

Chapter 23

Sulawesi beaches and shores: A look at an unusual coral tank

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ABSTRACT

The Sulawesi Beaches and Shores tank is an unusual live coral tank located at the Omaha Henry Doorly Zoo in Omaha, Nebraska U.S.A. This exhibit is unusual in that it is based on the Lembeh Straits region of Northeastern Sulawesi, Indonesia; a region known for its black volcanic sand reefs and unusual creatures. The original exhibit had a sloping sand bed that rose up to a dry beach area and was initially a Caribbean fish only display. In 2001, the exhibit was renovated using a black sand substratum and now houses a diverse collection of fish and live coral from Indonesia. Challenges arose in providing adequate light and water movement due to constraints in the original exhibit design. This chapter focuses on the unique characteristics of the display: the problems and solutions of housing corals in it, and the everyday maintenance required to keep it all running.

INTRODUCTION

The Sulawesi Beaches and Shores exhibit was inspired by a trip to the Lembeh Straits in Northeastern Sulawesi. After seeing the amazing creatures and striking black sand of this region, a seed was planted to recreate this area upon my return home. There was already a beach exhibit in the aquarium, but it was always lacking in appeal. The exhibit featured fish from the Caribbean and was decorated with dead coral rock. Though the exhibit was not designed with live corals in mind, it was decided to try to replicate the ecosystem of the Lembeh Straits with fish and live corals from that area. To do this the exhibit needed some lighting and water movement changes and of course removing 14 metric tonnes of silica sand and replacing it with 14 tonnes of black sand!

The tank

The Sulawesi beach tank has a total of a little over 98,280 L of water. Over half this water is located under the sand bed or behind the exhibit in a reserve tank. The actual display water is approximately 37,800 L.

Viewing

The exhibit is open to the air, with two acrylic windows, one 5.2 m long and 0.8 m high and

the other 2.4 m long, and sloping from 0.8 m to 1.2 m. The water is 0.76 m at the deepest and slopes up to a dry beach area. The water surface is roughly 14 m² with a dry beach area that is 1.2 m wide. The sand is on top of a false floor of fibergrate and screening material. There is a void space of water under the sand bed ranging 0.9 m to 1.5 m deep. The other area of extra water is located under the dry sand bed; it is approximately 5.8 x 1.8 x 1.8 m in size. All water that is located under both the wet and dry sand beds is continually circulating.

Life support systems

The filtration for this exhibit was kept to a minimum. The main filtering devices consist of two ETSS 5000 protein skimmers. There is also a large Stark sand filter, however, the sand was removed during the renovation and not replaced. The filter was kept in place though in case mechanical filtering was needed in the future. The filter sand was removed for a few reasons. First, as the sand filter clogs the flow is decreased. Since the protein skimmers are both fed by the main circulation pumps, this would cause the skimmers to fluctuate. The second reason was that it was felt that the sand in the display itself would filter out most debris.

Due to the slope of the exhibits floor, most of the sand had to be fairly deep (0.5 m), and it was thought the fine sand would trap most particles. The last reason was to decrease the amount of time and water used to backwash the filter. The sand does tend to trap most of the debris; however, this is causing clogging issues that now need to be dealt with by increasing sand vacuuming or replacing some of the substrate.

Circulation for the exhibit is supplied by a 15HP Ingersoll Rand pump, and a 7.5HP Ingersoll Rand pump, providing 756 L.min⁻¹ to the display. The larger pump is mainly used for tank turnover and to supply the protein skimmers, while the smaller pump supplies a wave maker. The water from the circulation pump is pulled from the water reservoir under the dry beach. From there it is returned under the sand bed in the front of the display. The front display and back reserve are connected via a four inch pipe. The supply for the wave maker pump and the heat exchange pump are both pulled off the main circulation line.

All water movement for the exhibit is supplied by one wave making device. The wave maker is housed in a 0.9 x 0.9 x 2.4 m well. The wave maker is a double action air cylinder that is attached to a butterfly valve on a 40.6 cm fiberglass pipe. This pipe leads down to the display and exits on the far right of the display. The Norgren air cylinder is controlled by a timing device that keeps the valve closed for 1,5 minutes and then opens the valve for 10 seconds, allowing all the water in the well to escape. Each dump consists of around 756 L of water. During the 6 years of operation, the wave maker has only needed repairs twice. One repair was to the butterfly valve and the other to the seals of the air cylinder.

Lighting for the exhibit originally consisted of five 400 W fixtures that could be tilted one way to light up the back of the exhibit, or tilted the other way to light up the water. During renovation, six 1000 W fixtures were added to the display. Since the display is an open display, the lights have to be kept high off the water to keep them from being viewed by the public. For this reason, the lights to the display are about 2.4 m from the water's surface. All of the 400 W fixtures are now pointed to the back of the exhibit, to illuminate the dry beach area, and the 1000 W fixtures illuminate the

water for fish and corals. The 1000 W and 400 watt bulbs are Sunmaster bulbs by Sunlight Supply. On average the PAR reading is around 150 $\mu\text{mol.m}^{-2}.\text{s}^{-1}$ at the surface of the water and can fall to around 50-75 $\mu\text{mol.m}^{-2}.\text{s}^{-1}$ at the bottom of the tank. Given the turbid nature of the Lembeh Strait, these PAR values may be close to what would be typically encountered in 12.1 or 15.2 m of depth.

AQUASCAPING AND SPECIES COMPOSITION

The exhibit is broken up into four distinct areas. The first area on the far right is a plateau reef that is dominated by bulb-tipped anemones (*Entacmea quadricolor*). Almost 100 anemones (from two distinct color lineages) occupy this area along with many *Amphiprion melanopus* clownfish. The next area is a rubble zone with a few species of *Montipora*, *Sinularia* and *Sarcophyton*. This is an area intended for various small fishes such as flasher wrasses, gobies and *Pictichromis*. A large colony (0.9 x 0.9 m) of lime green *Montipora aequituberculata* is the highlight of this section. The next section is a *Euphyllia* bommie with *E. glabrescens* and *E. divisa*. There are also large colonies of *Galaxea* sp. behind the bommie. The last section is a soft coral island that includes *Lobophytum*, *Sinularia*, *Sarcophyton* and *Anthelia* species.

EXHIBIT MAINTENANCE

Maintenance for the exhibit consists mainly of window cleaning, calcium additions and occasional sand vacuuming. The exhibit receives 100 g of calcium hydroxide dissolved in 60 L freshwater every night via a drip bucket. The only other chemical addition is 30 g of potassium iodide that is added on an irregular basis. Large water changes (30 %) are performed about every six months or so.

PROBLEMS

Over the years only a few problems have cropped up. One problem still being dealt with is the very fine sand that was used. At the time of the exhibit setup, only one product of black sand could be found, CaribSea's Tahitian Moon product, which is very fine. Over the years it

has become quite clogged with debris and has compacted in many areas of the display. The display is not easily hydrovaced, so this area often gets neglected. The second problem is dealing with *Majano* sp. anemones. These anemones were first introduced with the live rock. Various butterfly fish have been tried, with varying degrees of success. They might be keeping them in check, but not much else. Due to the size of the display, we mainly let them be. Every now and then, a rock that is really covered will be taken out and placed in the freezer for a few days to kill everything on the rock. It is then returned to the display in an area void of the pest anemones.

CONCLUSION

Though the exhibit was not designed for keeping live corals, the display has been very successful for over six years now. Coral growth and health, as well as fish growth and health, have both been very good. For the future, the diversity of both the fish and coral species will be increased. The clogged substrate issue is already being dealt with, with vacuuming and removal and replacement.



Figure 1: Overview of the coral display of Sulawesi beaches and shores

APPENDIX I: Aquarium Passport

Tank name Sulawesi Beaches and Shores
 Location Omaha's Henry Doorly Zoo
 Opening date August 2001

INFRASTRUCTURE / PHYSICAL DESCRIPTION

Volume 98,280 L
 Surface area 14 m²
 Depth 0.76 m at deepest and slopes to dry beach

LIGHT CONDITIONS

General 6x 1000 W metal halides over water, 5x 400 W illuminate back
 of display
 Hours of illumination 12 hours per day
 Daily max PAR 0.5 to 1 m depth 2.5 m depth 4.0 m depth
 75-150 NA NA

FILTRATION (external)

Protein skimmers 2 ETSS 5000
 Ozone injection NA
 Sand filters NA
 Vacuum by divers None

FILTRATION (internal)

Live-rocks ~2200 kg
 Substrate ~15 tons of CaribSea black sand

WATER MOVEMENT / CIRCULATION

External pumps 15HP Ingersol Rand Pump main circulation and 7.5HP pump
 for Wave Maker
 Submerged pumps NA
 Wave machine 756 L dump by pneumatic valve
 Total flow 90 m³.h⁻¹

WATER CHANGES

Type of system Closed
 Source of "new"
 salt-water Artificial Seawater
 Characteristics of
 "new" saltwater Calcium: 420 mg Ca²⁺.L⁻¹ Nutrients
 Magnesium: 1300 mg.L⁻¹ Nitrate: <1 mg NO₃⁻.L⁻¹
 Salinity: 32 ppt Nitrite: <0.1 mg NO₂⁻.L⁻¹
 Alkalinity : 136 mg.L⁻¹ Phosphate: <0.1mg PO₄³⁻.L⁻¹
 Temperature: 23,5 °C
 pH: 8.2
 Rate of water
 replacement 100 % per year

FEEDING REGIME

Dead food ~227 g of frozen mysids per day
 Live food NA

APPENDIX I (continued): Aquarium Passport

WATER QUALITY

Salinity	35 ppt	
Temperature	26.6 °C	
pH	8.0-8.3	
Redox (mV)	NA	
Dissolved Oxygen	95 to 100 %	
Nutrients	Nitrate (mg NO ₃ ⁻ -N.L ⁻¹):	15-25
	Nitrite (mg NO ₂ ⁻ -N.L ⁻¹):	0.001-0.01
	Phosphate (mg PO ₄ ³⁻ -P.L ⁻¹):	0.1-0.15
	Dissolved Organic Nitrogen (mg DON-N.L ⁻¹):	NA
	Dissolved Organic Phosphate (mg DOP-P.L ⁻¹):	NA

CHEMICAL ADDITIONS

Calcium	75 grams daily of calcium hydroxide
Alkalinity	No addition
Trace elements	No addition

APPENDIX II: Sulawesi Beach species list, updated 12-10-07

Genus	Species	Common names	#
FISH			
<i>Aeolistrus</i>	<i>strigatus</i>	Coral Shrimpfish	9
<i>Amphiprion</i>	<i>clarki</i>	Clark's Clownfish	2
<i>Amphiprion</i>	<i>melanopus</i>	Melanopus Clownfish	12
<i>Amphiprion</i>	<i>polymnus</i>	Black Percula Clownfish	1
<i>Amphiprion</i>	<i>frenatus</i>	Tomato Clown	1
<i>Caesio</i>	<i>caerulaurea</i>	Striped Fusilier	6
<i>Caesio</i>	<i>cunning</i>	Yellow tail Fusilier	10
<i>Callopleles</i>	<i>altivelis</i>	Marine Betta	1
<i>Centropyge</i>	<i>bispinosus</i>	Coral Beauties	1
<i>Chaetodon</i>	<i>ulietensis</i>	False Saddle Butterfly	1
<i>Chromis</i>	<i>viridis</i>	Green Chromis	17
<i>Chrysiptera</i>	<i>alleni</i>	Allen's Damsel	6
<i>Chrysiptera</i>	<i>cyanea</i>	Blue Damsel	1
<i>Chrysiptera</i>	<i>parasema</i>	Yellowtail Damsel	2
<i>Cirrhilabrus</i>	<i>rubriventralis</i>	Longfin Fairy Wrasse	2
<i>Cirrhilabrus</i>	<i>solerensis</i>	Clownhead Fairy	1
<i>Cirrhilabrus</i>	sp.	Sunset Wrasse	1
<i>Cirrhilabrus</i>	<i>falco</i>	Falco's Hawkfish	1
<i>Coris</i>	<i>formosa</i>	Coris Wrasse	1
<i>Dascylus</i>	sp.	3 stripe damsel	3
<i>Forcipiger</i>	<i>flavissimus</i>	Long Nose Butterfly	1
<i>Genicanthus</i>	<i>melanospilos</i>	Japanese Swallowtail Angel	1
<i>Genicanthus</i>	<i>lamarcki</i>	Lamarck's Angelfish	3
<i>Halichoeres</i>	<i>chloropterus</i>	Green Coris Wrasse	1
<i>Heniochus</i>	<i>diphreutes</i>	Bannerfish	2
<i>Naso</i>	<i>lituratus</i>	Naso Tang	1
<i>Novaculichthys</i>	<i>taeniourus</i>	Dragon Wrasse	2
<i>Pholidichthys</i>	<i>leucotaenia</i>	Engineer Goby	2
<i>Pomacentrus</i>	<i>moluccensis</i>	Golden Damsels	2
<i>Premnas</i>	<i>bimaculatus</i>	Maroon Clownfish	1
<i>Pseudanthias</i>	<i>hutchii</i>	Green Cheek Anthia	4
<i>Pseudochromis</i>	<i>polymnus</i>	Polymnus Dottyback	3
<i>Pseudochromis</i>	sp.	Red Pseudochromis	1
<i>Salarius</i>	<i>fasciatus</i>	Lawnmower Blenny	1
<i>Sargocentron</i>	<i>diadema</i>	Red Squirrelfish	1
<i>Spaeramis</i>	<i>nematoptera</i>	Pajama Cardinal	10
<i>Synchiropus</i>	<i>splendidus</i>	Green Mandarinfish	1
<i>Thallosoma</i>	<i>jansenii</i>	Jansen's Wrasse	1
<i>Thallosoma</i>	<i>lunare</i>	Lunar Wrasse	1
<i>Zebrasoma</i>	<i>scopas</i>	Scopas Tang	3
<i>Zebrasoma</i>	<i>veliferum</i>	Sailfin Tang	3

APPENDIX II (continued): Sulawesi Beach species list, updated 12-10-07

Genus	Species	Common names	#
INVERTEBRATES			
<i>Astrea</i>	sp.	Astrea Snail	<10
<i>Acropora</i>	<i>microthalma</i>	Micro Stag Coral	1
<i>Anthelia</i>	sp.	Waving Hands Polyps	>10
<i>Capnella</i>	<i>imbricata</i>	Soft Coral	<10
<i>Caulastrea</i>	<i>furcata</i>	Green Candy Cane	8
<i>Clavularis</i>	sp.	Clove Polyps	>10
<i>Clibanarius</i>	<i>tricolor</i>	Hermit Crabs	<10
<i>Discosoma</i>	sp.	Mushroom Anemone	>10
<i>Entamacea</i>	<i>quadricolor</i>	Bulb Anemone	62
<i>Euphyllia</i>	<i>divisa</i>	Frogspawn Coral	7
<i>Euphyllia</i>	<i>glabrescens</i>	Torch Coral	11
<i>Favia</i>	sp.	Green Closed Brain Coral	1
<i>Fungia</i>	sp.	Disk Coral	1
<i>Galaxea</i>	sp.	Galaxea	7
<i>Heliopora</i>	<i>coerulea</i>	Blue Ridge	1
<i>Holothuria</i>	sp.	Sea Cucumbers (sm.)	<10
<i>Lobophytum</i>	sp.	Devil's Head leather	11
<i>Macrodactyla</i>	<i>doorensis</i>	Long Tentacled Anemone	1
<i>Montipora</i>	<i>aquituberculata</i>	Green Montipora	6
<i>Montipora</i>	<i>capricornis</i>	Plating Montipora	1
<i>Platygyra</i>	sp.	Platygyra	2
<i>Pocillipora</i>	<i>damicornis</i>	Cauliflower Coral	3
<i>Porites</i>	<i>cylindrica</i>	Finger Porites	2
<i>Porites</i>	sp.	Porites	2
<i>Protopalythoa</i>	sp.	Button Polyp	>10
<i>Rumphella</i>	sp.	Purple gorgonian	1
<i>Sarcophyton</i>	sp.	Leather Coral	36
<i>Sinularia</i>	<i>dura</i>	Cabbage Coral	20
<i>Sinularia</i>	sp.	Finger Leather	16
<i>Sinularia</i>	sp.	Rasta Leather	2
<i>Strombus</i>	<i>gigas</i>	Queen Conch	2
<i>Stylophora</i>	<i>pistillata</i>	Cat's Paw	1
<i>Turbinaria</i>	<i>peltata</i>	Green Cup Coral	1
<i>Turbinaria</i>	<i>reniformis</i>	Yellow Cup	1
<i>Turbo</i>	sp.	Turbo Snail	<10
<i>Zoanthid</i>	sp.	Button Polyps	<10
PLANTS			
Mangroves			10