meij, MSc (NCB Naturalis) - *stony corals, molluscs, gall crabs*
- Bastian T. Reijnen, MSc (NCB Naturalis) - *soft corals, molluscs*
- Mr Joris van Alphen (Rijksuniversiteit Groningen and NCB Naturalis) - *sea slugs on sponges*
- Mr Koos van Egmond (NCB Naturalis) - *logistical support, general collection*

<u>Brunei</u>

- Dr David Lane (Universiti Brunei Darussalam) – *echinoderms*

Indonesian participants

Prof. Dr Suharsono, Director of RCO-LIPI, at Ternate. Preparatory visit March, 2009.

Ir Yosephine Tuti (RCO-LIPI, Jakarta).

Sumadijo (RCO-LIPI, Jakarta).

Fasmi Ahmad SPi (RCO-LIPI, Ternate).

Prof. Farnis Boneka (Universitas Sam Ratulangi, Manado).

Samar Ishah & Dodi (Universitas Khairun, Ternate).

Indra Bayu Vimono (RCO-LIPI, Jakarta).

Udhi Eko Hernawan (RCO-LIPI, Tual).

Supono (RCO-LIPI, Bitung).

Pipin Kusumawati (RCO-LIPI, Bitung).

Ucu Yanuardi (RCO-LIPI, Bitung).

Bambang Hermanto (RCO-LIPI, Bitung).

Collaboration


With Dr Ronald Vonk (ZMA, Amsterdam).


With Dr Stefano Draisma (NHN, Leiden).


With Dr David Lane (Universiti Brunei Darussalam).


With Dr Nicole de Voogd (Naturalis, Leiden).


With Dr David Lane (Universiti Brunei Darussalam) at background.


With Dr Bert Hoeksema (Naturalis, Leiden).

Working together.

Working together.

Working together.

Working together.

Working together.

Working together.

Logistics

Bus for passenger transport

Mini pick-up truck for equipment

Research Station (RCO-LIPI, Ternate)

Immigration formalities at Ternate

Buying equipment and tools for fieldwork

Filling SCUBA tanks (three compressors)


Outdoor laboratory activities


Outdoor laboratory activities


Indoor laboratory activities


Outdoor laboratory activties


Dr Ronald Vonk in indoor laboratory


Dr Stefano Draisma in outdoor laboratory

Research vessel Pulau Karang (RCO, LIPI)

Local research vessel NN

Research vessel Pulau Karang (RCO, LIPI)

MV Pulau Karang's 5 x 40 HP

MV Pulau Karang's top deck

MV Pulau Karang's interior


Loading of Pulau Karang


Unloading of Pulau Karang


Shore dive


Break in between two shore dives


Stygofauna team returns to boat


Shipment of samples to Jakarta, Bitung and Leiden

Methodology

SCUBA diving training of junior scientist

Sharing underwater camera's

Stygofauna team and snorkel team preparing for sampling

Stygofauna team perform beach survey with the help of pump, shovel and bucket

Koos van Egmond collects transparent shrimps from sponge

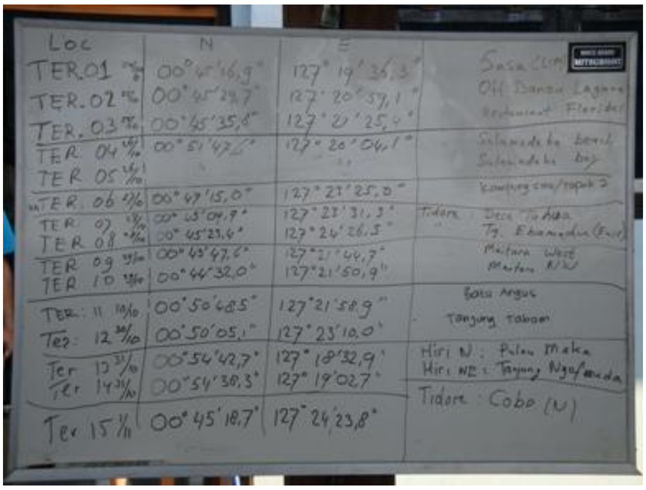
Dr Charles Fransen collects transparent shrimps from sponge after making *in situ* macro photographs

Dr Charles Fransen demonstrates inspection of bivalve mollusks for presence of commensal shrimps

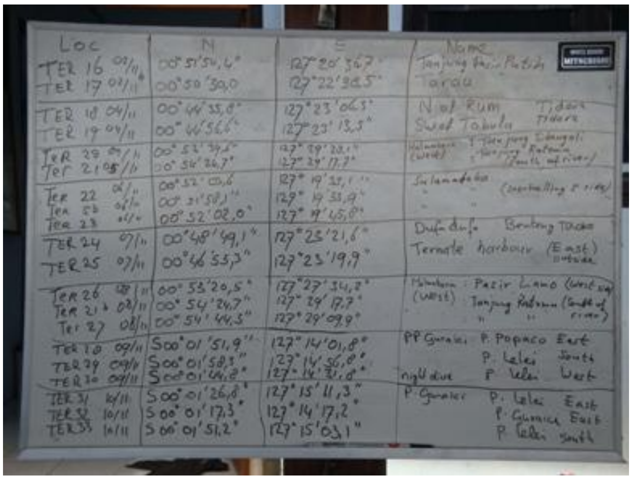
Aquarium set-up for observation of live animals

Dry preservation and labelling of starfish

Dry preservation and labelling of coral



Log of field stations TER 01 – TER 15.



Log of field stations TER 16 – TER 33.

Coastal environments

Behind field station (TER 01)

Coast line in front of Amara Hotel

Batu Angus lava flow (TER 11)

View on Pulau Hiri

Pulau Tidore (NE Coast)

Pulau Tidore (NE Coast): stygofauna sampling beach

Reef in front of village

Sulamadaha Bay (TER 05)

Stygofauna team lands on jetty in search for wells

Beach of Guraici (resort)

One of the Guraici Islands

Reef flat in the Guraici island group

Research topics

Stony corals (Fungiidae)

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In the coastal area of West Halmahera, in particular around Ternate, research efforts with regard to the biodiversity of stony corals were concentrated on the distribution of mushroom corals (Fungiidae) as a pilot group. 36 species were encountered in 39 samples (Table 1). The species accumulation curves (Fig. 1) show that the estimated species numbers (ICE, Chao 2) reaches the observed species number asymptotically with an error of almost 0. Therefore additional sampling would probably not have resulted in more species. Therefore, the total number of mushroom coral species is 36, which is less than the maximum number of 40 found at East Kalimantan and West Papua; it is the same number as found at Ambon (Fig. 2). However, based on cluster analyses Ternate can certainly be considered part of the center of maximum marine diversity (Fig. 3). The numbers of species recorded per station is very variable (Table 1), depending on the available reef conditions. Some species were very common, present at 37-39 stations (*Fungia fungites*, *F. granulosa*, *F. paumotensis*, *F. repanda*), while others were very rarely encountered at only two localities, which were usually the deeper living species in sheltered conditions (*Fungia somervillei*, *F. spinifer*, *F. taiwanensis*).

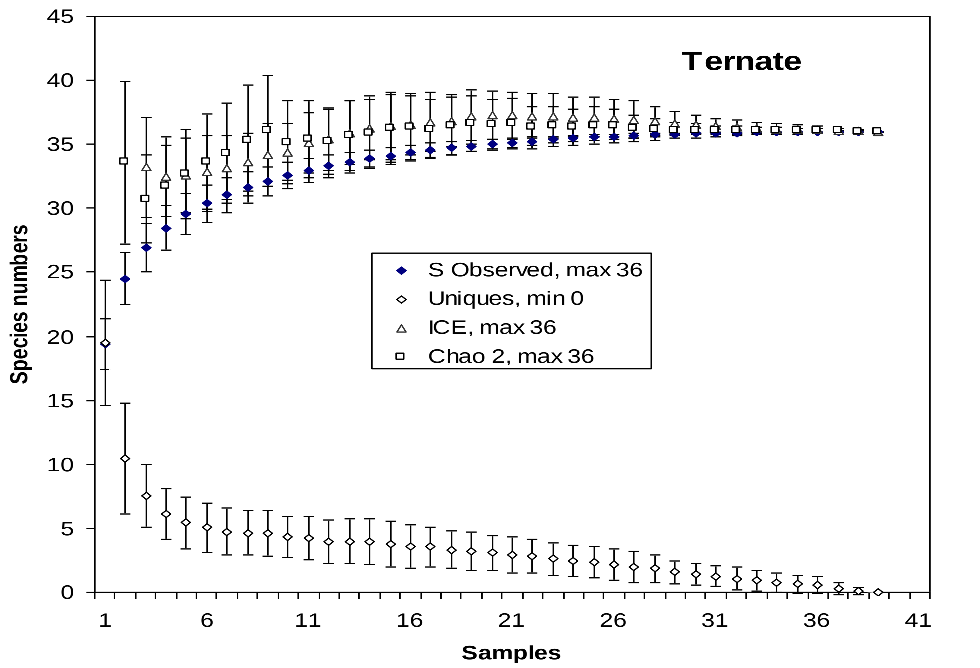

Fig. 1. Species accumulation curves (species observed, Chao2) indicating numbers (and standard deviations) of mushroom species observed (n=36) and to be expected (n=36) around Ternate (data source: Table 1) at 39 stations (species numbers ranging 1-27). The numbers of Uniques species is 0. For statistics, see: Colwell, R. K. 2006. EstimateS: Statistical estimation of species richness and shared species from samples. Version 8. User's Guide and application published at: http://purl.oclc.org/estimates.

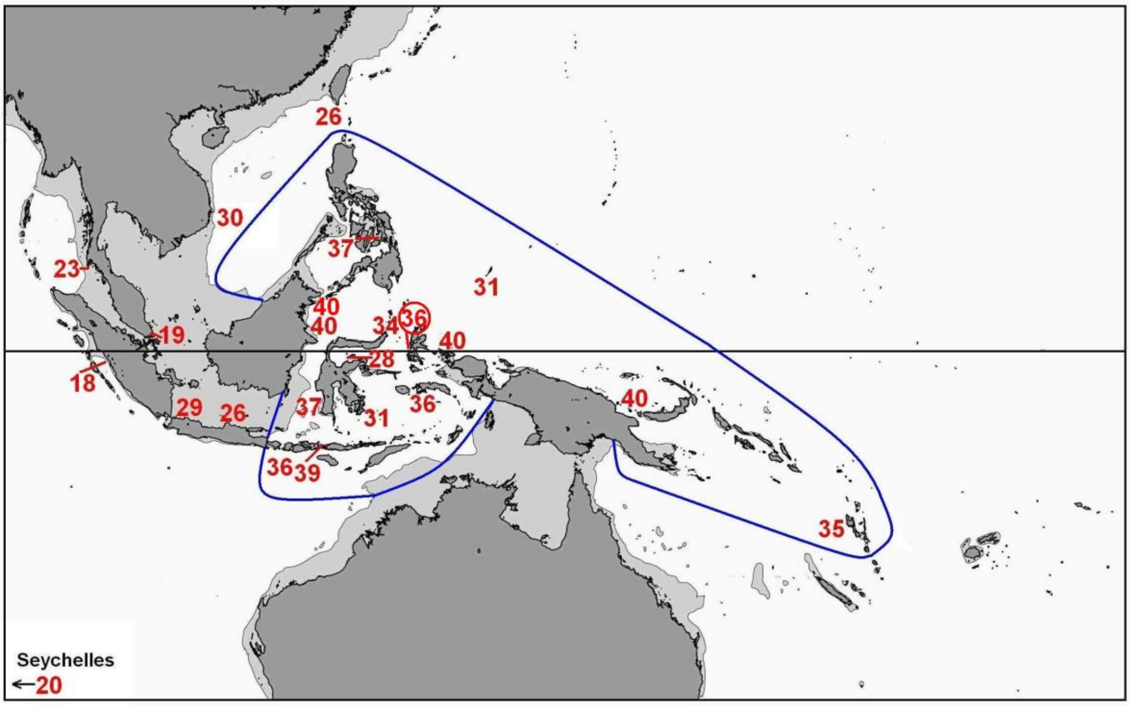

Fig. 2. Mushroom coral species numbers based on presence / absence data with additional records. Ternate / West Halmahera is indicated by the number 36 in a red circle.

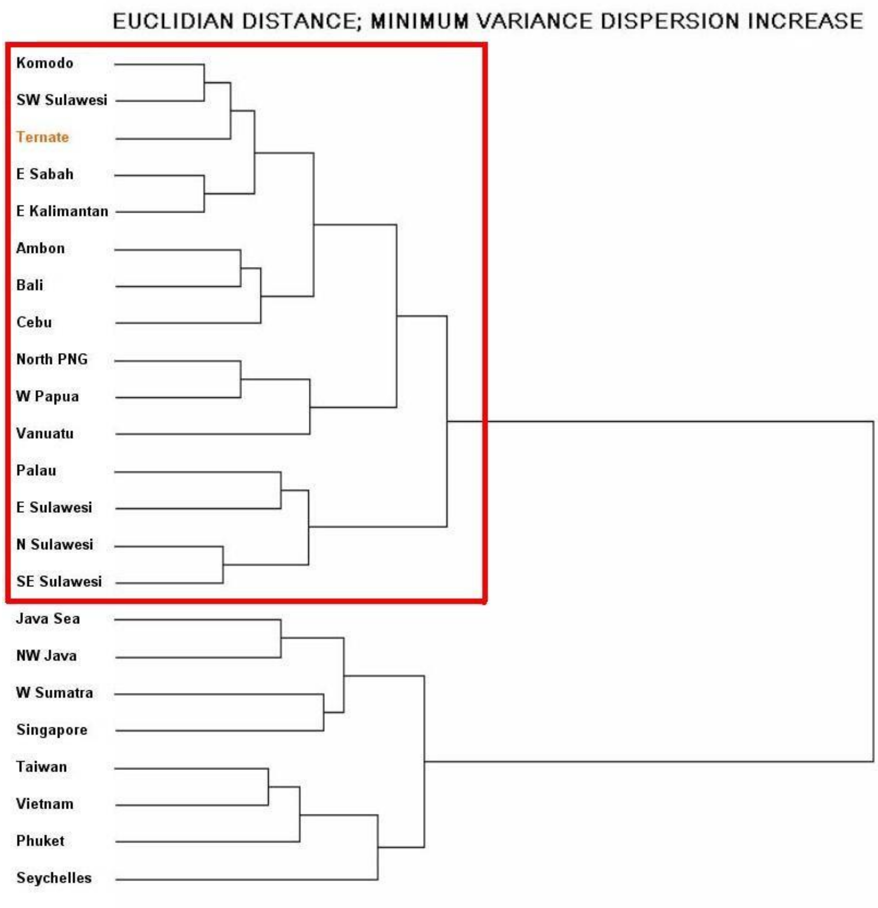

Fig. 3. Cluster analysis indicating the faunistic position of Ternate among other localities studied in the mushroom coral Triangle (red square) and those outside. Ternate is indicated by orange lettering.

Some species that are common in western Indonesia have not been observed in Ternate, such as *Fungia scabra* (Fig. 4) and *Lithophyllon undulatum*. These species were also not recorded at Raja Ampat. Ternate may be outside their distribution range, although they are present at nearby Northern Sulawesi. *L. ranjithi* has also not been found and therefore its known distribution area remains East Sabah and East Kalimantan, at the northeastern side of Borneo. *Cantharelus jebbi* was not found and therefore Raja Ampat is still the westernmost locality so far, and also the only one in Indonesia (Fig 5). For *Polyphyllia novaehiberniae*, Waigeo (Raja Ampat) also remains the westernmost distribution range limit (Fig. 6). The new record *of F. taiwanensis* is noteworthy, whereas *Halomitra clavator* (Fig. 7) usually a rare species appeared to be more abundant than any other locality investigated so far, partly because of its capacity of asexual reproduction through fragmentation.

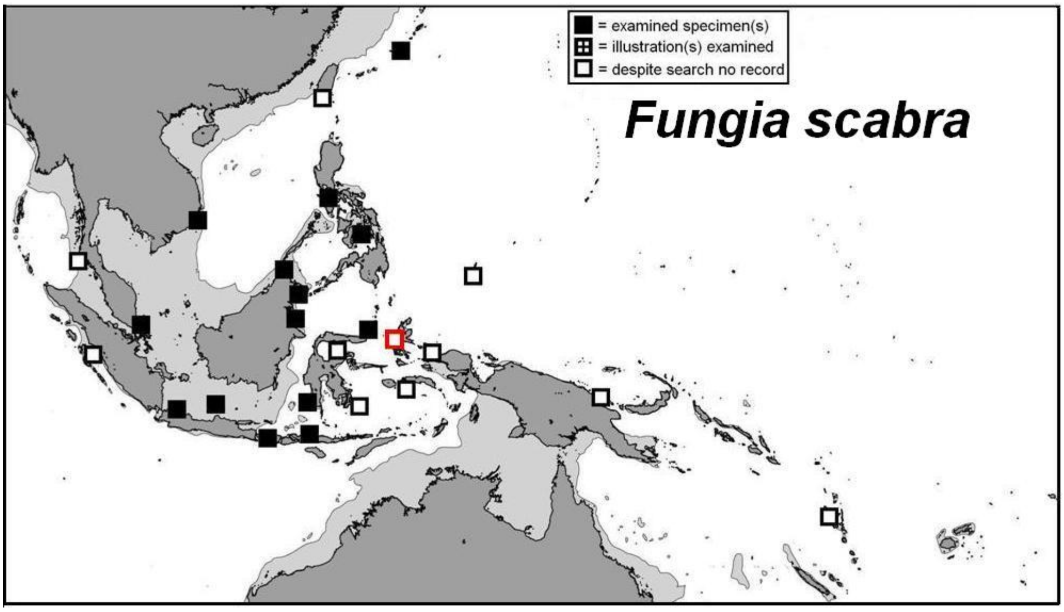

Figure 4. *Fungia scabra* shows an East Asian distribution range with North Sulawesi and southern Japan as easternmost localities. It was not recorded from Ternate.

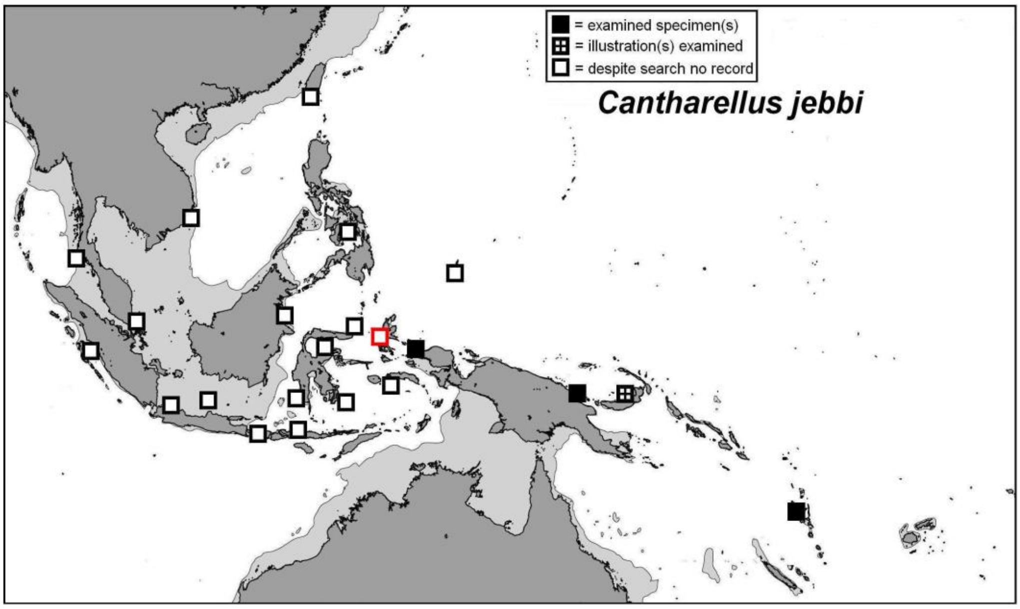

Figure 5. *Cantharellus jebbi* shows a West Pacific distribution range with Raja Ampat as westernmost locality. It was not recorded from Ternate.

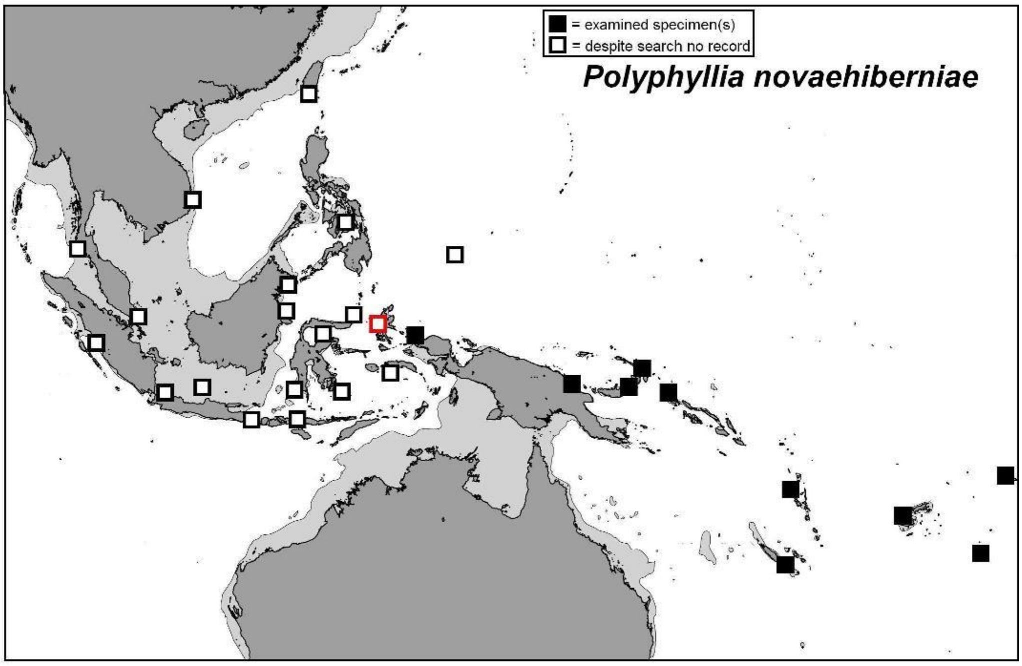

Figure 6. *Polyphyllia novaehiberniae* shows a West Pacific distribution range with Raja Ampat as westernmost locality. It was not recorded from Ternate.

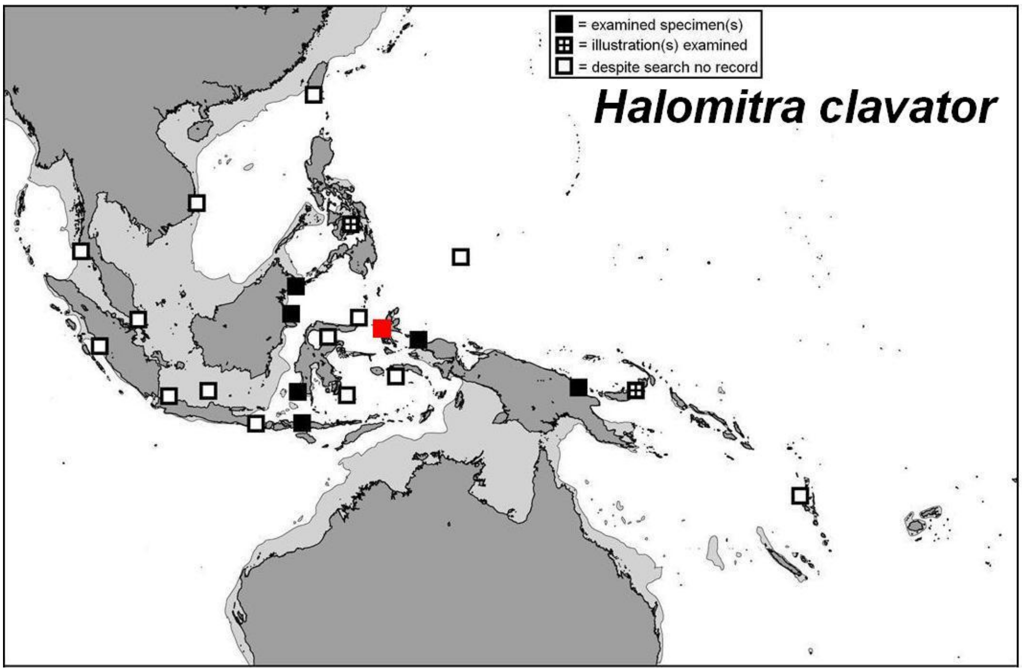

Figure 7. *Halomitra clavator* has since been recorded since 1989 from various places, including Ternate. In most areas it is a rare species, but at Ternate it has been found in large quantities. Records based on presence / absence surveys.


Figure 8. *Halomitra clavator* was abundantly present at some localities at Ternate, as fixed juveniles and as free-living adults.


Figure 9. *Halomitra clavator* was abundantly present due to fragmentation in one locality.

Table 1. Mushroom corals (Fungiidae) observed at Ternate stations (West Halmahera)

Sample number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Station number	1	2	3	4	5	6	6	7	8	9	10	11	12	13	14	15	16	17	20	21
Fungiidae per species	21	20	26	14	19	21	20	20	14	15	14	1	21	21	24	16	24	16	8	24
Fungia (*Cycloseris*) *sinensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
F. (*C.*) *distorta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
F. (*C.*) *cyclolites*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
F. (*C.*) *somervillei*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. (*C.*) *fragilis*	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0
F. (*C.*) *costulata*	1	1	1	0	1	1	0	1	0	0	0	0	1	1	1	1	1	1	0	1
F. (*C.*) *tenuis*	1	1	0	1	1	1	1	0	0	1	1	0	1	1	0	1	0	0	0	1
F. (*C.*) *vaughani*	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
F. (*C.*) *spec.*	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0
Fungia (*Verillofungia*) *spinifer*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. (*V.*) *concinna*	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1
F. (*V.*) *repanda*	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1
Fungia (*Danafungia*) *fralinae*	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1
F. (*D.*) *horrida*	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1
F. (*D.*) *scruposa*	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
Fungia (*Fungia*) *fungites*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fungia (*Wellsofungia*) *granulosa*	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
Fungia (*Lobactis*) *scutaria*	0	0	1	1	1	1	0	0	0	0	0	0	1	1	1	0	1	1	0	1
Fungia (*Pleuractis*) *moluccensis*	1	1	1	1	0	1	1	1	0	0	0	0	1	1	1	1	1	1	0	1
F. (*P.*) *taiwanesis*	0	0	0	`1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. (*P.*) *gravis*	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1
F. (*P.*) *paumotensis*	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
Heliofungia actiniformis	1	1	1	0	1	1	1	1	0	0	0	0	0	1	1	0	1	0	1	1
Ctenactis albitentaculata	0	0	1	0	0	1	1	1	0	0	0	0	0	0	1	0	1	0	0	1
C. echinata	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1
C. crassa	1	1	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	1
Herpolitha limax	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	0	0	1
P. talpina	0	1	1	1	1	1	1	1	0	0	0	0	1	0	1	0	1	1	0	1
Sandalolitha dentata	1	1	1	0	1	0	0	1	0	1	0	0	1	1	1	0	1	1	0	1
S. robusta	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
Zoopilus echinatus	1	1	1	0	1	0	1	0	0	0	0	0	0	1	1	0	1	0	0	1
Halomitra pileus	1	1	1	0	0	1	1	1	0	0	0	0	0	1	1	0	1	0	0	1
H. clavator	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L. mokai	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Podabacia crustacea	1	0	1	0	0	0	0	1	1	0	1	0	1	1	0	0	1	1	1	0
P. motuporensis	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1

Table 1 (continued). Mushroom corals (Fungiidae) observed at Ternate stations (West Halmahera)

Sample number	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Total
Station number	22	23	24	25	26	27	28	29	31	32	33	34	35	36	37	38	39	40	41	no. of
Fungiidae per species	15	22	27	23	19	20	20	22	21	23	21	25	23	23	23	18	17	25	9	stations
Fungia (*Cycloseris*) *sinensis*	0	0	0	0	0	1	0	0	0	1	0	1	0	1	1	0	0	1	0	6
F. (*C.*) *distorta*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
F. (*C.*) *cyclolites*	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	4
F. (*C.*) *somervillei*	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
F. (*C.*) *fragilis*	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	4
F. (*C.*) *costulata*	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	18
F. (*C.*) *tenuis*	0	1	1	1	0	0	0	1	1	0	0	1	1	0	0	0	0	1	0	8
F. (*C.*) *vaughani*	0	1	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	4
F. (*C.*) *spec.*	1	0	1	1	1	0	0	0	1	1	0	1	0	0	0	1	1	0	0	9
Fungia (*Verillofungia*) *spinifer*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2
F. (*V.*) *concinna*	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18
F. (*V.*) *repanda*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
Fungia (*Danafungia*) *fralinae*	0	1	1	0	0	0	1	0	0	1	1	1	1	1	1	1	0	1	0	11
F. (*D.*) *horrida*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	18
F. (*D.*) *scruposa*	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0	16
Fungia (*Fungia*) *fungites*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
Fungia (*Wellsofungia*) *granulosa*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
Fungia (*Lobactis*) *scutaria*	0	1	1	1	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	9
Fungia (*Pleuractis*) *moluccensis*	1	0	1	1	1	1	1	1	0	0	1	0	1	1	1	0	0	1	0	12
F. (*P.*) *taiwanesis*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
F. (*P.*) *gravis*	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	15
F. (*P.*) *paumotensis*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	18
Heliofungia actiniformis	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	17
Ctenactis albitentaculata	0	0	1	0	1	0	1	1	1	1	0	0	1	1	1	1	1	1	0	12
C. echinata	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	18
C. crassa	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	16
Herpolitha limax	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
P. talpina	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	1	1	14
Sandalolitha dentata	0	1	1	1	0	1	0	0	0	0	1	1	1	0	1	0	0	1	0	9
S. robusta	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	17
Zoopilus echinatus	0	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	1	0	7
Halomitra pileus	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	0	13
H. clavator	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1	0	4
L. mokai	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4
Podabacia crustacea	0	0	1	1	1	1	1	0	1	1	1	0	1	1	0	1	1	1	0	13
P. motuporensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Palaemonoid shrimps

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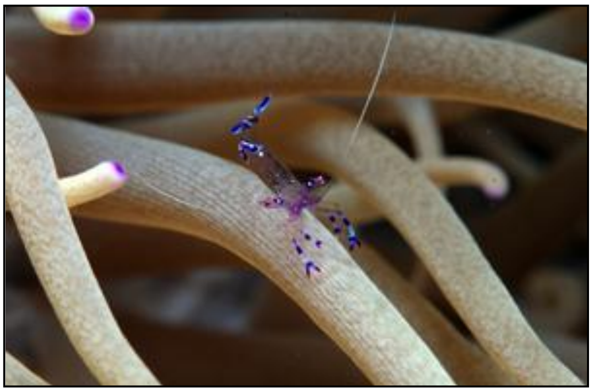
The most diverse subfamily of marine shrimps in the palaemonoids is the Pontoniinae. The Pontoniinae comprise around 550 species, of which around 400 have been recorded from the Indo-Pacific. Most species are living in association with other organisms. Only few records of these shrimps from the Ternate area are known in the scientific literature. De Man (1902) recorded nine species from this area of which four species were new to science. Holthuis (1952), in his monograph on the Pontoniinae of the Sibogae and Snellius Expeditions, recorded seven species of which one new to science. Most of the species in this preliminary report are now recorded from the Ternate area for the first time.
Shrimps were photographed on their host before collecting. During 41 dives a total of 340 samples was collected comprising about 600 specimens. Preliminary identification of the material yielded ca. 87 species (table 1). In genera like *Periclimenes* and *Periclimenaeus*, identification to species level awaits morphological study of the specimens. Several new species in the genus *Periclimenaeus* are expected, as a wide range of ascidians was collected by Dr A. Gittenberger and often found to be hosting specimens of *Periclimenaeus*. As species in this genus tend to be host-specific, new associations and new species can be expected. The number of palaemonoid species is comparable with the diversity measured in other localities within the area of maximal marine diversity (Fransen, 2007; Hoeksema, 2007): East Kalimantan (2003: ca. 90 species), Cebu (1999: ca. 87 species), Sulawesi (1994: ca. 80 species), Ambon (1996: ca. 90 species), Bali (2001: ca. 90 species), and Raja Ampat (2007: ca. 77 species) and distinctly higher than the localities outside this area: Seychelles (1992: 57 species), Pulau Seribu (2005: 60 species). Table 2 summarizes the number of species per host group for the areas studied over the years.

Cuapetes kororensis (Bruce, 1977) on *Heliofungia actiniformis*.



Periclimenes sarasvati Okuno, 2002 on *Heteractis* spec.

Table 1. Preliminary list of Palaemonoidea species collected during the Ternate 2009 Expedition.

SUPERFAMILY PALAEMONOIDEA RAFINESQUE, 1815
FAMILY HYMENOCERIDAE ORTMANN, A., 1890
Hymenocera picta Dana, 1852
FAMILY PALAEMONIDAE RAFINESQUE, 1815
SUBFAMILY PALAEMONINAE RAFINESQUE, 1815
Urocaridella spec.
SUBFAMILY PONTONIINAE KINGSLEY,1879
Anchiopontonia hurri (Holthuis, 1981)
Anchistus custoides Bruce, 1977
Anchistus/Paranchistus spec. 1
Anchistus/Paranchistus spec. 2
Brucecaris tenuis (Bruce, 1969)
Conchodytes meleagrinae Peters, 1852
Conchodytes pteriae Fransen, 1994
Conchodytes spec.
Coralliocaris superba (Dana, 1852)
Cuapetes kororensis (Bruce, 1977)
Cuapetes tenuipes (Borradaile, 1898)
Cuapetes spec. 1
Cuapetes spec. 2
Dactylonia ascidicola (Borradaile, 1898)
Dactylonia holthuisi Fransen, 2002
Dactylonia ? spec.nov.
Dasella herdmaniae (Lebour, 1939)
Dasycaris zanzibarica Bruce, 1973
Exoclimenella spec. 1
Hamodactylus boschmai Holthuis, 1952
Hamodactylus noumeae Bruce, 1970
Hamopontonia corallicola Bruce, 1970
Harpiliopsis spec. 1
Harpiliopsis spec. 2
Ischnopontonia lophos (Barnard, 1962)
Jocaste japonica (Ortmann, 1890)
Jocaste spec.
Laomenes amboinensis De Man, 1888
Manipontonia psamathe (De Man, 1902)
Odontonia katoi (Kubo, 1940)
Odontonia rufopunctata (Fransen, 2002)
Odontonia sibogae (Bruce, 1972)
Odontonia spec. nov. 1
Odontonia ? spec. nov. 2
Palaemonella pottsi (Borradaile, 1915)
Palaemonella rotumana (Borradaile, 1898)
Periclimenaeus pachydentatus Bruce, 1969
Periclimenaeus spec. 1
Periclimenaeus spec. 2
Periclimenaeus spec. 3
Periclimenaeus spec. 4
Periclimenaeus spec. 5
Periclimenaeus spec. 6
Periclimenaeus spec. 7
Periclimenaeus ? spec. nov. 1
Periclimenaeus ? spec. nov. 2
Periclimenaeus ? spec. nov. 3
Periclimenella spinifera (De Man, 1902)
Periclimenes affinis(Zehntner, 1894)
Periclimenes brevicarpalis (Schenkel, 1902)
Periclimenes commensalis Borradaile, 1915
Periclimenes holthuisi Bruce, 1969
Periclimenes imperator Bruce, 1967
Periclimenes incertus Borradaile, 1915
Periclimenes inornatus Kemp, 1922
Periclimenes lanipes Kemp, 1922
Periclimenes magnificus Bruce, 1979
Periclimenes ornatus Bruce, 1969
Periclimenes sarasvati Okuno, 2002
Periclimenes soror Nobili, 1904
Periclimenes venustus Bruce, 1990
Periclimenes watamuae Bruce, 1976
Periclimenes spec. nov. (in press.)
Periclimenes spec. nov. 2
Periclimenes spec. 1
Periclimenes spec. 2
Periclimenes spec. 3
Periclimenes spec. 5
Periclimenes spec. 6
Periclimenes spec. 7
Periclimenes spec. 8
Periclimenes spec. 9
Philarius gerlachi (Nobili, 1905)
Platypontonia hyotis Hipeau-Jacquotte, 1971
Pliopontonia furtiva Bruce, 1973
Pontonides unciger Calman, 1939
Pontoniopsis comanthi Borradaile, 1915
Rapipontonia galene (Holthuis, 1952)
Stegopontonia commensalis Nobili, 1906
Thaumastocaris streptopus Kemp, 1922
Tuleariocaris zanzibarica Bruce, 1967
Vir colemani Bruce, 2003
Vir euphyllius Marin & Anker, 2005
Vir philippinensis Bruce & Svoboda, 1984
Vir smiti Fransen & Holthuis, 2007

Table 2. Number of palaemonoid species per host group encountered in areas investigated.

	Ternate 2009	Raja Ampat 2007	P Seribu 2005	E Kalimantan 2003	Bali 2001	Cebu 1999	Sulawesi 1994	Ambon 1996	Seychelles 1992/93
Free-living	6	6	1	8	4	6	4	6	6
Porifera	6	8	4	6	22	10	10	6	4
Hydrozoa	2	1	1	1	2	2	2	2	2
Actiniaria	8	8	3	8	2	6	8	8	2
Corallimorpharia	2	1	1	1	1	1	1	1	1
Scleractinia	22	23	16	23	18	25	20	22	20
Alcyonaria	5	3	4	7	3	2	5	8	5
Gorgonaria	6	4	4	8	3	4	4	5	11
Antipatharia	5	3	1	6	8	9	6	5	5
Echinoidea	2	0	1	1	2	2	1	1	1
Asteroidea	1	1	1	1	1	2	1	1	1
Crinoidea	8	7	5	9	12	9	10	9	3
Holothuroidea	1	1	1	1	0	0	1	1	1
Bivalvia	8	6	9	8	6	8	7	7	9
Ascidiacea	17	8	5	10	9	3	4	8	3

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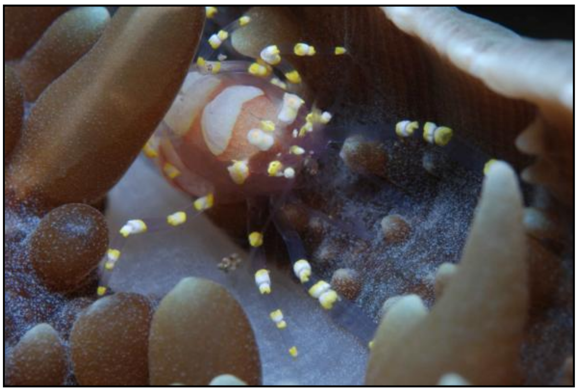
Periclimenaeus ? spec. nov. from compound ascidian.

Thaumastocaris streptopus Kemp, 1922 in *Haliclona* sponge.

Periclimenes spec nov. (in press) on *Amplexidiscus fenestrafer,* new association.



Pliopontonia furtiva Bruce, 1973 on *Amplexidiscus fenestrafer*.

Dasycaris zanzibarica Bruce, 1973 on *Cirripathes* spec.

Coralliocaris superba (Dana, 1852) on *Acropora* spec.

Platypontonia hyotis Hipeau-Jacquotte, 1971 between gills of *Hyotissa hyotis.*

Manipontonia psamathe (De Man, 1902) on Antipathes spec.

Hamopontonia corallicola Bruce, 1970 on *Fungia scruposa*, new association.

Stegopontonia commensalis Nobili, 1906 on *Echinotrix calamaris*.

Ovulidae and their Octocorallia hosts

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Ovulidae are gastropods that are obligate symbionts of Octocorallia, and are globally distributed in temperate and tropical seas (Schiaparelli, 2005). Over 200 species are known from the shallow and deep water reefs in the Indo-Pacific (Lorenz & Fehse, 2009). Until this expedition virtually no ovulid species were recorded from Ternate or from the surrounding islands. Fortunately this area proved to be relatively rich in species composition (Table 1). In total 28 species of Ovulidae were found divided over 15 genera of which 16 specimens were observed with egg capsules or in the act of ovipositing (Fig. 1-2). Also octocorallia hosts were collected. In total 80 Octocorallia were preserved for further identification on species level. Therefore the internal skeletal parts called sclerites have to be examined with a microscope and compared with species descriptions in scientific literature.

Before collecting most specimens were photographed *in situ* to record their morphology and colour patterns (Fig. 3-6). Some Ovulidae were only encountered after collecting the octocorallian host. These specimens were therefore photographed *in vivo* at the field station of LIPI Ternate. To preserve the soft body characters for examination, ovulids were relaxed for approximately 10 minutes in a fridge before conserving them on 80% ethanol. Octocorallia were directly stored on 80% ethanol.

Table 1. Overview of ovulid species and their host combined with their localities

#	Species	Host species	Locality (TER)
1	*Aclyvolva lanceolata*	*Ellisella* sp.	8, 9, 35
2	*Archivolva clava*	*Siphonogorgia* sp.	7, 10, 21
3	*Calpurnus verrucosus*	*Sarcophyton* sp.	30, 39, 40
4	*Crenavolva aureola*	*Acanthogorgia* sp.	18, 21, 27
5	*Crenavolva* cf. *matsumiyai*	*Annella* sp.	18
6	*Crenavolva* sp.	*Subergorgia* sp.	26
7	*Dentiovula dorsuosa*	*Siphonogorgia* sp.	8
8	*Dentiovula eizoi*	*Acanthogorgia* sp.	7, 13, 31, 41
9	*Dentiovula* cf. *colobica*	*Acanthogorgia* sp.	26
10	*Habuprionovolva aenigma*	*Dendronephthya* sp.	4, 7, 27, 30, 41
11	*Habuprionovolva hervieri*	*Dendronephthya* sp.	8
12	*Hiatavolva coarctata*	*Ellisella* sp.; *Dichotella* sp.	27, 29, 40
13	*Margovula marginata*	*Nephthea* sp.	38, 41
14	*Naviculavolva deflexa*	*Rumphella* sp.; *Pinnigorgia* sp.	10, 38, 39
15	*Naviculavolva kurziana*	*Rumphella* sp.	39
16	*Ovula ovum*	*Sarcophyton* sp.	16
17	*Pedicularia* sp.	*Stylaster roseus*; *Distichopora violacea*	3, 15, 22, 29, 33, 34
18	*Pellasimnia brunneiterma*	*Annella* sp.	14
19	*Phenacovolva* cf. *recurva*	*Paratelesto* sp.	31, 40
20	*Phenacovolva rhederi*	*Antipathes* sp.	20
21	*Phenacovolva philippinarum*	*Annella* sp.	6, 14, 40
22	*Phenacovolva* cf. *rosea*	*Astrogorgia* sp.	4, 18, 35
23	*Primovula rosewateri*	*Stereonephthya* sp; *Melithaea* sp.	20, 33

24	*Prionovolva brevis*	*Dendronephthya* sp.	21
25	*Prionovolva ericae*	*Dendronephthya* sp.	23, 30
26	*Prosimnia draconis*	*Melithaea* sp.; *Acabaria* sp.	10, 19, 15, 18, 20, 38, 39
27	*Prosimnia piriei*	*Euplexaura* sp.	2, 13, 15, 21
28	*Prosimnia semperi*	*Melithaea* sp.	4, 7, 8, 9, 14, 26, 27, 30, 32, 34, 35

Based on the GPS data and the collected samples, locations as Pulau Tidore and West Halmahera were particularly rich in Ovulidae species. When the Ternate region is compared to other regions in Indonesia (e.g. Raja Ampat, Papua and Manado, Sulawesi), Ternate seems very diverse (Table 2), although this could be caused by an observer bias. Night diving may help to find Ovulidae because species tend to be more active and crawl on top of their host, instead of hiding under or in between branches. Unfortunately we only had one opportunity to make a night dive, which proved to be successful.

Table 2. Combination of all Indonesian species collected per locality and their hosts.

Species	Raja Ampat	Manado	Ternate	Overall host species recorded
Aclyvolva lanceolata	x	-	x	*Ellisella* sp.; *Dichotella* sp.
Archivolva clava	-	x	x	*Siphonogorgia* sp.
Calpurnus verrucosus	-	-	x	*Sarcophyton* sp.
Crenavolva aureola	-	-	x	*Acanthogorgia* sp.
Crenavolva cf. *matsumiyai*	-	-	x	*Annella* sp.
Crenavolva sp. A	-	-	x	*Subergorgia* sp.
Dentiovula cf. *colobica*	-	-	x	*Acanthogorgia* sp.
Dentiovula dorsuosa	x	x	x	*Siphonogorgia* sp.
Dentiovula eizoi	x	x	x	*Acanthogorgia* sp.
Dentiovula sp. A	-	x	-	*Chironephthya* sp.
Dentiovula takeoi	x	-	-	*Mopsella* sp.
Habuprionovolva aenigma	-	x	x	*Dendronephthya* sp.
Habuprionovolva hervieri	-	-	x	*Dendronephthya* sp.
Hiata depressa	-	x	-	*Alertigorgia* sp.
Hiata rugosa	-	x	-	*Ellisella* sp.; *Verrucella* sp.
Hiatavolva coarctata	x	-	x	*Dichotella* sp.; *Ellisella* sp.; *Viminella* sp.
Margovula marginata	x	-	x	*Nephthea* sp.; *Stereonephthya* sp.
Naviculavolva deflexa	x	x	x	*Rumphella* sp.; *Hicksonella* sp.
Naviculavolva kurziana	x	x	x	*Rumphella* sp.; *Hicksonella* sp.
Ovula ovum	x	-	x	*Sarcophyton* sp.
Pedicularia pacifica	x	x	x	*Stylaster* sp.
Pedicularia vanderlandi	x	x	-	*Distichopora* sp.
Pellasimnia brunneiterma	-	-	x	*Annella* sp.
Phenacovolva cf. *recurva*	-	-	x	*Paratelesto* sp.
Phenacovolva gracilis	x	-	-	*Antipathes* sp.
Phenacovolva nectarea	-	x	-	*Astrogorgia* sp.
Phenacovolva philippinarum	x	-	x	*Annella* sp.
Phenacovolva rhederi	-	-	x	*Antipathes* sp.
Phenacovolva rosea	-	-	x	*Astrogorgia* sp.
Primovula astra	-	x	-	*Scleronephthya* sp.

Primovula rosewateri	x	-	x	*Melithaea* sp.; *Stereonephthya* sp.
Prionovolva brevis	-	-	x	*Dendronephthya* sp.
Prionovolva ericae	x	-	x	*Dendronephthya* sp.
Prosimnia draconis	x	x	x	*Acabaria* sp.; *Melithaea* sp.; *Mopsella* sp.
Prosimnia piriei	x	x	x	*Euplexaura* sp.; *Subergorgia* sp.
Prosimnia semperi	x	x	x	*Acabaria* sp.; *Melithaea* sp.; *Mopsella* sp.
Pseudosimnia culmen	x	x	-	*Dendronephthya* sp.

Figure 1. *Crenavolva* cf. *matsumiyai* ovipositing

Figure 2. Egg capsules of *Prosimnia draconis* on *Acabaria* sp.

Figure 3. *Cymbovula deflexa* on *Rumphella* sp.

Figure 4. *Habuprionovolva hervieri* on *Dendronephthya* sp.

Figure 5. *Aclyvolva lanceolata* on *Ellisella* sp.

Figure 6. *Dentiovula eizoi* on *Acanthogorgia* sp.

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Sponges (Porifera)

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A little bit over a century ago the German professor Kükenthal sailed the Moluccas seas and collected about 100 sponges somewhere around the island of Ternate. Once back in Germany he passed this collection on to a PhD-student (O. Kieschnick) of a well-known sponge taxonomist (J. Thiele). In 1896, Kieschnick described a total of 50 sponges of which 22 new to science, however his tutor wasn't satisfied and revised the whole collection. In 1903 Thiele published this revision "Kieselschwämme von Ternate" and remains one of most important works of sponges from Indonesia so far. Besides the already described 60, he described 44 new to science. Some of these species can be found around the coral reefs of the Indonesian archipelago while others have never been reported since their descriptions in 1896 and 1903. It is possible, that these sponges only live on the reefs around the island of Ternate, so called endemics. However, the city of Ternate has increased dramatically in the past century, for instance the dense mangrove forests have completely disappeared, and it is thus likely that the sponges of the 19th century have disappeared because of this.

It is the first time since 1896 that someone is looking at the sponge fauna of Ternate and it is a great challenge to try to recollect all sponges described in those papers anno 2009. After visiting 20 dive sites, a total of approximately 200 different sponge species were collected. Some of those have never been collected before in Indonesia, and might even be new to science. However, only 20 sponges out of the 250 specimens collected were mentioned in the paper of Thiele. However, many of his described species are thin encrustations growing on other organisms and these are almost impossible to identify in the field. The greatest challenge, thus has to wait until I can investigate the sponge skeleton under a microscope to conclude whether I have succeeded in recollecting the sponges then and now.

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Sponges are present in a variety of colors and body structures, such as these orange sponges *Stylissa carteri*, *Phakellia* sp (left) and *Amphimedon* sp (right).

Preliminary systematic list of sponge species observed at the sampled locations

Demospongiae
Homosclerophorida
Plakinidae
Plakortis lita (de Laubenfels, 1954)
Plakortis nigra Lévi, 1953
Spirophorida
Tetillidae
Cinachyrella australiensis (Carter, 1886)
Cinachyrella sp.
Paratetilla sp.
Tetilla sp.
Astrophorida
Ancorinidae
Jaspis splendens (de Laubenfels, 1954)
Melophlus sarassinorum Thiele, 1899
Penares sollasi Thiele, 1900
Rhabdastrella globostellata (Carter, 1883)
Stelletta clavosa Ridley, 1884
Stelletta sp.
Geodiidae
Erylus aff. *lendenfeldi* Sollas, 1888
Pachastrellidae
Stoeba aff. *exostotica* (Schmidt, 1868)
Hadromerida
Clionaidae
Spheciospongia vagabunda (Ridley, 1884)
Placospongiidae
Placospongia carinata (Bowerbank, 1858)
Placospongia melobesioides Gray, 1867
Placospongia mixta (Thiele, 1900)
Suberitidae
Aaptos suberitioides Brønsted, 1934

Suberites aff. *diversicolor* Becking & Lim, 2009
Tethyidae
Tethya cf. *seychellensis* (Wright, 1881)
Tethya sp.
<u>'Lithistid' Demospongiae</u>
Theonellidae
Theonella swinhoei Gray, 1868
Theonella sp

<u>Poecilosclerida</u>
Microcionina
Microcionidae
Clathria (*Clathria*) *basilana* Lévi, 1961
Clathria (*Isociella*) *eccentrica* (Burton, 1934)
Clathria (*Thalysias*) *cervicornis* (Thiele, 1903)
Clathria (*Thalysias*) *reinwardti* Vosmaer, 1880
Clathria (*Thalysias*) *vulpina* (Lamarck, 1813)

Raspailiidae
Echinodictyum sp.
Thrinacophora cervicornis Ridley & Dendy, 1886
Rhabderemiidae
Rhabderemia sp.
<u>Myxillina</u>
Chondropsidae
Chondropsis sp.
Coelosphaeridae
Lissodendoryx (*Acanthodoryx*) *fibrosa* (Lévi, 1961)
Crambeidae
Monanchora dianchora de Laubenfels, 1935
Iotrochotidae
Iotrochota baculifera Ridley, 1884
Iotrochota purpurea (Bowerbank, 1875)
<u>Mycalina</u>
Desmacellidae
Biemna aff. *humilis* Thiele, 1903
Biemna trirhaphis (Topsent, 1897)
Biemna / *Stelletta* sp.
Esperiopsidae
Ulosa aff. *ada* (de Laubenfels, 1954)
Mycalidae
Mycale (*Mycale*) *armata* Thiele, 1903
Mycale (*Naviculina*) *flagellifera* Vacelet & Vasseur, 1971
Mycale (*Arenochalina*) aff. *euplectelloides* (Row, 1911)
Mycale (*Mycale*) *vansoesti* Calcinai, Cerrano, Totti, Romagnoli & Bavestrello, 2006
Podospongiidae
Diacarnus megaspinorhabdosa Kelly-Borges & Vacelet, 1995
Isodictydidae

Coelocarteria agglomerans Azzini, Calcinai & Pansini, 2007

Halichondrida

Axinellidae

Phakellia sp.

Ptilocaulis aff. *fusiformis* Lévi, 1967

Reniochalina sp.

Dictyonellidae

Acanthella cavernosa Dendy, 1922

Acanthella aff. *cavernosa* Dendy, 1922

Liosina paradoxa Thiele, 1899

Stylissa carteri Dendy, 1889

Stylissa massa (Carter, 1887)

Svenzea devoogdae Alvarez, Rutzler & van Soest, 2002

Halichondriidae

Axinyssa aff. *aplysinoides* Dendy, 1922

Axinyssa spp.

Halichondria cartilaginea Esper, 1794

Halichondria (*Halichondria*) sp.

Heteroxyidae

Didiscus sp.

Myrmekioderma granulata (Esper, 1794)

Agelasida

Agelasidae

Agelas cavernosa Thiele, 1903

Agelas ceylonica Dendy, 1905

Agelas nemoechinata Hoshino, 1985

Agelas nakamurai Hoshino, 1985

Agelas aff. *nemoechinata* Hoshino, 1985

Haplosclerida

Haplosclerina

Callyspongiidae

Callyspongia (*Cladochalina*) *aerizusa* Desqueyroux-Faundez, 1984

Callyspongia (*Cladochalina*) aff. *confoederata* Ridley, 1884

Callyspongia (*Cladochalina*) *joubini* (Topsent, 1897)

Callyspongia (*Cladochalina*) *pseudoreticulata* Desqueyroux-Faundez, 1984

Callyspongia (*Cladochalina*) *samarensis* (Wilson, 1925)

Callyspongia (*Cladochalina*) aff. *subarmigera* (Ridley, 1884)

Callyspongia (*Toxohalina*) aff. *ramosa* (Gray, 1843)

Callyspongia (*Euplacella*) *biru* de Voogd, 2004

Callyspongia spp.

Chalinidae

Chalinula confusa (Dendy, 1922)

Chalinula hooperi (Bakus &Nishiyama 2000)

Cladocroce acuelata Pulitzer-Finali, 1982

Cladocroce sp.

Haliclona (*Gellius*) aff. *amboinensis* Lévi, 1959

Haliclona (*Gellius*) *cymaeformis* (*Esper, 1794*)

Haliclona (*Gellius*) sp.

(*Haliclona* (*Halichoclona*) *vanderlandi* de Weerdt & van Soest, 2001
Haliclona (*Reniera*) *fascigera* Hentschel, 1912
Haliclona (*Soestella*) sp.
Haliclona spp.
Niphatidae van Soest, 1980
Amphimedon paraviridis Fromont, 1988
Cribochalina sp.
Dasychalina fragilis Ridley & Dendy, 1886
Gelliodes fibulata (Carter, 1881)
Gelliodes aff. *hamata* (Thiele, 1903)
Gelliodes spp.
Niphates olemda (de Laubenfels, 1954)
Niphates spp.
Pachychalina sp. Schmidt, 1868
Petrosina
Phloeodictyidae
Aka sp.
Oceanapia sp.
Oceanapia sagittaria Sollas, 1902
Petrosiidae
Acanthostrongylophora ingens (Thiele, 1899)
Neopetrosia exigua (Kirkpatrick, 1900)
Neopetrosia aff. *carbonaria* (Lamarck, 1814)
Neopetrosia spp.
Petrosia (*Petrosia*) *hoeksemai* de Voogd & van Soest, 2002
Petrosia (*Petrosia*) *nigricans* Lindgren, 1897
Petrosia (*Petrosia*) *lignosa* Wilson, 1925
Petrosia (*Strongylophora*) *corticata* (Wilson, 1925)
Petrosia (*Strongylophora*) *strongylata* Thiele, 1903
Xestospongia aff. *mammillata* Pullitzer-Finali, 1982
Xestospongia vansoesti Bakus & Nishiyama, 2000
Xestospongia testudinaria (Lamarck, 1813)
Xestospongia spp.
Dictyoceratida
Irciniidae Gray, 1867
Ircinia ramosa Keller, 1889
Ircinia spp.
Thorectidae Bergquist, 1978
Thorectinae
Cacospongia mycofijiensis (Kakou,Crews & Bakus, 1987)
Dactylospongia elegans (Thiele, 1899)
Fascaplysinopsis reticulata (Hentschel, 1912)
Hyrtios erectus Keller, 1889
Hyrtios reticulatus Thiele, 1899
Hyrtios sp.
Luffariella variabilis (Polejaeff, 1884)
Semitaspongia sp.
Phyllospongiinae

Carteriospongia foliascens (Pallas, 1766)
Lendenfeldia sp.
Phyllospongia papyracea (Esper, 1806)
Phyllospongia aff. *lamellosa* (Esper, 1794)
Strepsichordaia aliena Wilson, 1925
Spongiidae
Hippospongia sp.
Leiosella ramosa Bergquist, 1995
Spongia (*Spongia*) *ceylonensis* Dendy, 1905
Dysideidae
Dysidea arenaria Bergquist, 1965
Dysidea frondosa Bergquist, 1995
Dysidea granulosa Bergquist, 1965
Dysidea sp.
Euryspongia sp.
Lamellodysidea herbacea (Keller, 1889)
<u>Dendroceratida</u>
Darwinellidae
Chelonaplysilla aff. *violacea* (Lendenfeld, 1883)
Dictyodendrillidae Bergquist, 1980
<u>Verongida</u>
Aplysinellidae
Suberea sp.
Ianthellidae Hyatt, 1875
Ianthella basta Pallas
Pseudoceratinidae Carter, 1885
Pseudoceratina verrucosa Bergquist, 1995

Little story of sponges in Ternate, North Moluccas, Indonesia

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In the tropical seas, sponges can be found at various depths, from the intertidal zone of less than 1 meter until thousand meters under the sea level. Sponges are the most primitive metazoan creatures. They can live in many ecosystems, such as rocky shores, seagrass beds, and coral reefs. Sponges can even live in seawater that is heavily polluted with organic matter, where other animals cannot survive.

Technical method for collecting sponges from the sea:

1. Taking of photograph of sample target in its habitat, using underwater camera.
2. If sample size was small, the sample was cut horizontally or, if possible, collected as a whole.
3. If the size of sample was big, the sample was cut horizontally and vertically, like cutting cake.
4. The sample was collected by use of gloves. This is important since many sponges are toxic and have sharp spicules, which can hurt when handling them with naked hands.
5. Each sample was put in a separate plastic bag to prevent contamination by mixing of spicules from other specimens.
6. The sample should always remain soaked in sea water, before preservation in alcohol.

Technical method for temporary sponge sample preservation:

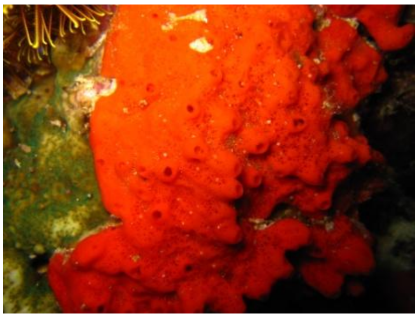
1. Take the sample from the plastic bag, then place it in a clean plastic jar/plastic bag.
2. Sample labelling (including: date, station number, sample code, depth, and collector, and the species name if possible).
3. The jar/plastic bag of sample was filled with ethanol 70% or 95%, then it was closed tightly

Sponge identification was by using the fieldguide books (Sponges Guide of Singapore and Tropical Pacific Invertebrates) for the common species. Identification by use of microscope to examine spicules will be done in Jakarta, after transport of the samples from Ternate.

Some interesting observations on sponges during this expedition:

1. Some particular sponge growth forms

Thin Encrusting sponge



Thick encrusting sponge

Exposed sponge, cup shape

Globular shape

Tubular shape

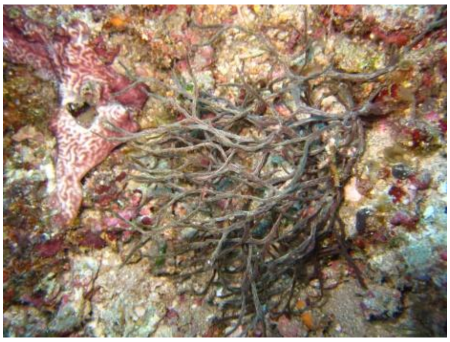
Fan-shape

Sponge buried in muddy substrate

Small sponge

Calcareous sponges

2. Ecological observations on sponges



Sponge in symbiosis with algae

Sponge overgrowing stylasterid coral

Predator prey relation between sponge and nudibranch / starfish

Association between sponge and isopod

3. Sponge reproduction

Phyllidiid nudibranchs and host sponges

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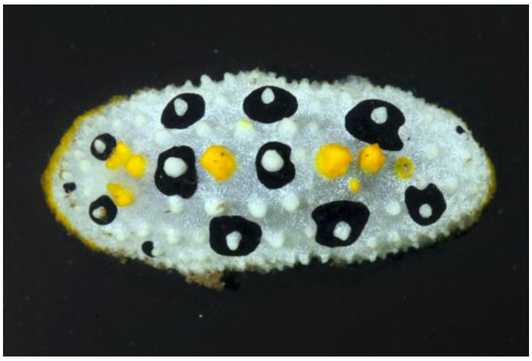
Coral reefs are among the most diverse ecosystems on earth, even though the availability of nutrients is relatively poor. The extreme biodiversity is allowed by the extensive interactions that occur between coral reef species. Predation is an important interaction between species and the selection pressures that result from it can lead to co-evolution: prey species continuously adapt in order to escape predation, to which predating species then adapt in order to cope with prey adaptations, and vice versa; it's an evolutionary arms race.

Some species of Halichondrida (Spongidae) produce secondary metabolites that render them inedible for many predators. However, many phyllidiid nudibranchs appear to be capable of feeding on them. Furthermore, they can transform and subsequently accumulate the secondary metabolites in their epithelial tissue to escape predation themselves. Most likely, this property is of great evolutionary importance to the relation between individuals of both taxa. Yet today the phylogeny of both groups remains largely uncertain.


Phyllidiopsis shireenae


Phyllidia babai.

During the expedition to Ternate, we have collected 165 samples of Phyllidiids, including 4 genera and 25 species, almost all of them with host sponges. Furthermore, we have observed previously unknown feeding behaviour. The encountered sponge species have yet to be determined. Further analysis of DNA samples will be used to create a molecular phylogeny of the collected Phyllidiid species, and determine the extent of co-evolution between Phyllidiidae and Halichondrida.

Species list

Phyllidiidae:

- *Phyllidia babai*
- *Phyllidia carlsonhoffi*
- *Phyllidia* cf. *alyta*
- *Phyllidia coelestis*
- *Phyllidia elegans*
- *Phyllidia exquisita*
- *Phyllidia krempfi*
- *Phyllidia ocellata*
- *Phyllidia picta*
- *Phyllidia ruppelli*
- *Phyllidia* sp. 1
- *Phyllidia* sp. 2
- *Phyllidia varicosa*
- *Phyllidiella* cf. *annulata*
- *Phyllidiella* cf. *granulata*
- *Phyllidiella* cf. *lizae*
- *Phyllidiella nigra*
- *Phyllidiella pustulosa*
- *Phyllidiella* sp. 1
- *Phyllidiella* sp. 2
- *Phyllidiopsis annae*
- *Phyllidiopsis shireenae*
- *Phyllidiopsis* sp.
- *Reticulidia fungia*
- *Reticulidia halgerda*

Echinoderms: Asteroidea & Holothuroidea

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This assessment reports on echinofaunal data and impressions for the Ternate region after 18 days of field work comprising SCUBA surveys at 33 sites plus intertidal site visits. This section of the report focuses on Asteroidea (sea stars) and Holothuroidea (sea cucumbers). Other members of the expedition, from LIPI, concentrated on other Echinoderm classes. Additional observations on sea stars and sea cucumbers were made by other E-WIN Expedition members during the final 4 days of the survey, after departure of the author. The shallow-water (< 50m depth) sea stars and sea cucumbers of the North Maluku region are little known. Historically the Albatross Expedition at the beginning of the 20th century, sampled the sea star fauna in the Moluccas (Fisher, 1913a,b; 1919) but much of that collection was by trawls or dredge hauls from deep water. Loisette Marsh of the Western Australian Museum studied the asteroids during an expedition to the Moluccas in the 1980s and the author observed and photographed Echinoderms during a live-aboard diving excursion to the southern part of N. Maluku province in 1996, but there is, as yet, nothing published from these earlier visits.

For the present survey, the shallow-water (<50m depth) Asteroidea (sea star) species count stands at 31 (see Table 1). About two thirds of these (21 sp.) belong to the family Ophidiasteridae. Ophidiasterids tend to dominate reef and near reef environments but it is considered that some other families, notable the Oreasteridae and Goniasteridae, and the infaunal Astropectinidae are underrepresented in the collection thus far. The species accumulation curve showed signs of flattening out but this perhaps reflects the logistic difficulty of accessing and sampling some habitat types during the survey. Several habitat types which were expected to be particularly productive, namely deep, steep reef slopes and drop offs, sea grass beds, and the intertidal zone, need to be sampled more extensively. Local disturbance factors may have slowed the rate of discovery. For example sea grass beds on mainland Ternate revealed hardly any asteroids, and just one specimen of the normally very common and ubiquitous knobby sea star, *Protoreaster nodosus.* Its absence is a possible indicator of overharvesting for the curio trade in the region, including the particular use of this species in shop window displays in cities world-wide. In contrast, this species, together with the sea urchin *Tripneustes gratilla* were found in abundance on the more remote sea grass beds of west Halmahera in the vicinity of Dodinga Bay.

The most notable sea star discovery in North Maluku, in the Guraici Archipelago, was the rare neoferdinid sea star, nominally *Neoferdina glyptodisca*, (Fig. 1). *N. glyptodisca* was originally only known from a single specimen found early in the last century off Buton, South Sulawesi during the Albatross Expedition. In recent years representatives have been recorded at several other sites, all of them around Sulawesi. Its discovery in northern Maluku during the E-WIN Expedition, if indeed it is this species, represents an extension of the known range for this asteroid and has important biogeographic implications. There is however the possibility, currently being investigated, that it is an entirely new species, which would be equally important from both taxonomic and biogeographic viewpoints. Another interesting sea star discovery was the rare but conspicuously colourful *Fromia pacifica* (Fig. 2).

The presence of the crown-of thorns (COT) sea star, *Acanthaster planci,* in significant numbers was noted for a number of reef sites. Most of these coral-eating sea stars were of large size and feeding on remnant corals in areas with much dead standing coral, e.g. table corals. This may represent the terminal phase of an outbreak of COT sea stars reported for December 2007 in the region (Science Daily, 2008). Juvenile *A. planci* were also found at a few sites. At many sites there were extensive fields of coral rubble and since Ternate, located on the Equator, is outside the cyclone belt it is possible that these rubble zones are evidence of either destruction due to blast fishing that was reported to be prevalent earlier this decade, or due to collapse of branching and plate corals following COT mortality and skeletal erosion and weakening, or both.

Fig. 1 Neoferdinid provisionally identified as *Neoferdina glyptodisca*

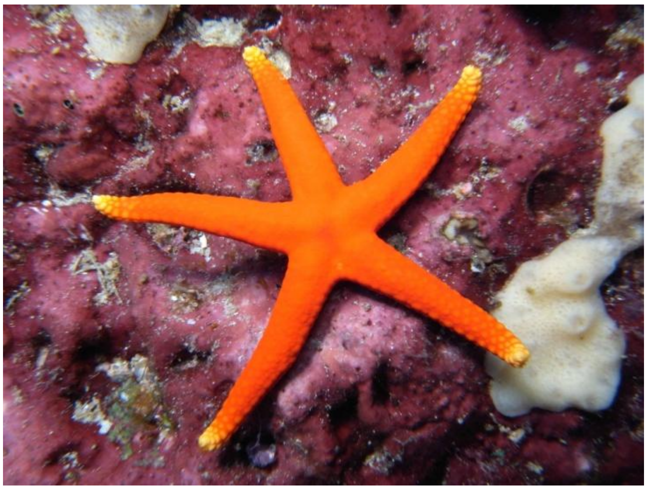

Fig. 2 *Fromia pacifica*

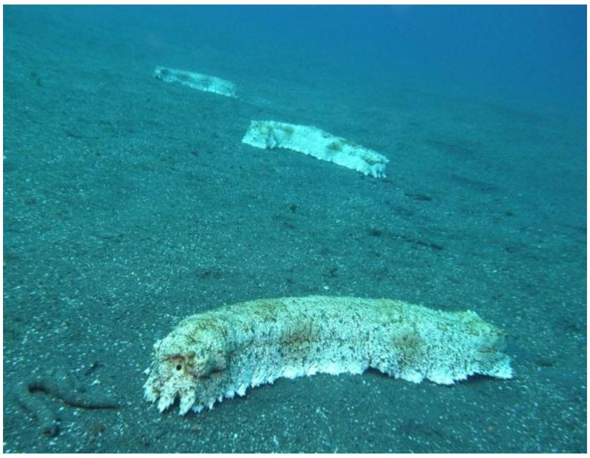

Fig. 3 A population of the large sea cucumber, *Thelenota anax* on volcanic sands off East Ternate.

Fig. 4 The rare *Actinopyga caerulea* in situ off West Halmahera.

The species count for Holothuroidea is currently 30-31, again somewhat low in terms of initial diversity evaluation. These initial findings however, as for asteroids, represent an incomplete set of habitat sites examined thus far and, in the case of sea cucumbers, discovery seems to have been hindered by overharvesting of commercial species. There are some striking features regarding the occurrence of the larger sea cucumber forms. Many species of large tropical Aspidochirote sea cucumbers are harvested throughout the Indo-Pacific for the beche-de-mer trade and, on initial evidence, most these species in the Ternate region are very low in abundance at most locations, if detected at all. It is quite likely therefore that several species have been missed in this brief survey. The very low densities of, for example, the 'teat-fish' *Holothuria fuscogilva* and for *Holothuria fuscopunctata* indicate overharvesting. Exceptions were two surprising locations off Ternate where sea cucumbers were not uncommon. At one site significant numbers of the very large sea cucumber species, *Thelenota anax,* were observed and photographed in situ (Fig. 3) while this species and a number of other commercial species, including large numbers of *Holothuria edulis,* were found at the other site, However, on current evidence it is quite likely that populations of sea cucumbers (which are broadcast spawners) that are reduced to very low densities by overharvesting, as is generally the case in the Ternate region, may, due to reduction in fertilization success, take a very long time to recover their numbers, if at all. The most notable sea cucumber finds were the recently described (2006) Indo-Pacific *Actinopyga caerulea,* found on a garden eel plain off west Halmahera (Fig. 4), the large suspension-feeding dendrochirote *Neothyonidium magnum*, and the striking, but rarely seen, candy-striped species of *Thelenota, T. rubralineata,* which was found by the E-WIN team in Dodinga Bay and represents a new record for the Halmahera/Ternate region.

Table 1. Faunal list of Sea Stars and Sea Cucumbers recorded in N. Maluku during the E-WIN Expedition, October/November 2009

ASTEROIDEA	HOLOTHUROIDEA
Acanthaster planci	*Actinopyga caerulea*
Anthenea sp.	*Actinopyga lecanora*
Astropecten polyacanthus	*Bohadschia argus*
Celerina heffernani	*Bohadschia marmorata*
Echinaster luzonicus	*Colochirus robustus*
Echinaster callosus	*Holothuria atra*
Choriaster granulatus	*Holothuria edulis*
Culcita novaecaledoniae	*Holothuria*
Fromia indica	*Holothuria fuscogilva*
Fromia milleporella	*Holothuria fuscopunctata*
Fromia monilis	*Holothuria hilla*
Fromia pacifica	*Holothuria impatiens*
Gomophia egyptiaca	*Holothuria leucospilota*
Gomophia watsoni	*Holothuria* sp. *1*
Leiaster speciosus	*Holothuria* sp. *2* (*pink edulis type*)
Linckia guildingi	*Labidodemas semperianum*
Linckia laevigata	*Neothyonidium magnum*
Linckia multifora	*Ophiodesoma spectabilis*
Linckia sp. (*mottled*)	*Pearsonothuria graeffei*
Linckia sp. (*purple*)	*Polycheira* sp.
Mithrodia clavigera	*Polyplectana keffersteini*
Nardoa frianti	*Stichopus chloronotus*

Nardoa galatheae	*Stichopus herrmanni*
Nardoa tuberculata	*Stichopus horrens*
Nardoa sp.	*Stichopus* sp.
Neoferdina cumingi	*Synapta maculata*
Neoferdina glyptodisca	*Synapta* sp.
Nepanthia belcheri	*Synaptula lamperti*
Ophidiaster hemprichi	*Thelenota ananas*
Ophidiaster lorioli	*Thelenota anax*
Protorester nodosus	*Thelenota rubralineata*

As a follow-up to this preliminary report, tasks that remain to be done prior to a detailed analysis of sea star distribution patterns, include: evaluation of the neoferdinid material, including the putative *Neoferdina glyptodisca;* a review of the *Nardoa/Gomophia* complex and the collected specimens assigned to this group, and collation of the current material and lists with the records of previous visits.

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Ophiuroidea (Brittle star)

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Most of the research work was done by scuba diving. Samples were collected at least twice a day by scuba diving and some localities species were collected with while snorkeling. This accounts especially for marine organism in shallow waters. In total about 41 dive sides were visited during this expedition. Samples were preserved in the *laboratory* of the LIPI Ternate field station using alcohol 70%.

In total 15 species of identified brittle stars were collected during the expedition. Six species belong to the family Ophiotrichidae, four species belong to the Ophiodermatidae, four species belong to the Ophiocomidae and one species belongs to the Ophiuridae (table 1).

There are many micro-brittlestar that have not yet been identified because their very small size and therefore need to be observed under a microscope. These micro-brittle stars are often found in association with corals, such as *Fungia* species, sponges, gorgonians and soft corals.

Table 1. Indentified brittlestar

Family	Name of species
Ophiotrichidae	*Ophiothrix variabilis*
	Ophiothrix nereidina
	Ophiothrix purpurea
	Ophiothela danae
	Ophiothrix sp.
	Macrophiothrix sp.
Ophiodermatidae	*Ophiarachna delicata*
	Ophiarachna affinis
	Ophiarachnella
	Ophiarachna incrassata
Ophiocomidae	*Ophiomastix caryophyllata*
	Ophiocoma erinaceus
	Ophiocoma sp.
	Ophiomastix cf. *venosa*
Ophiuridae	*Ophiolepis superba*

Ophiomastix caryophyllata (Fig. 1) - Found on rubble of coral with sands substrate. Some time found beneath on dead coral. This species have characteristic pattern in disk and along their arm.
Ophiarachna delicata (Fig. 2) - Found on coral with dwelling inside branches of Acropora. The arms are usually seen poking out of coral.
Ophiothrix purpurea (Fig.3) - Generally active at night. The disk has strongly marked with distinctive pentagonal and in have a cross black line in their arm.

Ophiocoma erinaceus (Fig. 4) - Found on coral. Usually found in great number in tidal area hide on the dead coral.
Macrophiothrix sp. (Fig. 5) - Found beneath under dead corals. Usually often found in large number on shallow water area, sea grass, and hole of dead corals.
Ophiomastix cf. *venosa* (Fig. 6) - Uncommon species. Found beneath under dead coral. This species have unique pattern in a cross line along their arms.

Fig. 1: *Ophiomastix caryophyllata*

Fig. 2 *Ophiarachna delicata*)

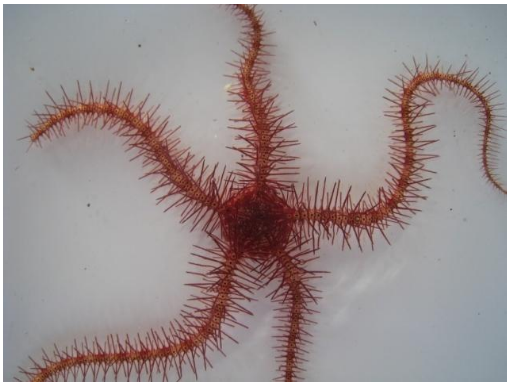

Fig. 3: *Ophiothrix purpurea*

Fig. 4 *Ophiocoma erinaceus*

Fig. 5: *Macrophiothrix* sp.

Fig. 6: *Ophiomastix* cf. *venosa*

Table 2. Association identified brittle star and host

Name of species	Host species
Ophiothela danae	gorgonians
Ophiothrix nereidina	sponges
Ophiothrix. sp	coral (*Fungia*)
Ophiothrix purpurea	gorgonians, sponges, coral (*Acropora*)

Tunicates (Tunicata: Ascidiacea and Thaliacea) and coral-dwelling gastropods

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During the Ternate expedition an inventory was made of the tunicate diversity (Fig. 1) present. This was done by photographing every species and colour morph found. In total about 120 different species and colour morphs were identified. This is a high biodiversity in comparison to other areas in Indonesia. The tunicate diversity is similar to that of the Thousand Islands off Jakarta, Java, but higher than the number found off Bali. In addition to about 3000 photographs as reference records of each species per locality, about 150 specimens and colonies were collected for anatomical studies. This was necessary for identifying these species, and for finding the endo-symbionts and commensals. In addition to the high number of associated shrimp species (Figs 2D,G), which were studied more specifically by Dr Charles Fransen, we have found a large variety of endo-symbionts and commensals that live inside tunicates, i.e. fish (Pisces: Fig. 2C), shrimps (Crustacea: Figs 2D,G) and amphipods (Crustacea), bivalves (Mollusca: Figs. 2D,E) and gastropods (Mollusca: Fig. 2B), and hydroids (Hydrozoa: Fig. 2A). Several of these species may be new to science.

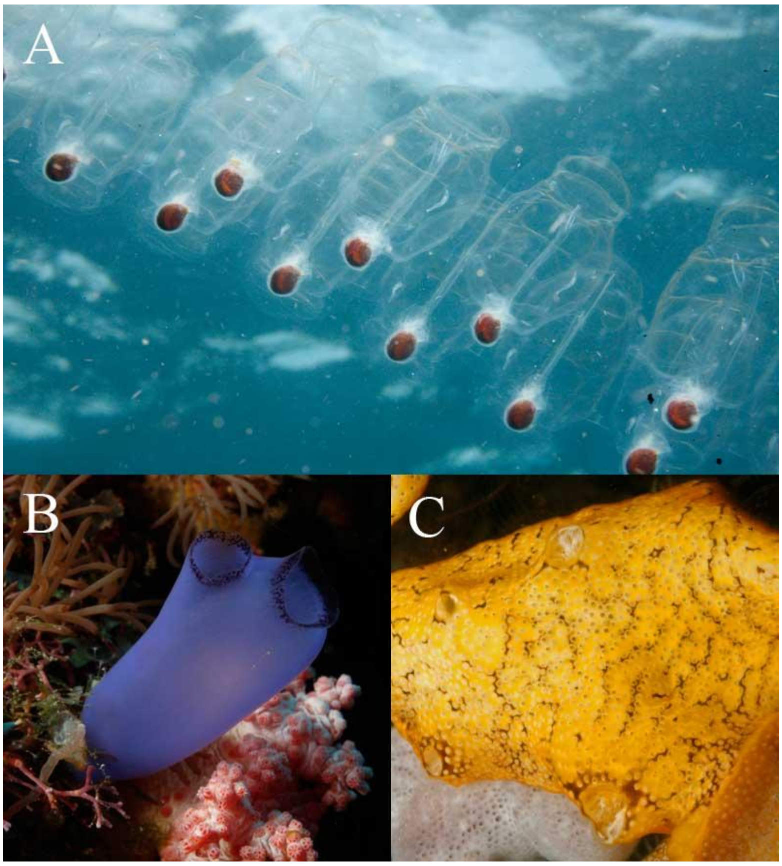

Fig. 1. Tunicates (Tunicata) found off the Ternates islands, Indonesia. A, salps (Thaliacea). B, solitary ascidians (Ascidiacea). C, colonial ascidians (Ascidiacea).

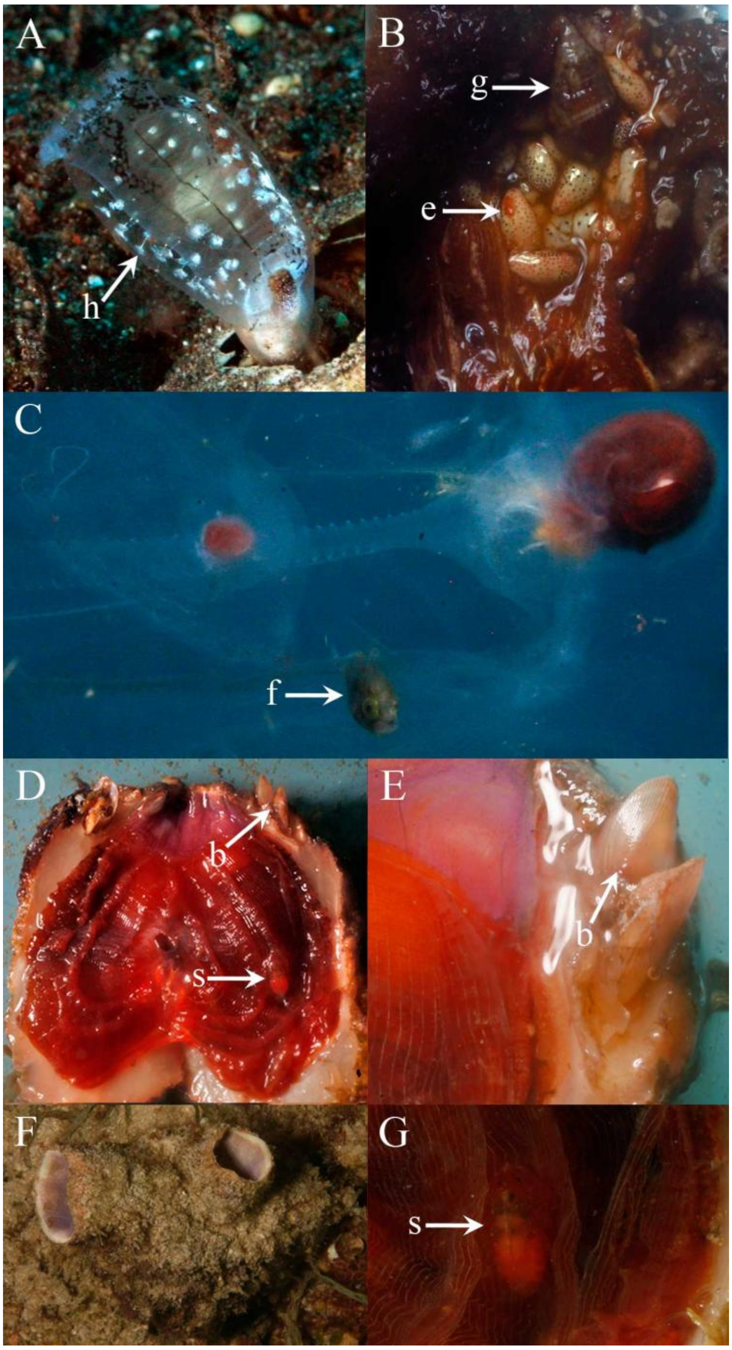

Fig. 2. Endo-symbionths and commensals of tunicates. A, the white dots visible inside this transparent sea-squirt, are the polyps of hydroids (Hydrozoa) that live in between the tunic and the branchial sac of their ascidian host. B, when opening up this ascidian, a gastropod snail revealed itself. It had laid its egg-capsules inside the ascidian, possibly in order to protect them against predators, or to provide them with a readily available food source, i.e. the tissue of the ascidian, after hatching. C, the little fish in the center of the photograph, lives inside a transparent salp, probably hoping that it won't be eaten by predators there. In addition to this fish a copepod was seen to live inside these salps. To our regret it could not be photographed or collected because of the strong currents quickly driving away the salps. D-G, *Polycarpa* sp. specimen. D-E, slose to the siphons several bivalves (cf. *Musculus* sp.) were found buried within the test. D, G, hidden in between the branchial sac folds, a reddish shrimp (*Odontonia* sp.: Pontoniinae, Palaemonidae) was discovered. Abbreviations: b, bivalve; e, egg-capsules; f, fish; g, gastropod; h, hydroid; s, shrimp.

Gastropod parasites (Gastropoda: Coralliophilidae & Epitoniidae) of corals (Scleractinia: Dendrophyllidae & Fungiidae)

In cooperation with Ucu Yanu Arbi of the Research Center of Oceanography of LIPI (Indonesian Institute of Sciences) an inventory was made of the gastropod parasites (Gastropoda: Coralliophilidae & Epitoniidae) of corals (Scleractinia: Dendrophyllidae & Fungiidae) off Ternate islands. This was done by photographing every gastropod parasite that was found together with its host, in detail and in overview. In case of rare associations and species, reference specimens were collected and preserved for the Naturalis collection. In total 20 gastropod parasites of corals were found (Tables 1-2). In comparison to the Thousand Islands area off Jakarta, Java, the biodiversity in Ternate is high. Off Bali and off SW Sulawesi a slightly higher diversity of gastropod parasites was found however, i.e. around 25 species.

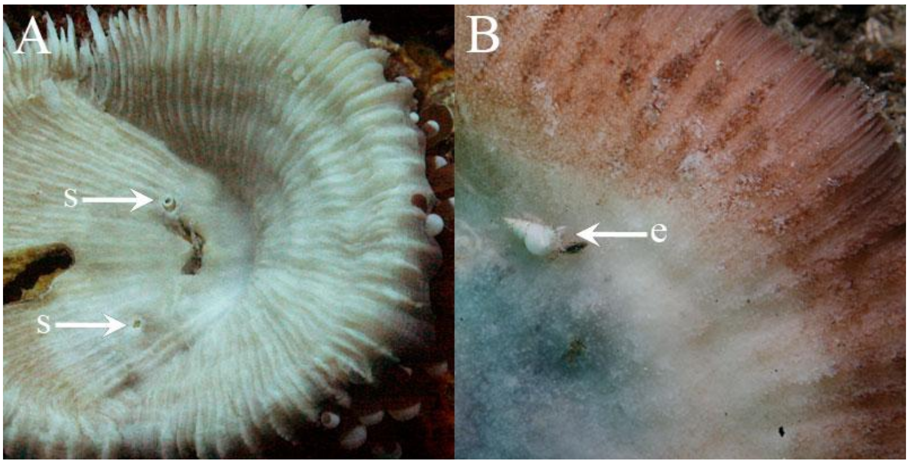

Fig. 5. Endo-parasitic gastropods, i.e. *Leptoconchus inactiniformis* (Coralliophilidae). B, ecto-parasitic gastropod, i.e. *Epifungium ulu* (Epitoniidae). Abbreviations: e, epitoniid shell; s, siphon of Leptoconchus specimen, which lives inside the fungiid coral.

Table 1. Associations of ecto-parasitic gastropods on corals (Epitoniidae). *, unknown association to literature

no	Gastropod	Host coral
1	*Epidendrium aureum*	*Tubastrea* sp.; Dendrophyllidae
2	*Epidendrium sordidum*	*Tubastrea* sp.; Dendrophyllidae
3	*Epifungium adgranulosa*	*Fungia* (*Wellsofungia*) *granulose*: Fungiidae
4	*Epifungium adgravis*	*Fungia* (*Pleuractis*) *gravis*: Fungiidae
5a	*Epifungium lochi*	*Fungia* (*Cycloseris*) *costulata;* Fungiidae
5b	*Epifungium lochi*	*Fungia* (*Cycloseris*) *cyclolites;* Fungiidae*
6	*Epifungium nielsi*	*Fungia* (*Pleuractis*) *paumotensis;* Fungiidae
7	*Epifungium ulu*	*Fungia* (*Verrillofungia*) *repanda*: Fungiidae
8a	*Epifungium pseudotwilae*	*Podabacia crustacean*: Fungiidae
8b	*Epifungium pseudotwilae*	*Zoopilus echinatus*: Fungiidae
9	*Epifungium twilae*	*Ctenactis*
10	*Surrepifungium ingridae*	*Heliofungia actiniformis:* Fungiidae*

Table 2. Endo-parasitic gastropods in corals (Coralliophilidae)

no	Gastropod	Host coral
1	*Leptoconchus inactiniformis*	*Heliofungia actiniformis*; Fungiidae
2	*Leptoconchus inalbechi*	*Ctenactis echinata*; Fungiidae
3	*Leptoconchus infungites*	*Fungia* (*Fungia*) *fungites*: Fungiidae
4	*Leptoconchus ingrandifungi*	*Zoopilus echinatus*; Fungiidae
5	*Leptoconchus ingranulosa*	*Fungia* (*Wellsofungia*) *granulose*: Fungiidae
6	*Leptoconchus inlimax*	*Herpolitha limax*; Fungiidae
7a	*Leptoconchus inpleuractis*	*Fungia* (*Pleuractis*) *gravis*: Fungiidae
7b	*Leptoconchus inpleuractis*	*Fungia* (*Pleuractis*) *paumotensis*: Fungiidae
8	*Leptoconchus inscruposa*	*Fungia* (*Danafungia*) *scruposa*: Fungiidae
9	*Leptoconchus intalpina*	*Polyphyllia talpina*; Fungiidae
10a	*Leptoconchus massini*	*Fungia* (*Verrillofungia*) *concinna*; Fungiidae
10b	*Leptoconchus massini*	*Fungia* (*Verrillofungia*) *repanda*; Fungiidae

Chemical specifications of the marine waters around Ternate, Indonesia

In search of correlations between marine floral and faunal species-communities, and the chemical environment, Hanna's HI 9828 portable multimeter, which monitors 13 different water quality parameters (6 measured, 7 calculated), and the HI 93414 turbidity and chlorine photometer were used. At each research locality at least one surface water sample and one bottom water sample were measured with a special focus on the salinity, oxygen content, pH, dissolved particles, and turbidity of the water. Two more general results of the measurements, concern the turbidity and salinity of the water in relation to the depth at which a water sample was taken. Both these parameters are highly variable in surface water, while bottom water samples show much less variability (Figs. 1-2). On average therefore the turbidity of the water becomes less at greater depths, i.e. the visibility becomes better and there is less sedimentation (Fig. 1). Furthermore the salinity (Fig. 2) at virtually every locality is about half a ppt less in surface water samples than in the bottom water samples. This is an indication that the fresh water influx from the islands is probably greatly influencing the surrounding marine environments. That such differences in salinity are consistently found, also at localities several kilometres off-shore, is at least remarkable and probably unique for Ternate in comparison to many other coral reef ecosystems around Indonesia. Awaiting the final lists of coral, ascidian, mollusc and algal species that were recorded per locality, no further analyses were conducted.

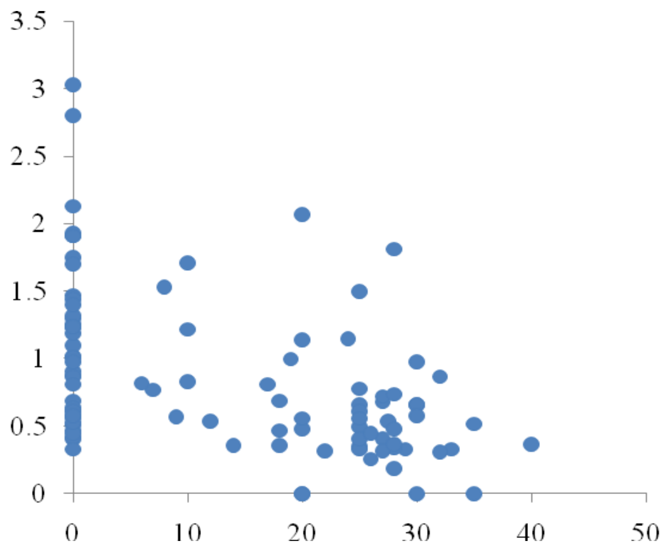

Fig 1. Turbidity in NTU (y-axis) and depth in meter (x-axis).

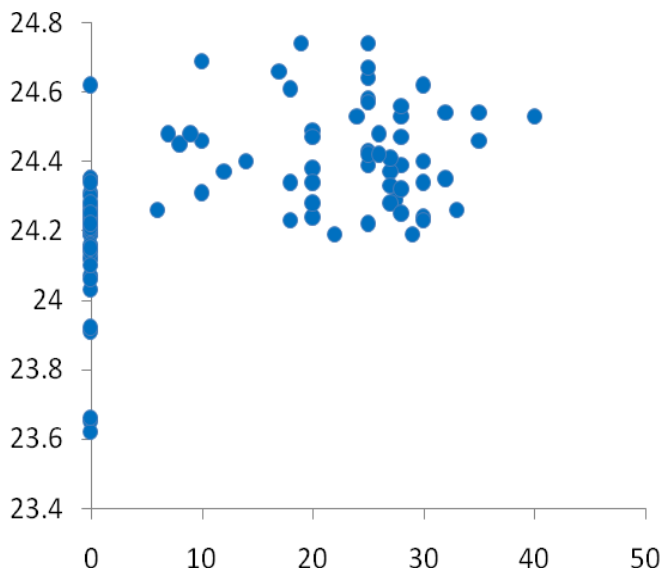

Fig. 2. Salinity in ppt (y-axis) and depth in meter (x-axis).

Octocorallia

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The soft coral fauna of Ternate waters appears quite rich. During the expedition Octocorallia and Antipatharia were collected and photographed. The specimens were preserved in alcohol 75% for further examination in Indonesia and Naturalis, The Netherlands together with Dr Leen van Ofwegen.
Identification of several genera is only possible after microscopic examination of the skeleton sclerites. Therefore, undoubtedly, the number of observed genera will increase after examination. No *Chromonephthea* specimen found, this recently described genus (Ofwegen, 2005) is rather rare in Indonesia. Also the genus *Ctenocella* was not found. This easily recognizable genus with harp-shaped colonies is normally present in Indonesian waters. Furthermore found only one specimen of *Solenocoulon*. The family Xeniidae, found mostly in every Ternate waters. During this expedition, two students of Khairun University cooperated with me by turns.

Table 1. Indo-Pacific genera of reef-dwelling Octocorallia recorded in Ternate.

Order Alcyonacea (soft corals & sea fans)

The Stolonifera Group
Family Clavulariidae
Carijoa

Family Tubiporidae
Tubipora

The Alcyoniina Group
Family Alcyoniidae
Lobophytum
Paraminabea
Eleutherobia
Sarcophyton
Sinularia

Family Nephtheidae
Dendronephthya
Nephthea
Scleronephthya
Stereonephthya

Family Xeniidae
Xenia
Heteroxenia

Family Nidaliidae
Nidalia
Siphonogorgia
Chironephthya

Family Paralcyoniidae
Studeriotes

The Scleraxonia Group
Family Briareidae
Briareum

Family Anthothelidae
Solenocaulon

Family Suberogorgia
Annella
Subergorgia

Family Melithaeidae
Melithaea
Acabaria

Suborder Holaxonia
Family Acanthogoriidae
Acanthogorgia
Muricella

Family Plexauridae
Euplexaura
Menella

Family Gorgoniidae
Rumphella
Pinnigorgia

Suborder Calcaxonia
Family Ellisellidae
Ellisella
Junceella
Dichotella

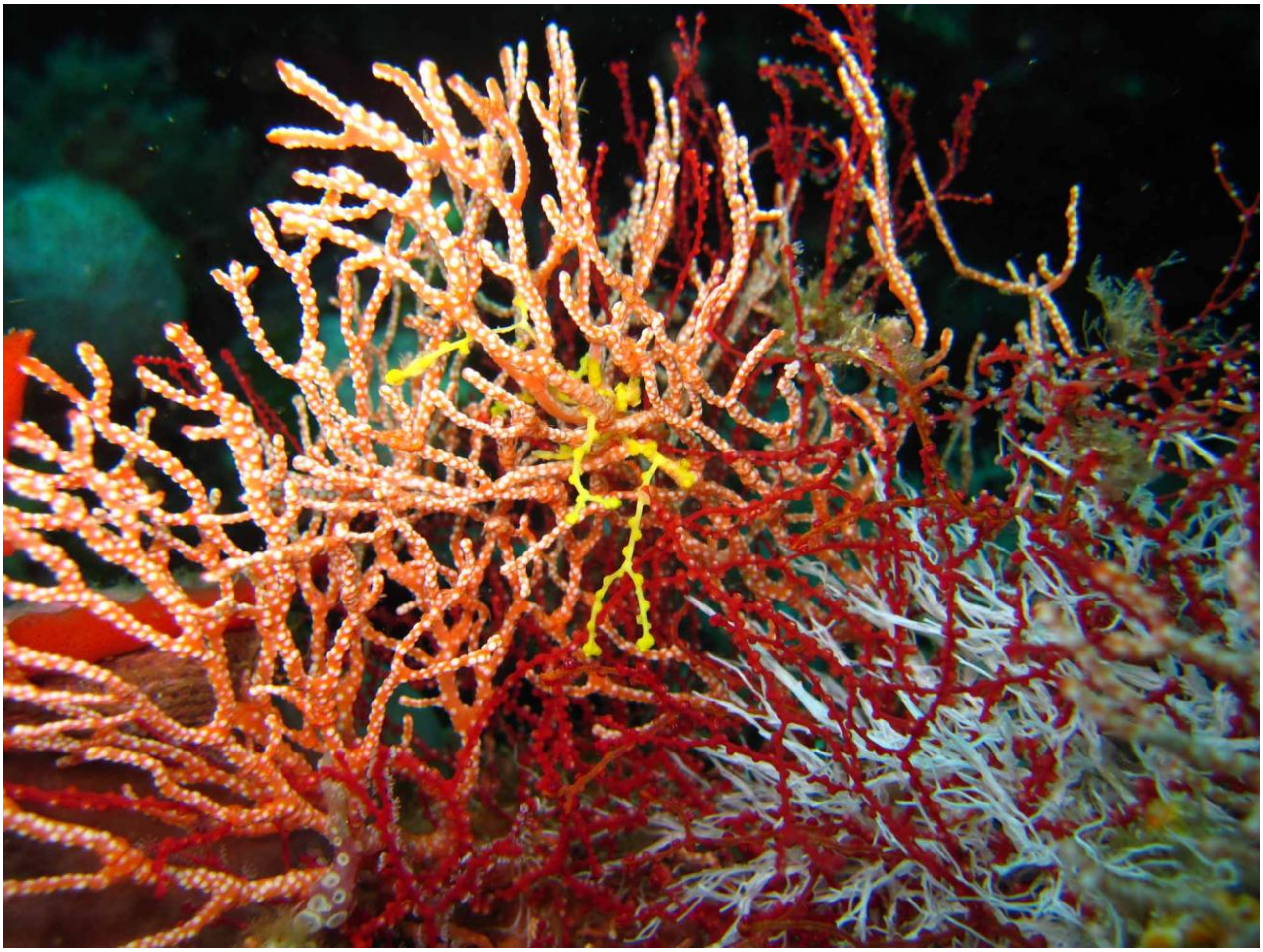
Family Chrysogorgiidae
Stephanogorgia

Family Isididae
Isis

Order Helioporacea
Heliopora coerulea

Order Pennatulacea
Family Pteroeidae

Family Virgularidae



Three colonies of Melithaeidae showing colour variation (TER 34).

Gall crabs associated with stony corals

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During the fieldwork carried out under E-Win (Ekspedisi Widya Nusantara) in Ternate, Halmahera, stony corals and the gall crabs associated with them were sampled. The goal was to obtain as many different species of gall crabs from the Ternate region.

Gall crabs where collected from a total of 26 coral genera, belonging to eight coral families, including at least 51 different species of coral (Table 1). When comparing the encountered coral genera with Kropp (1990), who describes host associations between corals and gall crabs, it can be concluded that most likely about 15 different genera of gall crabs have been collected. These include: *Cryptochirus, Dacryomaia, Fizesereneia, Fungicola, Hapalocarcinus, Hiroia, Lithoscaptus, Neotroglocarcinus, Opecarcinus, Pelycomaia, Pseudocryptochirus, Pseudohapalocarcinus, Sphenomaia, Utinomiella and Xynomaia.* A total of 20 gall crab genera have been described, of which six are either restricted to deep sea corals or the Atlantic Ocean. Hence it can be concluded that during this expedition all the genera that are known from the Indo-Pacific have been collected. Further research needs to prove how many of the known Indo-Pacific species have been collected.

For some species, identification to species level awaits microscopic study. The host associations presented in Table 1 largely results for knows associations in literature, and are noted together with the coral species from which gall crabs were collected.

Table 1: Corals species from which gall crabs were collected in Ternate 2009. Gall crabs species mentioned herein are taken from literature (Kropp 1990), and only partly on the collected material.

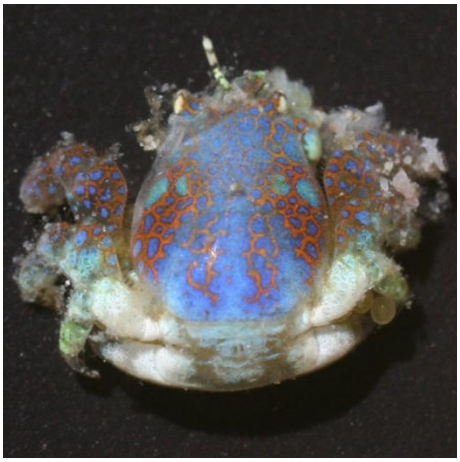
Family/Genus	Species	Associated gall crab species
Agariciidae		
Gardinoseris	*planulata*	*Opecarcinus* sp.
Leptoseris	*explanata*	*Opecarcinus* sp.
	hawaiiensis	*Opecarcinus* sp.
	mycetoseroides	*Opecarcinus* sp.
	solida	*Opecarcinus* sp.
Pavona	*cactus*	*Opecarcinus* sp. / *Pseudohapalocarcinus ransoni*
	clavus	*Opecarcinus* sp. / *Pseudohapalocarcinus ransoni*
	decussata	*Opecarcinus* sp. / *Pseudohapalocarcinus ransoni*
	explanulata	*Opecarcinus* sp. / *Pseudohapalocarcinus ransoni*
	maldivensis	*Opecarcinus* sp. / *Pseudohapalocarcinus ransoni*
	sp.	*Opecarcinus* sp. / *Pseudohapalocarcinus ransoni*
	varians	*Opecarcinus* sp. / *Pseudohapalocarcinus ransoni*
	venosa	*Opecarcinus* sp. / *Pseudohapalocarcinus ransoni*
Dendrophyllidae		
Turbinaria	*remiformis*	*Pseudocryptochirus viridis* / *Neotroglocarcinus* sp.
	sp.	*Pseudocryptochirus viridis* / *Neotroglocarcinus* sp.
Faviidae		
Cyphastrea	*micropthalma*	*Cryptochirus* sp. / *Dacryomaia* sp. / *Hapalocarcinus marsupialis* / *Lithoscaptus* sp. / *Pelycomaia* sp.

Echinopora	*lamellosa*	*Lithoscaptus* sp.
	sp.	*Lithoscaptus* sp.
Favia	*favus*	*Cryptochirus* sp. / *Lithoscaptus* sp. / *Xynomaia* sp.
	pallida	*Cryptochirus* sp. / *Lithoscaptus* sp. / *Xynomaia* sp.
Favites	*chinensis*	*Cryptochirus* sp. / *Lithoscaptus* sp. / *Sphenomaia pyriformis*
	halicora	*Cryptochirus* sp. / *Lithoscaptus* sp. / *Sphenomaia pyriformis*
	sp.	*Cryptochirus* sp. / *Lithoscaptus* sp. / *Sphenomaia pyriformis*
Goniastrea	sp.	*Cryptochirus* sp. / *Dacryomaia* sp. / *Lithoscaptus* sp. / *Xynomaia* sp.
Leptastrea	sp.	*Dacryomaia* sp. / *Lithoscaptus* sp. / *Pelycomaia* sp.
Leptoria	*phrygia*	*Cryptochirus* sp.
Oulophyllia	sp.	*Xynomaia* sp.
Platygyra	*lamellina*	*Cryptochirus* sp. / *Lithoscaptus* sp. / *Sphenomaia pyriformis / Xynomaia* sp.
	sp.	*Cryptochirus* sp. / *Lithoscaptus* sp. / *Sphenomaia pyriformis / Xynomaia* sp.
Fungiidae		
Fungia	*costulata*	*Fungicola fagei*
	fungites	*Fungicola utinomi*
	granulosa	*Fungicola fagei*
	moluccensis	*Fungicola fagei*
	paumotensis	*Fungicola fagei*
	repanda	*Fungicola utinomi*
	spinifer	unknown
Podabacia	*crustacea*	*Fungicola fagei*
	motuporensis	*Fungicola fagei*
Sandalolitha	*robusta*	*Fungicola fagei*
Merulinidae		
Hydnophora	*exesa*	*Hiroia krempfi* / *Lithoscaptus* sp. / *Sphenomaia pyriformis*
	rigida	*Hiroia krempfi* / *Lithoscaptus* sp. / *Sphenomaia pyriformis*
Merulina	*ampliata*	*Hiroia krempfi* / *Lithoscaptus* sp. / *Xynomaia* sp.
	sp.	*Hiroia krempfi* / *Lithoscaptus* sp. / *Xynomaia* sp.
Mussidae		
Symphyllia	*radians*	*Fizesereneia* sp.
	recta	*Fizesereneia* sp.
	sp.	*Fizesereneia* sp.
Pectiniidae		
Echinophyllia	*aspera*	unknown
	costata	unknown
	sp.	unknown
Mycedium	*mancaoi*	unknown
	robokaki	unknown
	sp.	unknown
Pectinia	*maxima*	*Xynomaia* sp.
	paeonia	*Xynomaia* sp.
	sp.	*Xynomaia* sp.
Pocilloporidae		
Pocillopora	*eydouxi*	*Utinomiella dimorpha / Hapalocarcinus marsupialis*
	sp.	*Utinomiella dimorpha / Hapalocarcinus marsupialis*
	verrucosa	*Utinomiella dimorpha / Hapalocarcinus marsupialis*
Seriatopora	*caliendrum*	*Hapalocarcinus marsupialis*
	hystrix	*Hapalocarcinus marsupialis*

Stylophora	*pistillata*	*Utinomiella dimorpha / Hapalocarcinus marsupialis*
Siderastreidae		
Psammocora	*digitata*	*Dacryomaia* sp.
	nierstraszi	*Dacryomaia* sp.
	sp.	*Dacryomaia* sp.
	stellata	*Dacryomaia* sp.
	vaughani	*Dacryomaia* sp.

Reference

Kropp, R.K., 1990. Revision of the genera of gall crabs (Crustacea: Cryptochiridae) occurring in the Pacific Ocean. Pacific Science 44(4): 417-448.



Pseudocryptochirus viridis

Fungicola fagei

Lithoscaptus sp.

Pseudohapalocarcinus ransoni

Mushroom corals (Fungiidae)

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Mushroom coral (Family Fungiidae) is one of the most conspicuous groups in the tropical Indo-Pacific reefs. These corals usually aggregate in large groups (Pichon, 1974; Littler *et al.*, 1997). In the tropical Indo-Pacific region, 41 species of fungiid corals have been found (Hoeksema, 1989). Corals of the family Fungiidae are all solitary species most commonly found on the surface substrates of reefs and lagoons. Unlike most other hard corals which are colonies of small polyps, most mushroom corals are a single giant polyp. Some species have a circular disk-like skeleton; others are more oval-shaped. Most have short tentacles, except for the *Heliofungia actiniformis* that has such long tentacles that they are often mistaken for sea anemones.

Mushroom corals have variable colours, and often the mouth is the most strikingly coloured. In some species, the tissue around the mouth is banded. Their tentacles are often extended in daytime. According to Veron, the violet or bright pink patches seen on some mushroom hard corals are due to damage and injury. A young mushroom coral starts life attached to a surface, and looks like a tiny stalked mushroom. In many species, as the coral matures eventually breaks away from the stalk and lives life as an adult unattached to the bottom. In some, the older coral remains attached and the stalk is obscured by the growing disk.

In the Ternate and Halmahera waters, little is known about the species diversity of fungiids and their distribution. 31 species were recorded by field survey at North Moluccas waters (see the table 1). During this research the species diversity of fungiid corals was investigated at 41 station surveys including Ternate Island, Tidore Island, Maitara Island, Hiri islands, western part of Halmahera, and Gura Ici islands. The fungiid corals were recorded per locality. Fungiid corals samples were collected from various depths, from 2 meter to a maximum depth 36 meter. The samples were cleaned by soaking them in fresh water for 3 days, after which the corals were dried in the sun. Each specimen was labeled (locality number, date, binomial name of the specimen, depth, and collector).

Table 1. List of fungiid species found in the Ternate and Halmahera waters

1	*Fungia sinensis*	12	*Fungia scruposa*	23	*Herpolitha limax*
2	*Fungia cyclolites*	13	*Fungia fungites*	24	*Polyphyllia talpina*
3	*Fungia somervillei*	14	*Fungia granulosa*	25	*Sandalolitha dentata*
4	*Fungia fragilis*	15	*Fungia scutaria*	26	*Sandalolitha robusta*
5	*Fungia costulata*	16	*Fungia moluccensis*	27	*Zoopilus echinatus*
6	*Fungia tenuis*	17	*Fungia gravis*	28	*Halomitra pileus*
7	*Fungia spinifer*	18	*Fungia paumotensis*	29	*Halomitra clavator*
8	*Fungia concinna*	19	*Heliofungia actiniformis*	30	*Podabacia crustacea*
9	*Fungia repanda*	20	*Ctenactis albitentaculata*	31	*Podabacia motuporensis*
10	*Fungia fralinae*	21	*Ctenactis echinata*		
11	*Fungia horrida*	22	*Ctenactis crassa*		

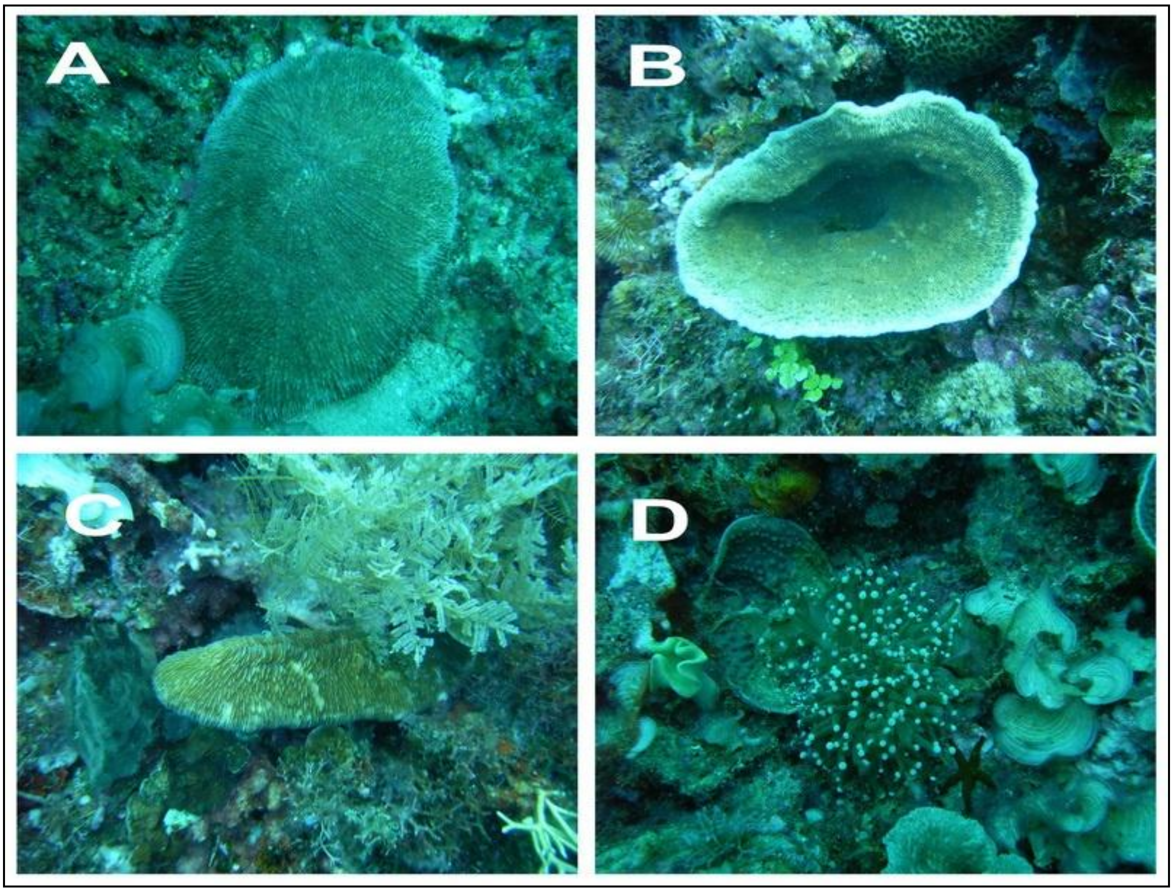
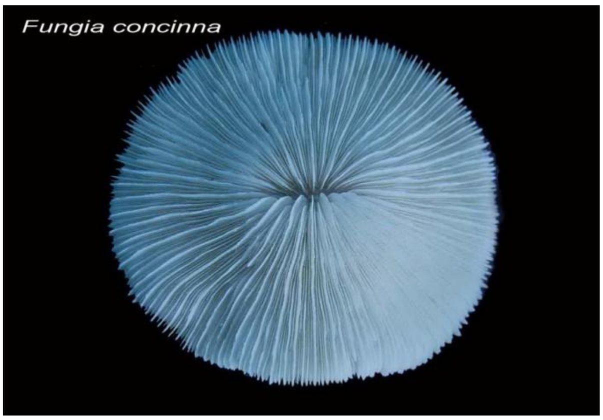
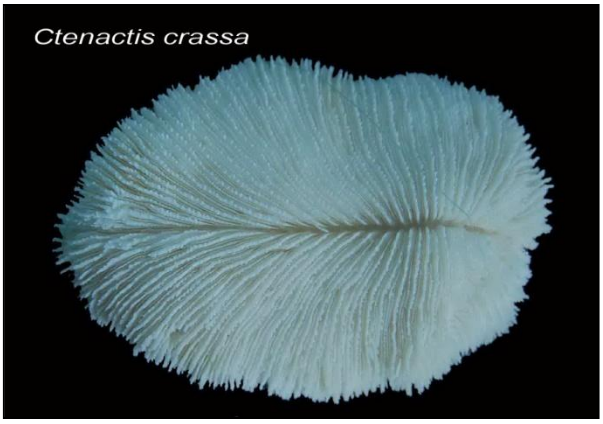


Figure 1. Four species of fungiid corals found at North Moluccas (A) *Zoopilus echinatus*, (B) *Podabacia crustacea* (C) *Herpolitha limax*, (D) *Heliofungia actiniformis*

Fungiidae species



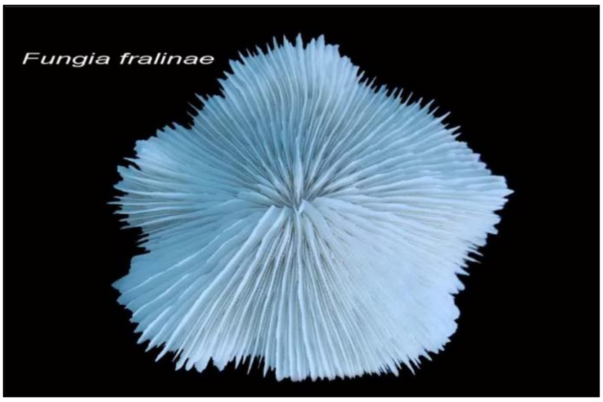

Fungia costulata

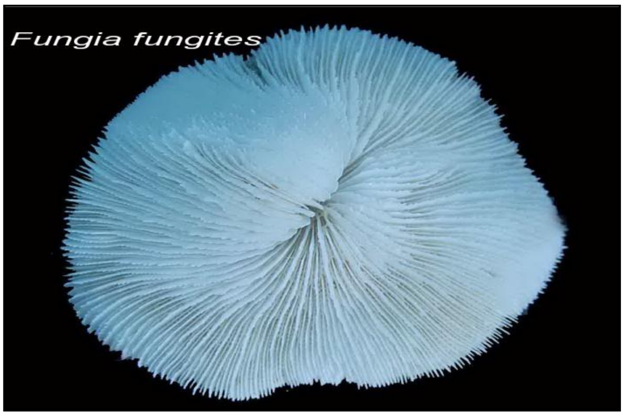

Ctenactis crassa


Sandalolitha dentata


Ctenactis echinata


Fungia fragilis


Fungia fralinae


Fungia fungites


Fungia gravis


Fungia granulosa

Fungia moluccensis

Herpolitha limax

Fungia paumotensis

Halomitra pileus

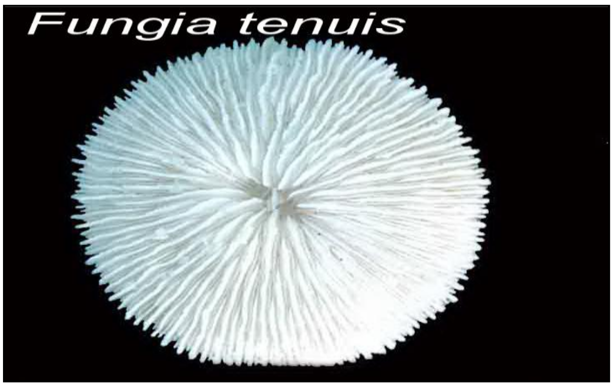
Fungia repanda

Podabacia crustacea

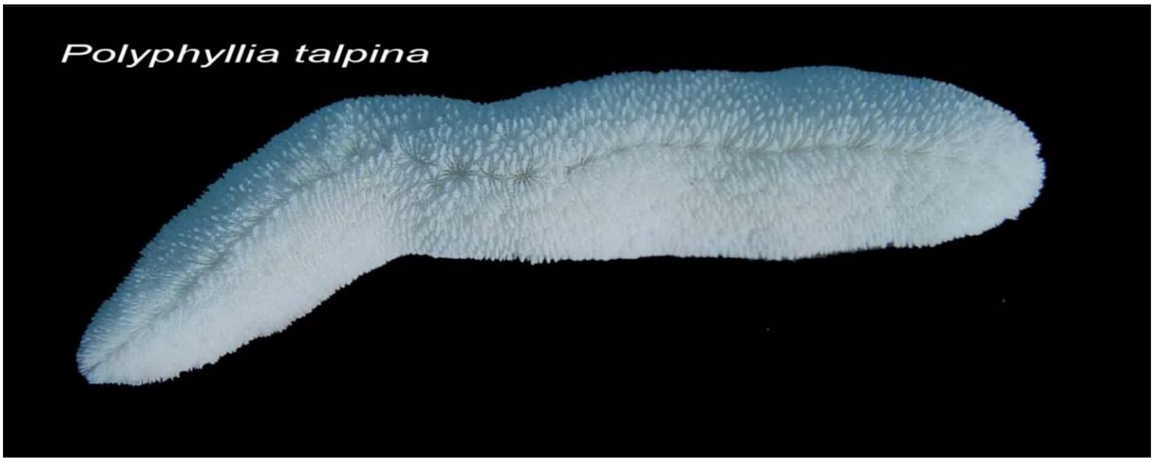
Fungia sinensis


Fungia scutaria


Sandalolitha robusta


Fungia tenuis


Fungia spinifer


Polyphyllia talpina

Macro algae

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Macro-algae were collected at stations TER 1-15, 18-29, and 31-41, as well as in the ferry port of Ternate and at fort Kalamata. In total 501 seaweed collections were made. Vouchers were preserved in 5% formalin in seawater or 96% ethanol. Subsamples were preserved in 96% ethanol or silica for eventual DNA extractions. Each collected sample was also photographed in its natural habitat and the depth at which it was collected was written down as well as a preliminary identification. At each station it was attempted to photograph all different species of macro algae (except small turf algae). These photographs will be used to make a complete species list per location. This species list will then be analyzed together with a series of environmental variables, together with Arjan Gittenberger.

The collected seaweeds represent the following genera:

Brown algae: *Sargassum, Turbinaria, Dictyopta, Dictyopteris, Padina*

Red algae: *Ceramium, Scinaia, Predaea, Gibsmithia, Titanophora, Vanvoorstia, Galaxaura, Hypnea, Dichotomaria, Halymenia, Renouxia*

Green algae: *Halimeda, Caulerpa, Ulva, Cladophora, Chaetomorpha, Avrainvillaea, Rhipidosiphon, Boodlea, Valonia, Ventricaria, Codium*

 

Gastropods (reef and parasitic)

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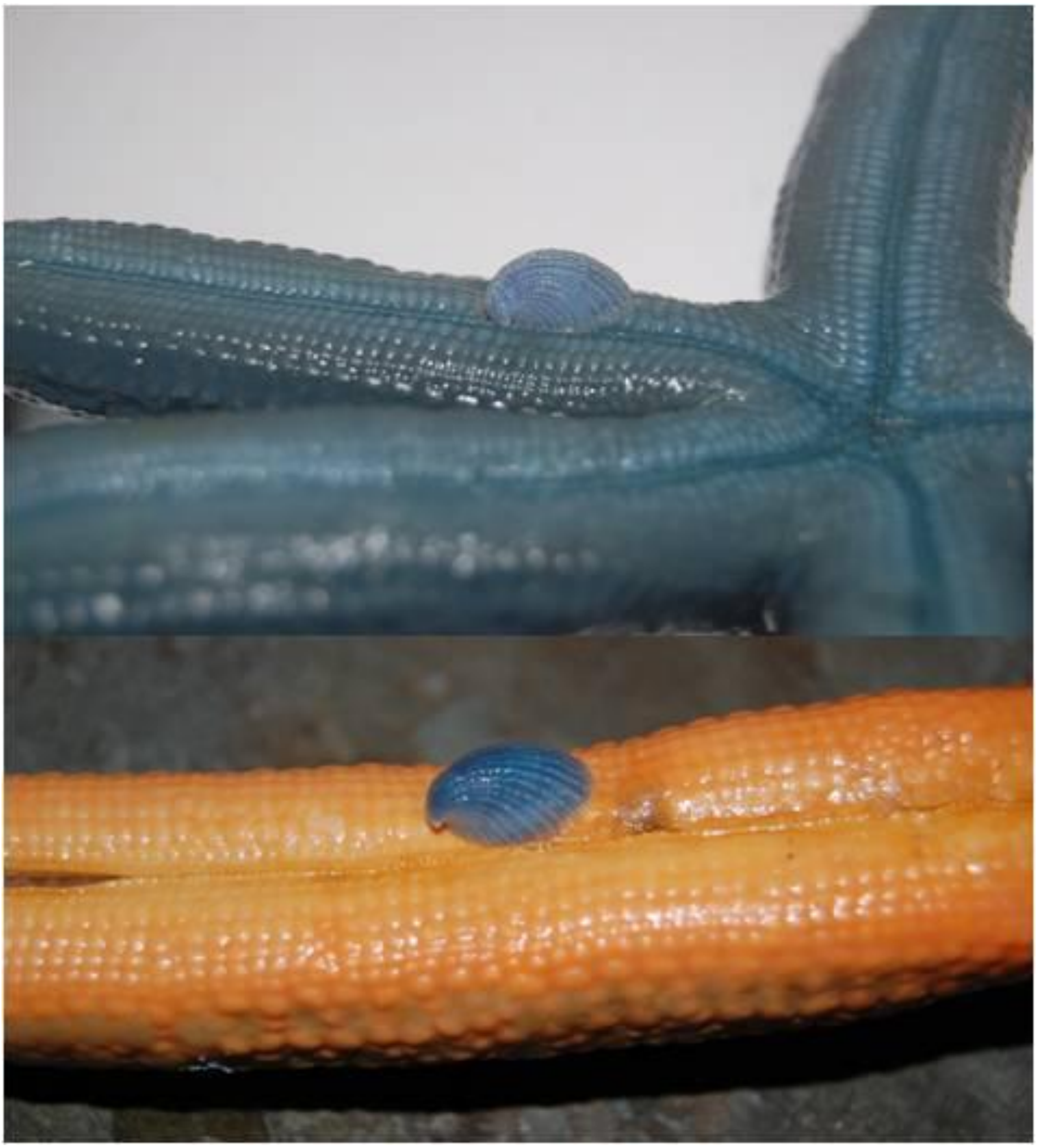
Inventories of gastropods associated with coral reefs where made to study gastropod diversity. Furthermore the snail diversity of symbiotic species (Coralliphyllidae, Epitoniidae, Eulimidae and Muricidae) was studied. These consisted of commensal and parasitic relationships between host and snail. For each species the presence per locality was reported. Photographs were made in lab, of both the parasitic snail and their host. No underwater photographs were made. Voucher specimens were deposited in the collection room of the LIPI Bitung station. All specimens are preserved on 75% ethanol for future research and identification.

Results

The research effort was divided between the reef associated gastropods and the parasitic gastropods. The total number of reef associated gastropods sums up to 321 species in 43 families of gastropods. More than 30% of the gastropod samples have not yet been identified. The number of species per locality is very variable, depending on the type of ecosystem and the available reef conditions. *Cypraea carneola* (Cypraeidae) and *Conus miles* (Conidae) are dominant species and relatively wide distributed with records at 30 stations. Especially TER.06 (57 species), TER.04 (56 species) and TER.38 (51 species) are rich localities with high numbers of gastropods.

Most of the encountered gastropods are common species in Indo-Pacific coral reefs, whilst others are almost extinct, such as *Charonia tritonis*, *Cassis cornuta* and *Turbo marmoratus*. These species, together with 13 other species represent species that now have the status protected molluscs under Indonesian legislation. Identification of most gastropods was done with Abbott & Dance, 1990 and Wilson 1993, 1994. Identification of several genera, especially the parasitic snails is only possible after microscopic examination of special characters. Some parasitic snails can be identified when the host species is known.

For Indonesian waters, parasitic gastropods, such as *Leptoconchus* spp. and epitoniid snails only several records are available. No records are available for the Ternate regions and most parasitic snails are recorded for this region for the first time during this expedition. Until now, most species are only recorded from the Spermonde Archipelago (South Sulawesi); Wakatobi National Park (North-East Sulawesi); Bunaken National Park and Lembeh Strait (North Sulawesi); Tomini Bay (Central Sulawesi); Derawan (East Borneo); Ambon (Moluccas); Komodo (East Nusa Tenggara); and Bali (A. Gittenberger *et al.*, 2000; A. Gittenberger, 2003; A. Gittenberger & E. Gittenberger, 2005; Kokshoorn & Goud, 2007; Kokshoorn *et al.*, 2007; Wallace *et al.*, 2000).



Parasitic snail *Thyca cristallina* (Gastropoda: Eulimidae), associated with sea star *Linckia laevigata* (Asteroidea: Ophidiasteridae)

Parasite snail *Leptoconchus* spec. (Gastropoda: Coralliophilidae) invested mushroom coral (Scleractinia: Fungidae)

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Bivalvia (Cardiidae)

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Introduction

Recently, it has been accepted that marine environments are still incompletely explored. Therefore, there is a high chance for describing new species. For marine molluscs, approximately 75% of the newly described species are from the tropical areas, with the Indo-Pacific alone accounting for 43% of a total yearly increment of 280 species (Bouchet, 1997). Abbot and Dance (1982) estimated that there may be 10.000 living species of bivalvia in the world's seas.

Most of bivalvia living in marine ecosystem can be found in many habitat types, from intertidal areas to great depths, soft substrates to hard substrates. They live in mangrove, seagrass bed, coral reef, or seabed communities. Majorities are infauna living in the sandy or muddy bottom. Others are epifaunal or endolitihic which have adapted with hard bottom, stone or coral boulder.

This was aimed to explore the marine life in coral reef ecosystem of Ternate-Halmahera waters. Some expert in marine zoology, focusing on parasite crabs and snails on coral, nudibranch on sponges, mollusk, echinoderms and seaweed, participated in this expedition. The author, one of the selected trainees in the previous workshop conducted in Cibinong Science Center, was included in this expedition.

Time schedule and sampling sites

Sampling activities were done during the day. Started from 8.00 am in the morning, the expedition team prepared everything that was needed for the sampling and went to the sampling sites from Ternate Marine Research Station. There were 32 smpaling sites located in coral reefs of Ternate – Halmahera waters (Appendix 1). In the afternoon, roughly at 17.00 pm, the team went back to the research station and continued their activities to samples management in a laboratory of the research station until evening.

Collecting samples

Bivalvia samples, especially Cardiidae, were collected by SCUBA at maximum depth of 30m. For tridacnine samples, living individuals found were directly identified in the field without removing them from their substrates. Epifaunal and endolithic species were collected from reef substrate, while dead shells and infaunal bivalves were taken by fanning the sand. The shells were cleaned, brushed from muck attached on the shell surface. Then the samples were labeled with the number of station, date, family of the specimens, depth, and also the collector. The empty shells were kept as dried specimens. The living shells were preserved in alcohol 70 %.

Identification

Cardiidae, commonly known as cockles has determining characters, such as two cardinal teeth and anterior-posterior lateral teeth typically present in each valve. The cardinal teeth form a cruciform in arrangement when valves interlock. Pallial line without a sinus is present on the inner surface of each valve. Internal margins bear crenulations which correspond with the outer sculpture. The clams can be found commonly littoral and shallow subtidal waters.

The specimens were observed to identify the species. All have been personally examined, re-identified and determined using Poorten (2007), Lamprell dan Whitehead (1992), Abott dan Dance (1998), and Poutiers (1998). An overview of the examined specimens was given with a diagnostic characters, remarks, habitat and distribution. All determined species were examined to identify the distinctive combinations of qualitative morphological characters among species. Approximately, there were at least 22 species, belonging 13 families identified from this expedition, i.e. Malleidae, Tellinidae, Arcidae, Pectinidae, Cardiidae, Veneridae, Limidae, Lucinidae, Glycymerididae, Chamidae, Spondylidae, Pteriidae, Mytilidae and Ostreidae. Further studies are needed to explore the taxonomic aspect of bivalvia collected from this expedition.

For Cardiidae, there were 56 specimens, with a range of shell length at 10 mm – 70 mm. Identification results four subfamilies, Tridacninae (4 species: *Tridacna squamosa, T. maxima, T. crocea,* dan *Hippopus hippopus*), Fragiinae (3 species: *Fragum fragum, F. unedo, and Corculum cardissa*), Laevicardiinae (unidentified species) dan Cardiinae (unidentified species. Examination of the last two subfamilies (Laevicardiinae dan Cardiinae) will need more time. This is caused by less literature supporting the study.

In addition, Cardiidae is a taxon comprising taxonomic problems. There has been no final classification yet on Cardiidae because of the synonyms and confusing characters encouraging this taxon to be revised (Vidal, 2000). There are commonly shared characters in cardiid morphology, suppose characters on rib numbers, rib ornamentation and cardinal teeth resulting misidentification (Poutiers, 1998). This is a challenging taxon for young taxonomists to improve and revise the systematics of Cardiidae.

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Marine Stygofauna

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Coastal groundwater survey of Maluku Utara, Indonesia

The marine stygofaunal research carried out in October and November 2009 in the North Moluccas concentrated on collecting subterranean species in diverse habitats on different places on the islands. We sampled in coastal areas, wells, small brackish lakes, beaches, and mangrove fringes of Ternate, Hiri, Tidore, Maitara, Guraici Islands, and the west and east side of North Halmahera. Sampling gear consisted of a biophreatical Bou-Rouch groundwater pump (B-Rh. pump) and steel pipes, Cvetkovnet, dipnet, and shovel. In beaches the pump is placed near to the waterline. When the marine groundwater flow is not steady and pipe holes or pump cilinder are clogged with sand and silt the pump is placed directly in the sea. Low tide is the preferable time to sample but since the tidal difference was low - between 1 and 2 meters - and locations logistically restricted, sampling was performed at all tides. In some cases, ground water accumulating in holes dug with a hand shovel was filtered (the so-called Karaman-Chappuis method, K-Ch). In wells we used a self-closing vertical net, a so-called Cvetkov (Cv) net, mesh 0.30 mm diameter, and in scooping up sand from shallow marine reef flats hand nets of various mesh sizes were employed. The 2% formalin-preserved samples (short time for hardening tissue) were later sorted in the LIPI Ternate fieldstation laboratory under a dissecting microscope and transferred to 70% ethanol. Some samples with abundant specimens were directly stored in 96% alcohol. In the lab, some physico-chemical parameters were measured, viz. electric conductivity (eC in μS/cm or mS/cm; 1 mS = 1000 μS), and total salinity (S in parts pro thousand, p.p.t.). The results of these measurements will be confirmed when all water samples taken from non-marine sites are analysed upon arrival of the material in The Netherlands.

List of sampling stations October-November 2009

09-01. South beach Ternate (Sasa), in front of LIPI marine fieldstation, on a small prominence pointing seaward of a narrow beach in coarse sediment of volcanic sand mixed with coral rubble; B-Rh. pump, probe at 50 cm below sediment surface; 50 liter; 24 Oct. 2009; coord. 0 45' 15.82" N, 127 19' 36.67" E; organisms: harpacticoida, ostracoda, polychaeta, oligochaeta.

09-02. South beach Ternate, beach under steep cliff with freshwater runoff coming down from cemented steps, partly sewage water; beach narrow with large boulders and volcanic sand, brownish black, mixed with fine sediment; B-Rh pump, probe at 50 cm, 80 liters filtered; 25 Oct. 2009; coord. 0 45' 23.26 ", 127 20'45.44" E; organisms: copepoda.

09-03. South beach Ternate, 300 m. east of cliff; volcanic sand, black and mixed with finely eroded coral rubble; B-Rh pump, probe at 20 cm, 20 liters filtered; 25 Oct. 2009; coord. 0 45' 37.14" N, 127 21' 26.03" E; organisms: harpacticoida, cyclopoida.

09-04. North beach Ternate, Sulamadaha, western end of the beach, very fine black volcanic sand; B-Rh pump 50 cm.; 26 Oct. 2009; coord. 0 51' 44.61" N, 127 20' 08.30" E; no macrofauna.

09-05. North beach Ternate, Sulamadaha, eastern end of the beach, very fine black volcanic sand; K-Ch method, 30 cm depth, surface skimmed with dip net; 26 Oct. 2009; coord. 0 51' 44.61" N, 127 20' 08.30" E; copepoda.

09-06. North beach Ternate, Sulamadaha, end of narrow cement road leading over rocks and out of beach area towards secluded bay, small white beach, coarse coral rubble between boulders; B-Rh pump 50 cm, 100 liters filtered; 26 Oct. 2009; coord. 0 51' 49.68" N, 127 20' 01.35" E; benthic amphipods, sample lost.

09-07. North beach Ternate, Sulamadaha, end of narrow cement road leading over rocks and out of beach area towards secluded bay, small lake just behind rubble bar; B-Rh pump 40 cm, 50 liters filtered (brown, smelly water); 26 Oct. 2009; coord. 0 51' 49.68" N, 127 20' 01.35" E; decapoda (surface).

09-08. North beach Ternate, Sulamadaha, end of narrow cement road leading over rocks and out of beach area towards secluded bay, small lake just behind rubble bar; B-Rh pump 90 cm, 40 liters filtered (black water); 26 Oct. 2009; coord. 0 51' 49.68" N, 127 20' 01.35" E; no macrofauna.

09-09. East beach Ternate, governor's office, left of the jetty in coarse sand, upper layer consisting of loose pebbles and pumice but after 20 cm fine sand and silt; K-Ch method; 27 Oct. 2009; coord. 0 46' 38" N, 127 23' 07" E; copepoda, tanaidacea, acari, decapoda.

09-10. East beach Ternate, governor's office, left of the jetty in coarse sand, upper layer consisting of loose pebbles and pumice but after 20 cm fine sand and silt; B-Rh pump 95 cm; 27 Oct. 2009; coord. 0 46' 38" N, 127 23' 07" E; copepoda, polychaeta.

09-11. North beach Tidore, slowly sloping beach in sheltered bay, coarse sand, whitish-brown, mainly consisting of finely eroded coral debris; B-Rh pump 80 cm - 50 cm, water light brown, no smell; 28 Oct. 2009; coord. 0 45' 02" N, 127 23' 36" E; no macrofauna.

09-12. North beach Tidore, slowly sloping beach in sheltered bay, coarse sand, whitish-brown, mainly consisting of finely eroded coral debris, 200 m. west of station 09-11; B-Rh pump 80 cm - 50 cm; 28 Oct. 2009; coord. 0 45' 05" N, 127 23' 46" E; amphipoda.

09-13. North beach Tidore, slowly sloping beach in sheltered bay, coarse sand, whitish-brown, mainly consisting of finely eroded coral debris, 5 m. west of station 09-12; K-Ch method; 28 Oct. 2009; coord. 0 45' 05" N, 127 23' 46" E; amphipoda.

09-14. North beach Tidore, slowly sloping beach in sheltered bay, coarse sand, whitish-brown, mainly consisting of finely eroded coral debris, collected from beach; 28 Oct. 2009; coord. 0 45' 05" N, 127 23' 46" E; coenobitidae.

09-15. North beach Tidore, bay of Cobo village, beach with brown sand, sampling just in the mouth of a small freshwater river flowing out on the beach, 1-2 m. wide, very shallow, slow current; K-Ch method; 28 Oct. 2009; coord. 0 44’ 49” N, 127 24’ 31” E; amphipoda.

09-16. North beach Tidore, bay of Cobo village, small freshwater river flowing out on the beach, 1-2 m. wide, very shallow, slow current, sampling at a spot under bridge; dipnet ; 28 Oct. 2009; coord. 0 44’ 49” N, 127 24’ 31” E; ostracoda, cyclopoida, oligochaeta.

09-17. North beach Tidore, bay of Cobo village, river in village, standing water, sampling at the mouth on the beach, no outflow of freshwater visible; B-Rh pump 80 cm, 50 l. filtered, coarse sand, black water with sulphurous smell; 28 Oct. 2009; coord. 0 45’ 04” N, 127 24’ 19” E; no macrofauna.

09-18. North beach Tidore, bay of Cobo village, river in village, standing water, sampling on the beach 50 m. north of dry rivermouth; K-Ch method, coarse sand, black water with sulphurous smell; 28 Oct. 2009; coord. 0 45’ 04” N, 127 24’ 19” E; collembola.

09-19. Maitara, west coast; snorkelling with Cvetkov trap net at 2-4 m., disturbing upper sandy bottom layer by hand until a depth of 10 cm, swirling net in the watercolumn just above the stirred sand; 29 Oct. 2009; coord. 0 43’ 47.84” N, 127 21’ 44.95” E; tanaidacea, amphipoda.

09-20. Maitara, north coast; 40 m. north west of wooden jetty on broad beach strewn with rounded boulders at the high water mark, coarse sand, coral rubble; B-Rh pump 80-50 cm, 150 l filtered; 29 Oct. 2009; coord. 0 44’ 20” N, 127 22’ 27” E; amphipoda.

09-21. Maitara, north coast; 100 m. north west of wooden jetty in an uncovered well, 5 m deep and 2 m wide, between houses of village Kailupa, 20 m from beach, well used for washing, depth 50 cm; Cvetkov net, bottom of well stirred with bamboo pole; 29 Oct. 2009; coord. 0 44’ 20” N, 127 22’ 27” E; copepoda, amhipoda, mosquito larvae, oligochaeta.

09-22. Maitara, north coast; 20m. north west of wooden jetty in dry river mouth just behind sand bar on the beach at the inland side; K-Ch method; 29 Oct. 2009; coord. 0 44’ 20” N, 127 22’ 27” E; harpacticoida.

09-23. Ternate, off Batu Angus, sandy bottom sample, scoop with pot across top layer, depth. 8 m, black fine silt and sand, organic detritus; 30 Oct. 2009; coord. 0 50′ 47.37″ N, 127 21′ 28.84″ E; collected by Yosephine Tuti (RCO-LIPI) amphipoda, tanaidacea, harpacticoida.

09-24. Ternate, off Batu Angus, sandy bottom sample, use of Cvetkov trap net in water column just above stirred-up sandy bottom, depth 5 m; 30 Oct. 2009; coord. 0 50′ 47.37″ N, 127 21′ 28.84″ E; tanaidacea.

09-25. Ternate, Tandjung Tabam, sandy bottom sample, use of Cvetkov trap net in water column just above stirred-up sandy bottom, depth 10 m; 30 Oct. 2009; coord. 0 50′ 04.30 N, 127 23′ 10.41″ E; copepoda, tanaidacea, amphipoda, cumacea, polychaeta.

09-26. Hiri, north coast off Pulau Maka, use of Cvetkov trap net in water column just above stirred-up sandy bottom, depth 10 m; 31 Oct. 2009; coord. 0 54′ 42.68″ N, 127 18′ 32.92″E; cumacea, tanaidacea, ostracoda, copepoda, isopoda.

09-27. Hiri, south coast, mangrove stand of about 10 trees, thick packet, at least 1 m, and walls of coral rubble, exposed to wave action; B-Rh pump on waterline, 90 cm, 100 l filtered; 31 Oct. 2009; coord. 0 52′ 54.51″ N, 127 19′ 15.74″ E; cumacea, copepoda, tanaidacea, isopoda.

09-28. Hiri, south coast, well near harbor jetty, 2 m wide, 6 m deep, 30 cm water; Cvetkov net; 31 Oct. 2009; coord. 0 53′ 06.54″ N, 127 19′ 33.24″ E; cumacea, polychaeta.

09-29. Tidore, north coast, new Cobo village, well, 1.5 m wide, 10 m deep, 1 m water; Cvetkov net; 1 Nov. 2009; coord. 0 44′ 54″ N, 127 24′ 48″ E; cyclopoida, insecta.

09-30. Tidore, north coast, new Cobo village, well, 1.5 m wide, 10 m deep, 1 m water, used for drinking water (after boiling), pipes and electric pumps in and next to well; Cvetkov net; 1 Nov. 2009; coord. 0 44′ 54″ N, 127 24′ 48″ E; cyclopoida.

09-31. Tidore, north coast, new Cobo village, well, 1 m wide, 8 m deep, 50 cm water, 15 m east of dry river (barranca); Cvetkov net; 1 Nov. 2009; coord. 0 44′ 54″ N, 127 24′ 48″ E; no macrofauna.

09-32. Tidore, north coast, new Cobo village, well, 1.5 m wide, 6 m deep, 50 cm water, 40 m east of dry river (barranca), 20 m from the sea; Cvetkov net; 1 Nov. 2009; coord. 0 44′ 54″ N, 127 24′ 48″ E; no macrofauna.

09-33. Ternate, east beach, Tobololo, coarse sand and coral debris, sample at waterline in front of shallow dead coral reefflat with heated seawater; B-Rh pump 50 cm, 50 l filtered; 2 Nov. 2009; coord. 0 50′ 30″ N, 127 22′ 38″ E; no macrofauna.

09-34. Ternate, east beach, Tobololo, well, heated by volcanic warmth in the underground, 40 m from beach in banana tree patch, 1.5 m wide, 7 m deep, 1 m water; Cvetkov net; 2 Nov. 2009; coord. 0 50′ 30″ N, 127 22′ 38″ E; no macrofauna.

09-35. Ternate, east beach, Tobololo, well, 20 m from beach in banana tree patch, 1 m wide, 5 m deep, 1 m water; Cvetkov net; 2 Nov. 2009; coord. 0 50′ 30″ N, 127 22′ 38″ E; insect larvae.

09-36. Ternate, east beach, Dufadufa, well between houses, 2 m wide, 12 m deep, 1 m water; Cvetkov net; 2 Nov. 2009; coord. 0 48′ 49″ N, 127 23′ 21″ E; no macrofauna.

09-37. Ternate, east beach, Dufadufa, well between houses, 100 m north from harbor market square, 1.5 m wide, 10 m deep, 1 m water; Cvetkov net; 2 Nov. 2009; coord. 0 49′ 05″ N, 127 23′ 28″ E; no macrofauna.

09-38. Ternate, east beach, Dufadufa, well between houses, 75 m north of harbor market square, 10 m from the sea, 1.5 m wide, 3 m deep, 1 m water; Cvetkov net; 2 Nov. 2009; coord. 0 48′ 49″ N, 127 23′ 21″ E; no macrofauna.

09-39. Tidore, Rum village, beach near jetty, coarse sand of volcanic and coral rubble mixing; B-Rh pump 100-50 cm, 100 l filtered; 4 Nov. 2009; coord. 0 44′ 56″ N, 127 23′ 13″ E; amphipoda, copepoda.09-40. Tidore, Rum village, beach near plaquette of Spanish landfall in 1521, coarse sand of volcanic and coral rubble mixing; B-Rh pump 100-50 cm, 100 l filtered; 4 Nov. 2009; coord. 0 44′ 56″ N, 127 23′ 13″ E; cumacea.

09-41. Tidore, Rum village, most eastern corner of beach, coarse sand, boulders and freshwater streaming from under rocks onto the beach; B-Rh pump 100-50 cm, 50 l filtered; 4 Nov. 2009; coord. 0 44′ 56″ N, 127 23′ 13″ E; isopoda.

09-42. Tidore, Rum village, most eastern corner of beach, coarse sand, boulders and freshwater streaming from under rocks onto the beach; B-Rh pump in seawater just at waterline, 100-50 cm, 50 l filtered; 4 Nov. 2009; coord. 0 44’ 56” N, 127 23’ 13” E; polychaeta.

09-43. Tidore, Rum village, well between houses just off the main road south, 1.5 m wide, 2 m deep, 1 m waterdepth; Cvetkov net; 4 Nov. 2009; coord. 0 44’ 10” N, 127 27’ 10” E; mosquito larvae, polychaeta.

09-44. Tidore, Rum village, well in field near the road, covered with corrugated iron plates, 1 m wide, 1.5 m deep, 30 cm waterdepth; Cvetkov net; 4 Nov. 2009; coord. 0 44’ 10” N, 127 27’ 10” E; mosquito larvae.

09-45. Tidore, Rum village, beach below wall bordering a small park just south of the village entrance gate; dipnet in surf; 4 Nov. 2009; coord. 0 44’ 10” N, 127 27’ 10” E; no macrofauna.

09-46. Halmahera, beach north of unused shipwharf, pump in small freshwater stream flowing out on the beach, fine brown sand mixed with pebbles and wood debris; B-Rh pump 30 cm, 50 l filtered; 5 Nov. 2009; coord. 0 53' 40.07" N, 127 29' 36.01" E; no macrofauna.

09-47. Halmahera, beach north of unused shipwharf, fine brown sand mixed with coral rubble and wood debris; B-Rh pump 50-20 cm, 80 l filtered; 5 Nov. 2009; coord. 0 53' 40.06" N, 127 29' 33.60" E; no macrofauna.

09-48. Halmahera, beach north of unused shipwharf, pit digging in small freshwater stream flowing out on the beach, fine brown sand mixed with pebbles and wood debris; K-Ch method; 5 Nov. 2009; coord. 0 53' 40.07" N, 127 29' 36.01" E; harpacticoida.

09-49. Halmahera, diving sample of seabottom, use of Cvetkov trap net in water column above stirred-up sandy bottom, depth 10 m; 5 Nov. 2009; coord. 0 54' 24" N, 127 29' 17" E; amphipoda, isopoda, copepoda.

09-50. Ternate north coast, beach in small bay west of Sulamadaha, coarse volcanic sand with a thin toplayer of coral rubble, 3-10 cm, sample at eastern beach corner between large boulders; B-Rh pump 50 cm, 80 l filtered; 6 Nov. 2009; coord. 0 51' 56.63" N, 127 19' 25.53" E; cyclopoida, amphipoda.

09-51. Ternate north coast, beach in small bay west of Sulamadaha, coarse volcanic sand and fine coral rubble, sample in middle of beach (exposed); B-Rh pump 70-30 cm, 80 l filtered; 6 Nov. 2009; coord. 0 51' 56.63" N, 127 19' 25.53" E; isopoda, copepoda.

09-52. Ternate north coast, isolated brackish lake of 20 by 30 m. behind beach in small bay west of Sulamadaha, fishes sighted, probably imported as new houses were under construction; 6 Nov. 2009; coord. 0 51' 56.63" N, 127 19' 25.53" E; ostracoda, tanaidacea.

09-53. Ternate north coast, touristic inlet and secluded bay near Sulamadaha, hand collected sample from holes dug between boulders on narrow beach; dipnet; 6 Nov. 2009; coord. 0 52' 01" N, 127 19' 45" E; no macrofauna.

09-54. Ternate north coast, diving sample of seabottom, use of Cvetkov trap net in water column above stirred-up sandy bottom, depth 6-10 m; Cvetkov net; 6 Nov. 2009; coord. 0 52' 01" N, 127 19' 45" E; no macrofauna.

09-55. Ternate north coast, diving sample of seabottom, use of Cvetkov trap net in water column above stirred-up sandy bottom, depth 20 m; Cvetkov net; 6 Nov. 2009; coord. 0 52' 01" N, 127 19' 45" E; copepoda.

09-56. Ternate, northwest coast, Tolire kecil, lake behind sand- and boulder bar, fine black volcanic sand; K-Ch method; 8 Nov. 2009; coord. 0 50' 29.60" N, 127 18' 17.36" E; collembola.

09-57. Gura Ici islands, north beach of Pulau Lelei, thick coral rubble bar at waterline bordering a shallow reefflat; B-Rh pump 80 cm, 100 l filtered; 9 Nov. 2009; coord. 0 01' 38.64" N, 127 14 38.53" E; amphipoda.

09-58. Gura Ici islands, north beach of Pulau Lelei, thick coral rubble bar at waterline bordering a shallow reefflat, 10 m west of station 09-57; B-Rh pump 50 cm, 50 l filtered; 9 Nov. 2009; coord. 0 01' 38.64" N, 127 14 38.53" E; amphipoda.

09-59. Gura Ici islands, north beach of Pulau Lelei, thick coral rubble bar at waterline bordering a shallow reefflat, pump 2 m from waterline; B-Rh pump 70 cm, 50 l filtered; 9 Nov. 2009; coord. 0 01' 38.64" N, 127 14 38.53" E; amphipoda.

09-60. Gura Ici islands, north beach of Pulau Lelei, thick coral rubble bar at waterline bordering a shallow reefflat, pump placed on slope of coral bar; B-Rh pump 50 cm, 50 l filtered; 9 Nov. 2009; coord. 0 01' 38.64" N, 127 14 38.53" E; amphipoda.

09-61. Gura Ici islands, north beach of Pulau Lelei, thick coral rubble bar at waterline bordering a shallow reefflat, tide higher than previous day, pump in finer substrate; B-Rh pump 80 cm, 100 l filtered; 10 Nov. 2009; coord. 0 01' 38.64" N, 127 14 38.53" E; not sorted.

09-62. Gura Ici islands, north beach of Pulau Lelei, thick coral rubble bar at waterline bordering a shallow reefflat; B-Rh pump 80 cm, 50 l filtered; 10 Nov. 2009; coord. 0 01' 38.64" N, 127 14 38.53" E; not sorted.

09-63. Tidore east coast, small island Pulau Pilongga, diving sample of seabottom, use of Cvetkov trap net in water column above stirred-up sandy bottom, depth 1-5 m; Cvetkov net; 12 Nov. 2009; coord. 0 42' 49" N, 127 28' 45" E; cumacea, tanaidacea, isopoda, copepoda, zoea larvae.

09-64. Tidore east coast, narrow beach with boulders and fine volcanic sand under coral rubble opposite Pulau Pilongga on Tidore's main land; B-Rh pump 80 cm, 50 l filtered; 0 43' 04" N, 127 27' 30" E; no macrofauna.

09-65. Halmahera, east coast, Kau bay, Jikolama beach, fine volcanic sediment; B-Rh pump 50 cm, 50 l filtered; 13 Nov. 2009; coord. 0 54' 52.54" N, 127 38' 05.27" E; copepoda, polychaeta.

09-66. Halmahera, east coast, freshwater stream next to road; dipnet; 13 Nov. 2009; coord. 0 55' 59" N, 127 37' 29" E; decapoda.

09-67. Halmahera, east coast, Kau bay, Batang beach, fine volcanic sediment, pump on waterline next to small outflow of river; B-Rh pump 50 cm, 50 l filtered; 13 Nov. 2009; coord. 1 14' 03.49" N, 127 55' 34.31" E; no macrofauna.

09-68. Halmahera, east coast, Kau bay, Batang beach on small cape with some mangrove trees in the water, brown volcanic sand and coral rubble between large boulders; B-Rh pump 50 cm, 50 l filtered; 13 Nov. 2009; coord. 1 14' 02.74" N, 127 55' 51.00" E; isopoda.

09-69. Halmahera, west coast Teluk Dodinga, karang Ngeli W, snorkelling 0-5 meter with Cvetkov trap net: 14 Nov. 2009; coord. 0 46' 25.26 "N, 127 32' 22.01" E; tanaidacea, isopoda, copepoda, cumacea, amphipoda, zoea larvae.

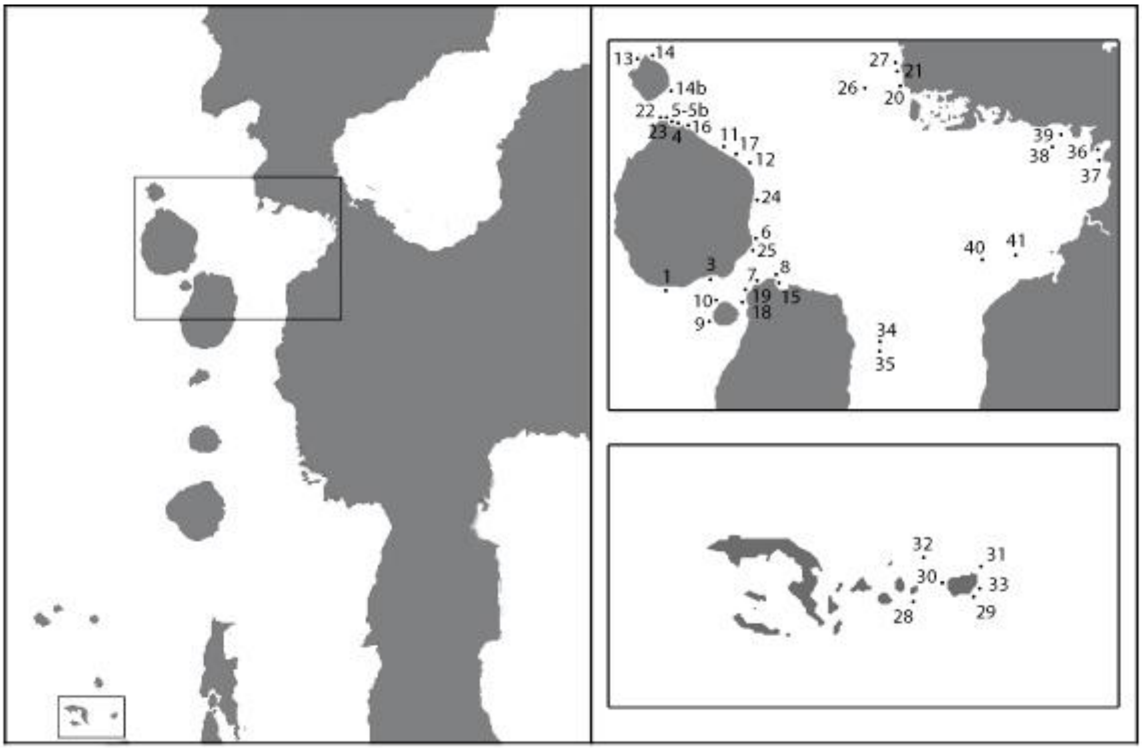
09-70. Halmahera, west coast Teluk Dodinga, karang Luelue E, snorkelling 0-5 meter with Cvetkov trap net: 15 Nov. 2009; coord. 0 46' 32.62 "N, 127 33' 43.74" E; tanaidacea, isopoda, copepoda, amphipoda.

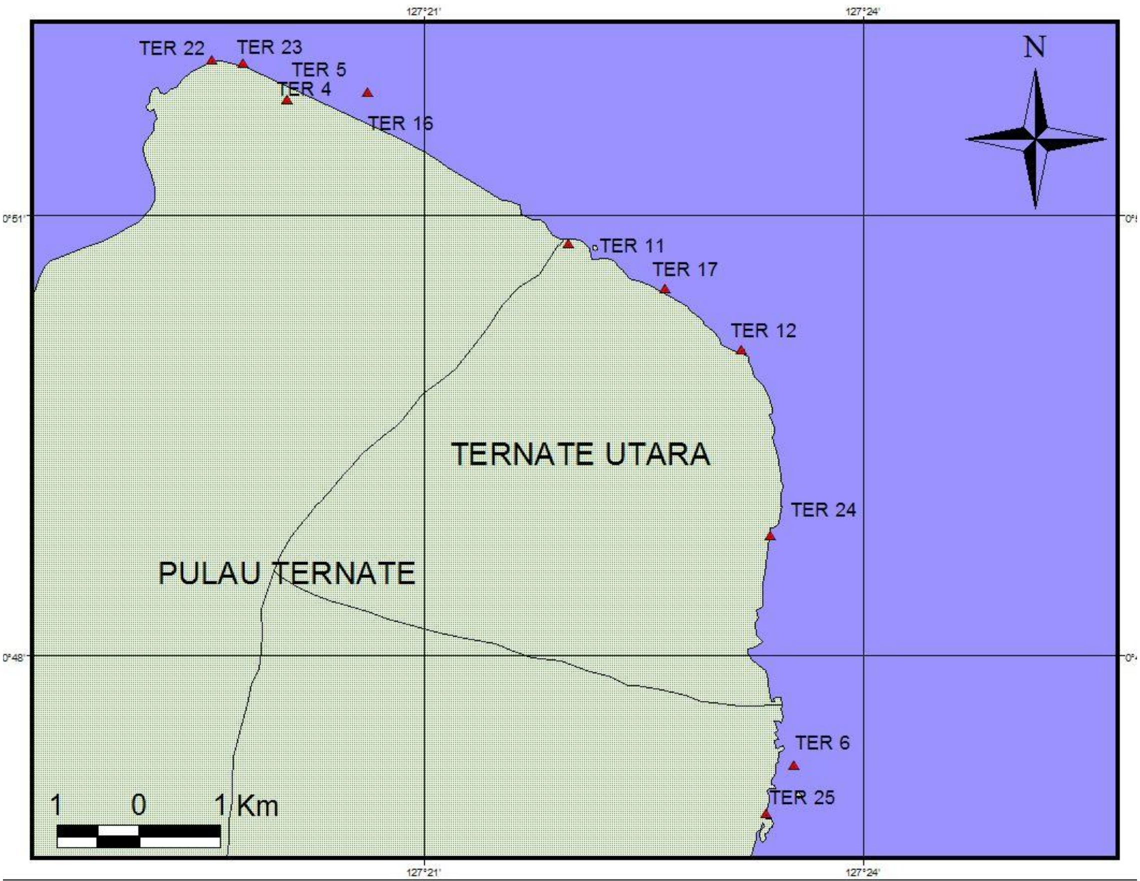
Photo: Bou-Rouch pump used on a marine beach. The suction creates an irregular inflow that detaches groundwater organisms from their substrate and brings them to the surface. Water is filtered through a net.

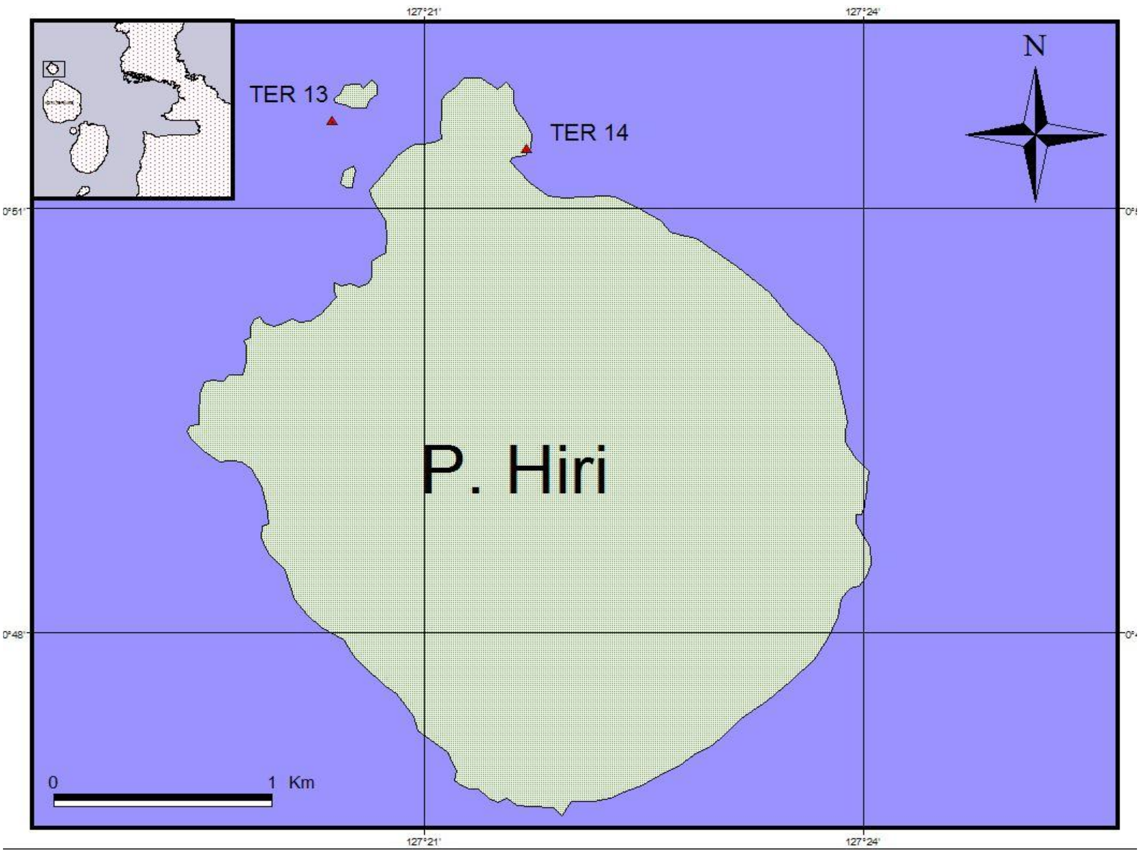
List of localities

	Location	Locality Name	N/S	deg	min	sec	E/W	deg	min	sec
TER01	Ternate	LIPI Sasa	N	0	45	16,9	E	127	19	36,3
TER02	Ternate	off Danau Laguna	N	0	45	29,7	E	127	20	59,1
TER03	Ternate	Restaurant Floridas	N	0	45	35,8	E	127	21	25,4
TER04	Ternate	Sulamadaha Beach	N	0	51	47,6	E	127	20	4,1
TER05	Ternate	Sulamadaha Bay	N	0	51	58,1	E	127	19	53,9
TER05b	Ternate	Sulamadaha Bay (snorkeling)	N	0	51	58,1	E	127	19	53,9
TER06	Ternate	Kampung Cina / Tapak 2	N	0	47	15	E	127	23	25
TER07	Tidore	Desa Tahua	N	0	45	9,9	E	127	23	31,3
TER08	Tidore	Tanjung Ebamadu	N	0	45	23,4	E	127	24	26,5
TER09	Maitara	Maitara W	N	0	43	47,6	E	127	21	44,7
TER10	Maitara	Maitara NW	N	0	44	32	E	127	21	50,9
TER11	Ternate	Batu Angus	N	0	50	48,5	E	127	21	58,9
TER12	Ternate	Tanjung Tabam	N	0	50	5,1	E	127	23	10
TER13	Hiri	Maka	N	0	54	42,7	E	127	18	32,9
TER14	Hiri	Tanjung Ngafauda	N	0	54	38,3	E	127	19	2,7
TER14b	Hiri	Tanjung Ngafauda (snorkeling)	N	0	53	10,3	E	127	19	38,6
TER15	Tidore	Cobo	N	0	45	18,7	E	127	24	23,8
TER16	Ternate	Tanjung Pasir Putih	N	0	51	50,4	E	127	20	36,7
TER17	Ternate	Tarau	N	0	50	30	E	127	22	38,5
TER18	Tidore	N of Rum	N	0	44	35,8	E	127	23	6,3
TER19	Tidore	SW of Tobala	N	0	44	56,6	E	127	23	13,5
TER20	Halmahera	Tanjung Sidangolo	N	0	53	39,6	E	127	29	28,1
TER21	Halmahera	Tanjung Ratemu (S of river)	N	0	54	24,7	E	127	29	17,7
TER21b	Halmahera	Tanjung Ratemu (S of river; snorkeling)	N	0	54	24,7	E	127	29	17,7
TER22	Ternate	Sulamadaha I	N	0	52	3,6	E	127	19	33,1
TER23	Ternate	Sulamadaha II	N	0	52	2	E	127	19	45,8
TER24	Ternate	Dufadufa / Benteng Toloko	N	0	48	49,1	E	127	23	21,6
TER25	Ternate	Ternate Harbour (E outside)	N	0	46	55,3	E	127	23	19,9
TER26	Halmahera	Pasir Lamo (W side)	N	0	53	20,5	E	127	27	34,2
TER27	Halmahera	Tanjung Ratemu (S of river)	N	0	54	44,5	E	127	29	9,9
TER28	Gura Ici	Popaco E	S	0	1	51,9	E	127	14	1,8
TER29	Gura Ici	Lelai S	S	0	1	58,3	E	127	14	56,8
TER30	Gura Ici	Lele W	S	0	1	44,8	E	127	14	31,8
TER31	Gura Ici	Lelai E	S	0	1	26,8	E	127	15	11,3
TER32	Gura Ici	Gura Ici E	S	0	1	17,3	E	127	14	17,2
TER33	Gura Ici	Lela S	S	0	1	51,2	E	127	15	3,1
TER34	Tidore	Pilongga N	N	0	42	49,8	E	127	28	45,4
TER35	Tidore	Pilongga S	N	0	42	44,1	E	127	28	47,3
TER36	Halmahera	Teluk Dodinga E; N of Jere	N	0	50	47,8	E	127	37	48,7
TER37	Halmahera	Teluk Dodinga E; NW of Jere	N	0	50	26	E	127	37	54
TER38	Halmahera	Teluk Dodinga; Karang Galiasa Besar E	N	0	50	45,6	E	127	35	7,4
TER39	Halmahera	Teluk Dodinga; Karang Galiasa Kecil W	N	0	51	9,1	E	127	35	19,5
TER40	Halmahera	Teluk Dodinga; Karang Ngeli W	N	0	46	25,3	E	127	32	22
TER41	Halmahera	Teluk Dodinga; Karang Luelue E	N	0	46	32,8	E	127	33	43,4

Locality maps



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127°24'
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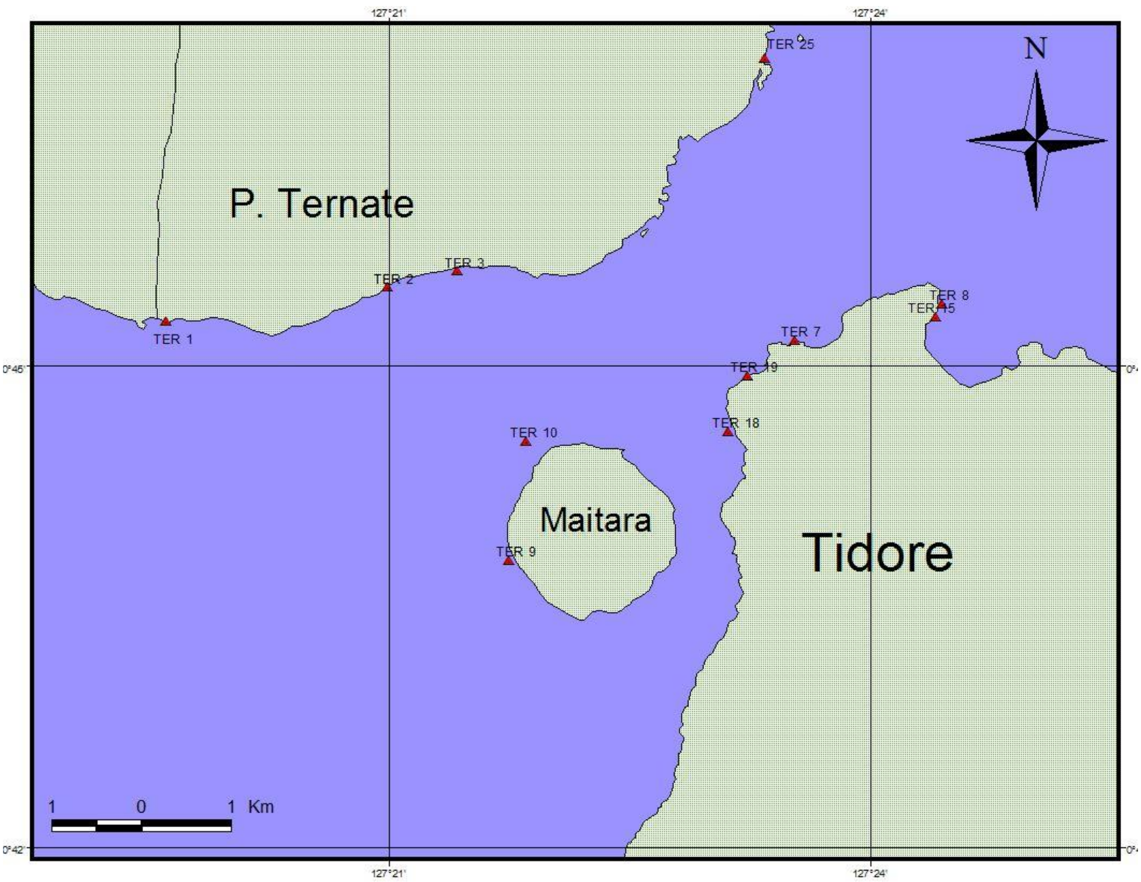
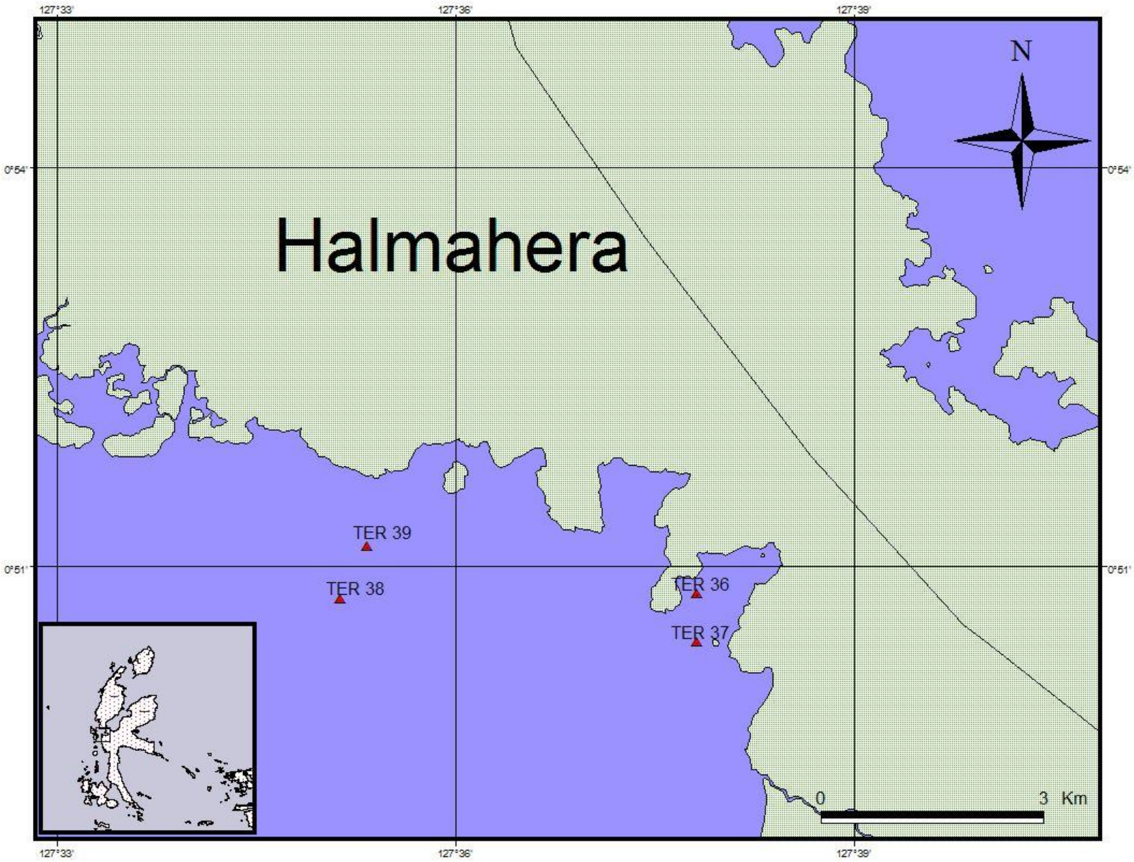
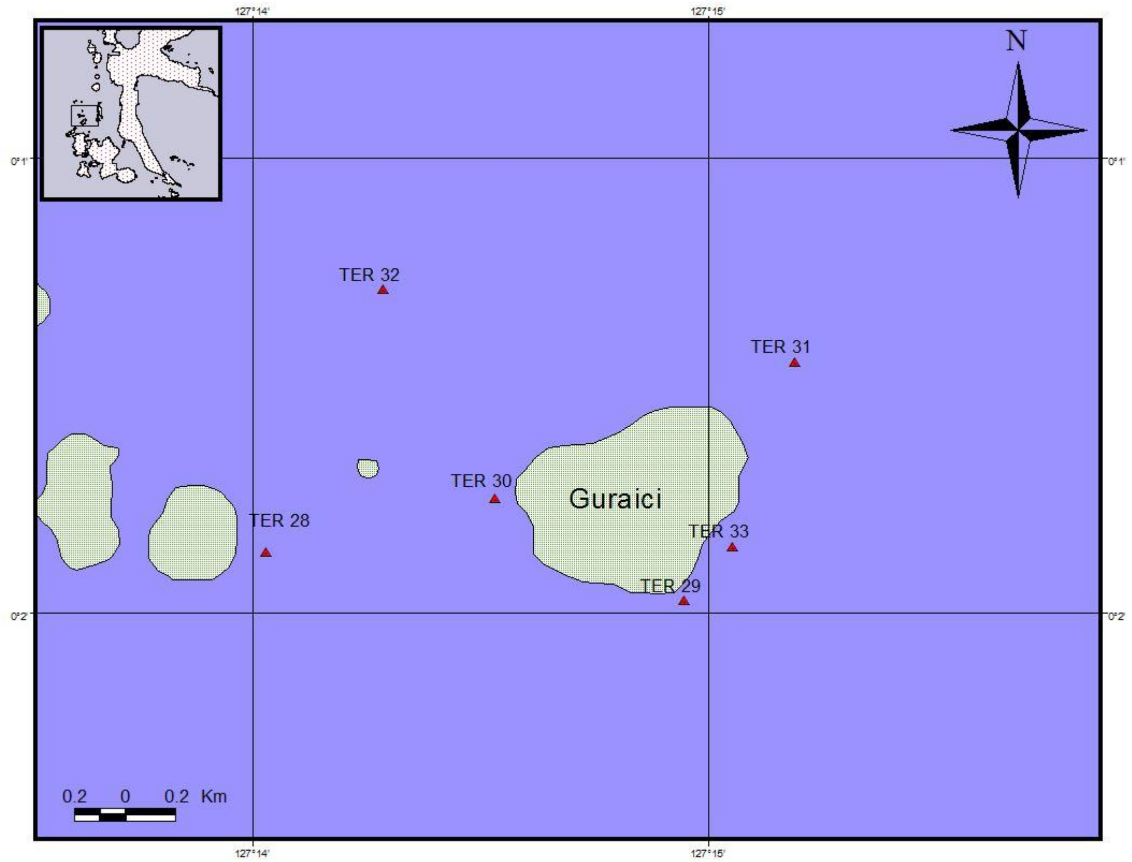
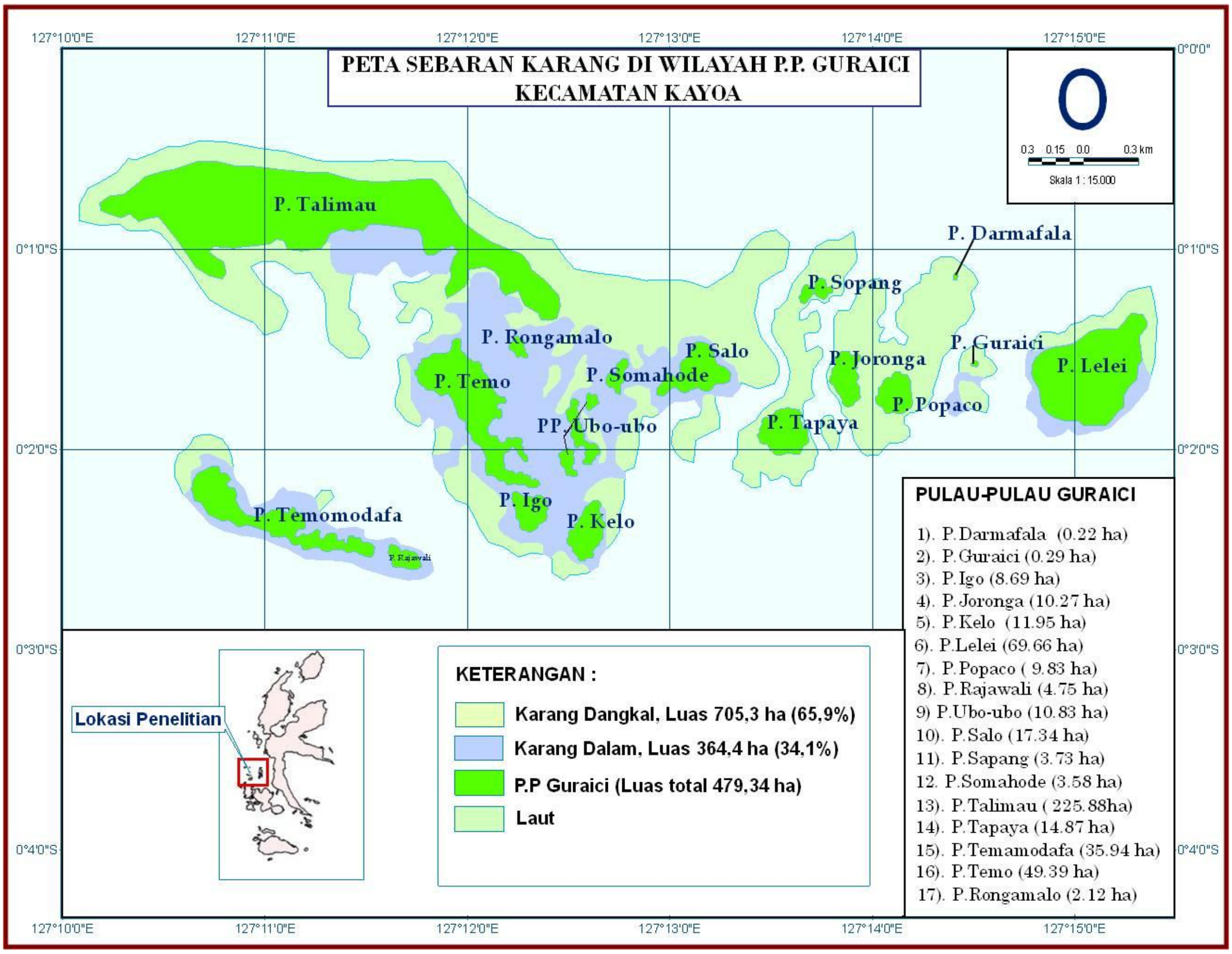
TER 13
TER 14
P. Hiri
0
1 Km

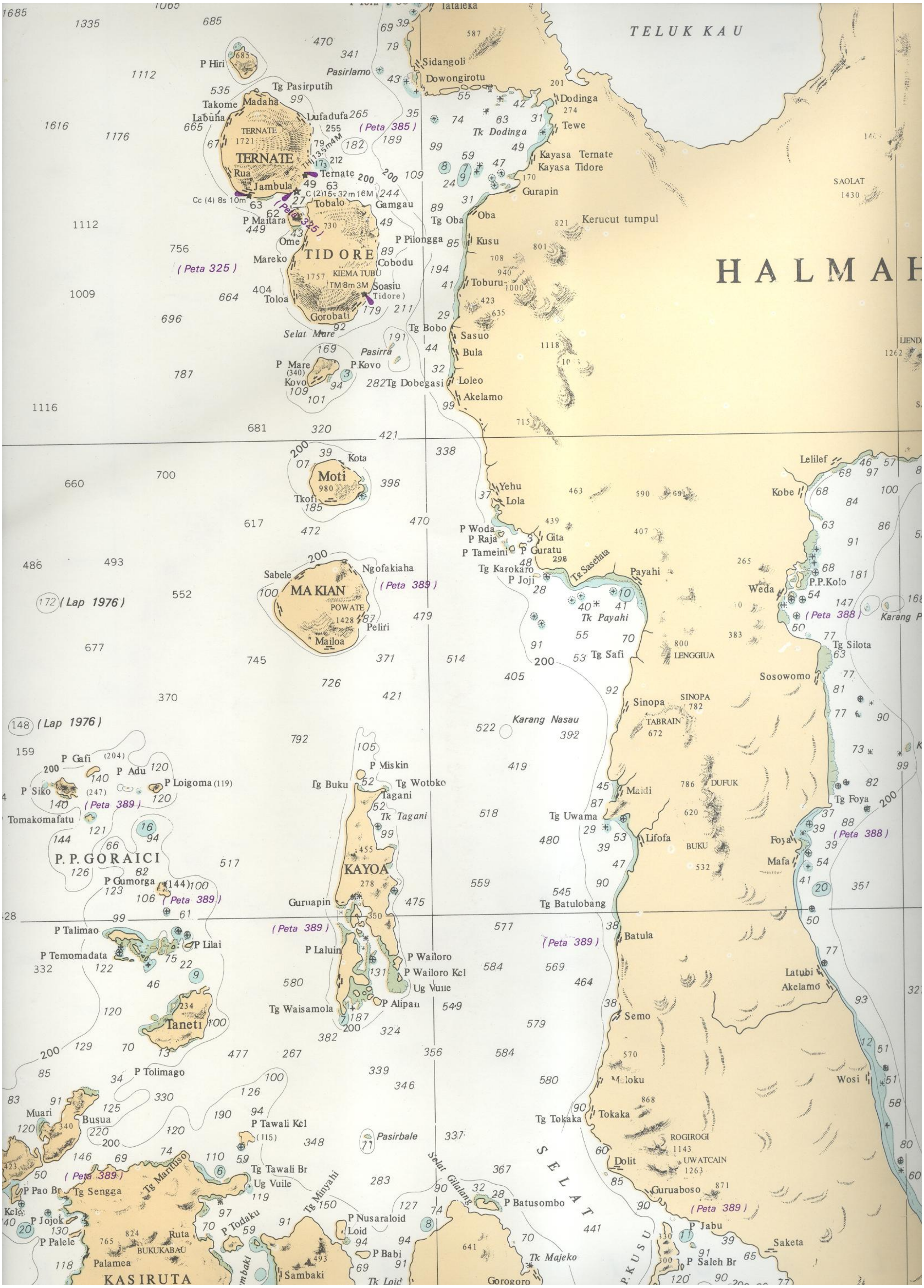

127°21'
127°24'
N
TER 25
P. Ternate
TER 3
TER 2
TER 1
TER 8
TER 15
TER 7
TER 19
TER 18
TER 10
Maitara
TER 9
Tidore
1
0
1 Km


Halmahera
N
TER 39
TER 38
TER 36
TER 37
0
3 Km
127°33'
127°36'
127°39'
0°54'
0°51'


N
TER 32
TER 31
TER 30
Guraici
TER 28
TER 33
TER 29
0.2
0
0.2 Km
127°14'
127°15'
0°1'
0°2'



Map of Guraici. Source: Samar Ishak, Universitas Khairun, Ternate.



Part of Nautical Map 404 (Indonesian Navy).