MICRONESIA-AMERICAN SAMOA STUDENT INTERNSHIP PROGRAM (MASSIP)

PROJECT REPORT FOR:

CORAL REEF RESEARCH ON ASCIDIANS

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Abstract:

In the search for a cure for cancer, more and more researchers and scientists have been studying coral reef invertebrates for anti-tumor chemicals. During my two-month Micronesia-American Samoa Internship Program (MASSIP) internship at the Coral Reef Research Foundation (CRRF) in Palau, I studied a little known marine invertebrate family called ascidians. I learned the techniques and skills involved in collecting, photographing, cataloging and shipping marine invertebrates, specifically ascidians, for study at the National Cancer Institute in Washington DC.

I also learned much about the many marine ecosystems of my home country, some of which include marine lakes, seagrass beds and coral reefs. In addition, I made many friends and contacts that will help me in my career during college and after graduation. My internship at CRRF taught me not only about ascidians but also the methodology that marine scientists use when doing research in the field, and I am sure that will help me in my classes this fall at the University of Hawaii.
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The Republic Of Palau is a nation in a state of transition. With its newly gained independence, Palau is trying to get out from underneath the wing of the United States which has been supporting Palau for far too long. One way that Palau is trying to build a strong economy is to start a booming tourism industry. Although tourism is definitely an industry that is lucrative, it also can be very destructive to the environment if it is not controlled by laws and enforcement.  

Palau should not only have to rely on tourism as the one major source of income to the islands. An ideal situation would be to have at least two major industries in Palau which would have very little impact on its environment. One industry that is just beginning to surface is the research industry.

In the search for a cure for cancer, more and more researchers are looking to the ocean in search of anti-tumor chemicals. Recently studies on marine invertebrates have indicated that some produce anti-tumor chemicals. These chemicals are being tested as possible treatments or cures for some kinds of cancer.

Researching invertebrates can be a very big industry for a nation such as Palau which boasts some of the richest marine ecosystems in the world. There is incredible diversity in the marine life of Palau and because of this, Palau is one of the most sought after destinations for visiting scientists and researchers in the world.  

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1 Wesley-Smith, Terence  
2 Scheuer, Paul  
3 Carlson, Bruce
The Coral Reef Research Foundation (C.R.R.F.) is a non-profit organization, based in Palau and funded by the National Cancer Institute (N.C.I.) and the government of Palau. C.R.R.F.'s mission is to search coral reefs around the world for organisms which may have anti-tumor properties. Samples are collected for study at the N.C.I. in Washington DC. If an anti-tumor chemical is found in a sample invertebrate from Palau and is manufactured as a cancer treatment or cure, Palau would get royalties. This income could match or exceed the amount produced by Palau's booming tourism industry.

My project at the C.R.R.F. was comprised of two major activities. First I was part of the team in charge of the collection of samples for the N.C.I. Second, I was expected to learn as much as possible about a particular marine invertebrate called an ascidian. I had never heard of an ascidian before the trip, but I got to know them pretty well during my internship. My project involved collecting ascidians from the coral reefs around Palau, photographing them, preserving them, cataloging them, and finally developing my film and creating a slide collection with a database to go along with my samples. I chose this project because ascidians around the world, not to mention Palau, are not studied as much as other marine invertebrates.

Ascidians are marine invertebrates that can take many forms. They are classified in the phylum, Chordata and the class, Ascidiacea. There are two categories of ascidians, solitary and colonial. Both solitary and colonial ascidians are found in a variety of colors and patterns. Although they may look different, all ascidians share common characteristics such as skin like tunic and two openings through which water passes.

(Figure 1)

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4 Coral Reef Ascidians of New Caledonia
Solitary ascidians, sometimes referred to as a “sea squirts” consist of one animal or zooid surrounded by a tunic that usually feels leathery. People call solitary ascidians sea squirts because of the way water shoots out of the atrial\(^5\) siphon when the ascidian is taken out of the water. Solitary ascidians are usually larger than colonial ascidians. They range from about the size of a fingernail to the size of a grapefruit.

Colonial ascidians are small when compared with solitary ascidians. Colonial ascidians live in colonies of many individual zooids surrounded by one common tunic. An individual zooid or animal in a colonial ascidian has basically the same structure of a solitary ascidian but is smaller and shares its skin with many other ascidians. These zooids can sometimes be microscopic but are usually about one to three millimeters in diameter. The single tunic or skin that surrounds the colony can vary in color and it took me a while to correctly distinguish between some colonial ascidians and a sponges that had the same color.

The individual zooids in colonial ascidians sometimes structured so that together they form patterns to accommodate for one shared atrial siphon. This allows them to save space on the already crowded reef surface.

The competition with other benthic\(^6\) marine animals for space on the reef ecosystem is the reason for the ascidian’s chemical production. There is limited amount of space coral reefs and because of the enormous diversity of marine reef life, competition for space is fierce and predation is very high. Some organisms compensate for this by

\(^5\) One of the two siphons through which water passes on an ascidian, *Invertebrate Zoology* (pg. 385)

\(^6\) Animals that live on the ocean bottom.
creating defenses. Hard corals have hard calcium shells to protect them. Other organisms such as sponges have siliceous spikes which, among other things, deter predators.

Ascidians have no hard covering and no spikes to protect them, so some produce toxic chemicals to keep predators from eating them. It is these chemicals which researchers are searching for and studying in hopes of finding a cure for cancer.

Ascidians are filter feeders and each individual zooid has two siphons. Water flows in one siphon (buccal) and out the other (atrial) and the ascidian filters out the plankton in the water. Ascidians can filter large amounts of water and their body tissue can be a good indicator of polluted water because they retain heavy metals and toxins in their bodies.

Ascidians are fascinating as invertebrates because they are more closely related to humans than any other invertebrate. During the ascidians planktonic stage, the ascidian resembles a tadpole and has a notochord. This notochord is the reason that ascidians are classified as Chordates.

Ascidians are planktonic for a very short time. Approximately 24 hours after they are born, they attach themselves to a solid surface and undergo a metamorphosis in which they lose their notochord and become a more simple life form. This example of 'backwards' evolution is one of the reasons I am interested in ascidians.

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7 Invertebrate Zoology (pg. 385)
Because ascidians are a very 'understudied' group of invertebrates, no one knows exactly how many species there are and what their distribution is throughout the world. More new species are being discovered all the time, and I am hoping that some of my samples may turn out to be an undiscovered species of ascidian.
Data Collection

Most of my internship was spent either collecting or processing the data that I collected. The method in which I collected my specimens differed with each type of ascidian that I collected. After finding the ascidian, I would photograph it and remove it from the reef. Some ascidians could just be picked off the substrate\(^8\) quite easily, but usually they had to be scraped off with a knife or other sharp object. Some colonial ascidians were very delicate and I had to be very careful not to destroy them during collection. (Figure 3)

Having removed the ascidian from the substrate, I would then place it in a clear plastic collection bag. I usually tried to keep the ascidian specimens separate from each other, but sometimes I would end up with a bunch of ascidians all in one bag. After the dive, I would record the ascidian information such as the depth it was collected, the collection site, the G.P.S.\(^9\) location and the substrate on which it was collected. (Appendix 2)

When we got back to the lab, our sample bags would then be poured into tubs and the samples would be separated. Once the samples were separated, I would place my individual samples along with a collection number for identification into Whirl Bags\(^{10}\) and fill the bags half full with a formalin solution. Formalin is liquid formaldehyde and it is the

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\(^8\) Substance to which the organism is attached or growing on.

\(^9\) Global Positioning Satellite.

\(^{10}\) Polyethylene bags with built-in twist ties used for preservation of ascidian samples.
chemical C.R.R.F. uses to preserve ascidian samples. The formalin solution we were using was made up of 10% formalin and 90% water.

After my samples were nicely preserved in formalin, I would place them on trays awaiting their respective slides to be developed. Before I knew it, I was collecting too many samples to keep track of. I solved this problem by creating a database. I have included a copy of my database as Appendix 1, 2 and 3. My database includes information about each sample along with the location site, depth it was collected and the date it was collected. Each sample is numbered so it can be cross referenced with its corresponding slide.

Before my internship was over I had collected over one hundred specimens and slides to go with them. The task then was to go through the slides to see which samples we could identify at the C.R.R.F. and which ones we would be sending to Paris for identification. Pat, Lori and Larry helped me a lot with the identification, but even with their help, we couldn’t identify many of the samples. Pat also said that there was a good chance that there were some unidentified species in my samples.
Pre-Departure Training and Preparation

May 16-25, 1996

My internship officially started the first week of June, but the pre-departure preparations started two weeks before that. On May 16, I flew to Hilo to join the other MASSIP interns for the pre-departure training. The MASSIP staff consisting of Jenny Saman, Sharon Ziegler, Liz Kumabe, and Jim Mellon spoke to us about re-entering our culture and how things would seem different. We also had guest speakers which included previous MASSIP interns.

A few days later, we were off to Honolulu to meet with our contacts and to get our supplies that we would need in the field. It was through my research at the University of Hawaii at Manoa and my contacts at the Bishop Museum and the Waikiki Aquarium that I finally found out what an ascidian was. Professor Paul Scheuer\textsuperscript{11} was very helpful in answering my questions about ascidians and even let me borrow his ascidian book which proved to be very helpful during my internship.

A part of our MASSIP training involved learning how to communicate on the PeaceSat satellites. We were scheduled to have weekly meetings over the satellite system and we needed to learn the basic protocol of satellite communication. This was one of the more interesting parts of the pre-departure training. Tom Okamura\textsuperscript{12} was a great help and very enthusiastic in teaching us the proper lingo.

\textsuperscript{11} Scheuer, Paul. Professor, Department of Chemistry, University of Hawaii
\textsuperscript{12} Okamura, Tom, Program Developer, Peacesat
I also met with Sherwood Maynard, the director of the Marine Option Program (also my faculty advisor), and we laid out a plan on what I was going to be doing at the C.R.R.F. Sherwood suggested that I collect samples of ascidians in Palau and with the slides that I would take, create a handbook of the ascidians of Palau. He was very helpful in getting me motivated and kept me on track before, during and after my internship.
Starting the Internship

June 1, 1996

During the first week of my internship, I spent most of my time getting to know the people at the C.R.R.F. Pat and Lori Colin manage C.R.R.F. and employ four people to help in the collection and cataloging of the specimens: Larry Sharon, the Chief Collector, his two assistants, Matt and Emelio who helped him on the collection, and Carla Salii, the curator of the C.R.R.F. invertebrate collection.

The staff at the C.R.R.F. turned out to be very friendly and I felt very comfortable working with them. The collection team which consisted of Larry, Matt, Emelio and me, went on collection trips about two to three times a week. The collection trips would range from three hours to a whole day. During my two month internship, we collected at twelve different locations. (Figure 2) The collection sites ranged from spectacular “drop-offs”, with a hundred feet of visibility to mangrove swamps where the visibility ranged from one to two feet. (Appendix 2)

One of the skills that I acquired during the internship was learning how to take and develop underwater photos. This was important in collection because each sample species that is collected must be photographed for identification. Pat taught me to use a Nikonos underwater camera which included a flash and close-up lens with extension
tubes. I learned how to develop my own slides and soon I was put in charge of
developing all of the film for the C.R.R.F. slides during remainder of my internship.

We used two types of 35 mm film for all of our specimen slides. Fuji Velvia and Sensia, I was told, were the best films to use in taking close-up underwater photos. We used a basic developing kit from Kodak to develop the slides. This process involved winding the film onto spindles that were then inserted into an enclosed tube. Chemicals could be poured into the tube but light could not enter. Each chemical had a specific time in which it should wash in the tube.

Pat, Lori and I decided that I would collect and photograph as many ascidian samples as I could, and, when I was through, they would send the samples and photos to France to be identified by the leading experts on ascidians, the Monniots.

Ascidians, as previously stated, are a very unstudied group of invertebrates. Only a handful of people in the world are qualified to identify them. Claude and Francoise Monniot are two of them. The couple lives in Paris and they do all of the ascidian taxonomy for the C.R.R.F.
Follow-up

The last few weeks on my internship were spent finishing up with the database and getting my slides in order. Pat and I had agreed for me to leave the samples at the C.R.R.F. and to take the slides back to the MASSIP staff because they wanted duplicates. This way, I could have the people at MASSIP make duplicates and send the originals back to C.R.R.F. so Pat could send the samples along with the slides to the Monniots for identification.

After all this was taken care of, I said my good-byes and, I was off. A few days after arriving in Hawaii, I met with Liz and Sherwood. We went over my data and slides and we agreed to have the slides reproduced and the originals sent back to C.R.R.F.

The follow-up procedures in Hawaii involved creating a presentation in which each of the MASSIP interns did a slide show on their projects. I also had to have duplicates made of all my slides.
Evaluation

The MASSIP Internship was a wonderful learning opportunity for me. I learned how invertebrates can be a resource that will possibly halt one of the world’s greatest killers, cancer. In addition to the health benefits of underwater organisms, I learned to recognize the economic value of what I had only considered valuable to tourists. It was a real eye-opener in more ways than one. I also learned how to take and develop underwater photographs.

Further, I learned how to collect and catalog specimens for scientific study. This process taught me a great deal about the marine ecosystems of my home island. I think the most important thing that I achieved on the internship was the contacts that I made both in Palau and Hawaii. The entire experience has given me a better understanding about my home, my people, and our fragile and rich environment.
References


7. Wesley-Smith, Terence, Professor. University of Hawaii, Department of Pacific Island Studies. Lecture class, Fall 1996

Basic structure of a solitary ascidian

Mouth (buccal siphon)

Brain

Atrial siphon

Pharyngeal basket

Rectum

Intestine

Stomach

Gonads
Collection Sites

1. Badheib
2. Ibobang
3. Nederrak
4. Flatworm Lake
5. Ngermutidech
6. Lighthouse Channel
7. Airai Seagrass Bed
8. Wonder Channel
9. Omodes
10. Ngerikul Pass
11. Big Jellyfish Lake
12. KB Channel
CHO: 95
This is a cluster of solitary ascidians collected at Ngerikul Pass. 7/22/96

CHO: 34
This group of solitary ascidians were collected at the Lighthouse Channel. Note the individual openings of the buccal and atrial siphon. 6/18/96
Figure 4

CHO: 92
This is an example of a colonial ascidian collected at KB Channel. 7/22/96

CHO: 38
Here is another example of a colonial ascidian. Note: each dot is an individual zooid. Collected at Lighthouse Channel. 6/18/96
## Appendix 1

<table>
<thead>
<tr>
<th>COLLECTION</th>
<th>DATE</th>
<th>LOCATION</th>
<th>DEPTH</th>
<th>HABITAT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>cho-1</td>
<td>6/8/92</td>
<td>Badebezi</td>
<td>15m</td>
<td>Sandy basin bottom</td>
<td>Gray encrusting</td>
</tr>
<tr>
<td>cho-2</td>
<td>6/8/92</td>
<td>Badebezi</td>
<td>15m</td>
<td>Sandy basin bottom</td>
<td>Light gray w/ dark gray depressions</td>
</tr>
<tr>
<td>cho-3</td>
<td>6/8/92</td>
<td>Badebezi</td>
<td>30m</td>
<td>Sandy basin bottom</td>
<td>Burgundy globs slightly translucent</td>
</tr>
<tr>
<td>cho-4</td>
<td>6/9/92</td>
<td>ibobang</td>
<td>1m</td>
<td>Sea grass bed</td>
<td>Stalked, orange w/ translucent white pompons</td>
</tr>
<tr>
<td>cho-5</td>
<td>6/9/92</td>
<td>ibobang</td>
<td>1m</td>
<td>Rocky shelf</td>
<td>Slightly stalked, olive green</td>
</tr>
<tr>
<td>cho-6</td>
<td>6/9/92</td>
<td>ibobang</td>
<td>10m</td>
<td>Rocky shelf</td>
<td>Bright yellow w/ white specs around siphon</td>
</tr>
<tr>
<td>cho-7</td>
<td>6/9/92</td>
<td>ibobang</td>
<td>7m</td>
<td>Rocky shelf</td>
<td>Gray w/ black specs, encrusting</td>
</tr>
<tr>
<td>cho-8</td>
<td>6/10/92</td>
<td>ibobang</td>
<td>15m</td>
<td>Ship wreck</td>
<td>Solitary, pink translucent (soft)</td>
</tr>
<tr>
<td>cho-9</td>
<td>6/10/92</td>
<td>ibobang</td>
<td>12m</td>
<td>Rock ledge</td>
<td>Transparent w/ translucent blue towards siphon</td>
</tr>
<tr>
<td>cho-10</td>
<td>6/10/92</td>
<td>ibobang</td>
<td>15m</td>
<td>Rock ledge</td>
<td>Encrusting, translucent w/ dark green specs</td>
</tr>
<tr>
<td>cho-11</td>
<td>6/11/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Rock ledge</td>
<td>Inflated balls, gray w/ green inside</td>
</tr>
<tr>
<td>cho-12</td>
<td>6/11/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Algae mat</td>
<td>Gray encrusting</td>
</tr>
<tr>
<td>cho-13</td>
<td>6/11/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Algae mat</td>
<td>Black encrusting, shiny</td>
</tr>
<tr>
<td>cho-14</td>
<td>6/11/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Algae mat</td>
<td>Brown encrusting</td>
</tr>
<tr>
<td>cho-15</td>
<td>6/11/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Algae mat</td>
<td>White encrusting, inflated</td>
</tr>
<tr>
<td>cho-16</td>
<td>6/12/92</td>
<td>Flotworm La</td>
<td>1m</td>
<td>Marine lake</td>
<td>Stalked translucent pale yellow, silty</td>
</tr>
<tr>
<td>cho-17</td>
<td>6/12/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Encrusting, thin, pink inflated</td>
</tr>
<tr>
<td>cho-18</td>
<td>6/12/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Burgundy encrusting around seagrass</td>
</tr>
<tr>
<td>cho-19</td>
<td>6/12/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Translucent white and green, encrusting</td>
</tr>
<tr>
<td>cho-20</td>
<td>6/13/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Thick encrusting dark olive green</td>
</tr>
<tr>
<td>cho-21</td>
<td>6/13/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Stalked, light gray, mottled</td>
</tr>
<tr>
<td>cho-22</td>
<td>6/13/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Inflated balls, gray w/ green inside</td>
</tr>
<tr>
<td>cho-23</td>
<td>6/13/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Thin encrusting white</td>
</tr>
<tr>
<td>cho-24</td>
<td>6/13/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Brown encrusting</td>
</tr>
<tr>
<td>cho-25</td>
<td>6/13/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Pink encrusting w/ white openings</td>
</tr>
<tr>
<td>cho-26</td>
<td>6/13/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Translucent w/ white zooids</td>
</tr>
<tr>
<td>cho-27</td>
<td>6/13/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Pale orange thin encrusting</td>
</tr>
<tr>
<td>cho-28</td>
<td>6/13/92</td>
<td>Ngeddarak</td>
<td>1m</td>
<td>Seagras bed</td>
<td>Translucent pink soft, solitary</td>
</tr>
<tr>
<td>cho-29</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>10m</td>
<td>Coral</td>
<td>Green encrusting and rubbery (thin)</td>
</tr>
<tr>
<td>cho-30</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>10m</td>
<td>Soft Coral</td>
<td>Encrusting, inflated, brown (thin)</td>
</tr>
<tr>
<td>cho-31</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>10m</td>
<td>Coral</td>
<td>Stalked, mottled, gray and white</td>
</tr>
<tr>
<td>cho-32</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>10m</td>
<td>Coral</td>
<td>Thin encrusting purple (smooth)</td>
</tr>
<tr>
<td>cho-33</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>10m</td>
<td>Rock</td>
<td>Thin encrusting dark pink, inflated</td>
</tr>
<tr>
<td>cho-34</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>10m</td>
<td>Soft Coral</td>
<td>Colony of solitary, translucent yellowish w/ yellow border around siphon.</td>
</tr>
<tr>
<td>cho-35</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>10m</td>
<td>Rock</td>
<td>Thin encrusting red stuff.</td>
</tr>
<tr>
<td>cho-36</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>15m</td>
<td>Rock</td>
<td>Very thick encrusting forming large globs (rubbery)</td>
</tr>
<tr>
<td>cho-37</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>15m</td>
<td>Rock</td>
<td>Thin encrusting gray w/ yellow dots (inflated)</td>
</tr>
<tr>
<td>cho-38</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>15m</td>
<td>Rock</td>
<td>Thin encrusting gray w/ black dots</td>
</tr>
<tr>
<td>cho-39</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>15m</td>
<td>Rock</td>
<td>Spherical, stalked (sand covered)</td>
</tr>
<tr>
<td>cho-40</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>15m</td>
<td>Rock</td>
<td>Thin encrusting yellow stiff (white underneath)</td>
</tr>
<tr>
<td>cho-41</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>15m</td>
<td>Rock</td>
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</tr>
<tr>
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<td>15m</td>
<td>Rock</td>
<td>Spherical red gelatinous</td>
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<td>cho-45</td>
<td>6/17/92</td>
<td>Lighthouse C</td>
<td>15m</td>
<td>Soft Coral</td>
<td>Yellow w/ dark green spots (staked, firm)</td>
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<tr>
<td>cho-46</td>
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<td>15m</td>
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<tr>
<td>cho-47</td>
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<td>Thin encrusting black/white pattern w/ some red dots</td>
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<td>cho-48</td>
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<td>15m</td>
<td>Rock</td>
<td>Forms large lumps (large visable holes, rubbery)</td>
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<td>Thick encrusting Army Green Rubbery</td>
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<td>Algae mat</td>
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<td>Rock/Coral</td>
<td>Encrusting, light brown, soft white, black around siphon</td>
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<td>Encrusting bumps about 1-2 mm in diameter; light orange</td>
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<td>15-20m</td>
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<td>15-20m</td>
<td>Rock/Coral</td>
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<td>Small clumps of individual zooids; Colonial; Dirty orange with milky orange z</td>
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<td>Thin encrusting, beige/pale; Same as 76</td>
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<td>cho-86</td>
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<td>Omodex</td>
<td>1m</td>
<td>Rock</td>
<td>Thin encrusting; Dark Brown with orange Motting (slightly pink)</td>
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<td>Rock</td>
<td>Thick encrusting and dark purple</td>
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<td>Big Jellyfish</td>
<td>1m</td>
<td>Branches &amp; ascidian</td>
<td>Encrusting sometimes forming dribbles on mangrove roots; Grey to white</td>
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<td>1m</td>
<td>Rock, Branches, oyster</td>
<td>Solitary, orange living in clusters</td>
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<tr>
<td>cho-91</td>
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<td>Big Jellyfish</td>
<td>1m</td>
<td>Solitary Ascidian</td>
<td>Thin white encrusting living on the orange ascidian</td>
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<td>cho-92</td>
<td>7/21/92</td>
<td>KB Channel</td>
<td>15m</td>
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<td>Orange gelatinous, thick encrusting with darker orange depressions</td>
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<td>Rock</td>
<td>Thin encrusting pink with red circles (pebbly); larger zooids</td>
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<td>Ngerikul Pas</td>
<td>15m</td>
<td>Rock</td>
<td>Solitary dark blue with yellow around siphons; Small and delicate</td>
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<td>Rock</td>
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<td>Solitary dark blue with yellow around siphons; Small and delicate</td>
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<td>Solitary dark blue with yellow around siphons; Small and delicate</td>
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<td>Rock</td>
<td>Solitary dark blue with yellow around siphons; Small and delicate</td>
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## Appendix 2

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<tr>
<th>LOCATION</th>
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<tbody>
<tr>
<td>Badibei</td>
<td>N 7°23.69 - E 134°35.3</td>
<td>Depressions in reef aprox. 5m/Sandy bottom channel.</td>
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<td>Ibobang</td>
<td>N 7°30.58 - E 134°29.6</td>
<td>Narrow passage of a bay, muddy w/ some seagrass.</td>
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<td>Nederrak</td>
<td>N 7°23.69 - E 134°35.3</td>
<td>Algae mat outside of Malakal harbor/ 1m</td>
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<td>Flatworm lake</td>
<td>N 7°19.12 - E 134°07.3</td>
<td>Marine lake SW side of KB channel 5m</td>
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<td>Ngermutidech</td>
<td>N 7°18.74 - E 134°31.1</td>
<td>Seagrass bed outside of Flatworm lake</td>
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<td>Lighthouse Channel</td>
<td>N 7°18.74 - E 134°31.1</td>
<td>Channel that runs into Malakal on East opening</td>
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<td>Airai Seagrass Bed</td>
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<td>Other Side of Ngermutidech</td>
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<td>Wonder Channel</td>
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<tr>
<td>Omodes</td>
<td>N 7°18.74 - E 134°31.1</td>
<td>The channel leading out of Nikko bay before uel island</td>
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<td>Channel leading out of the KB bridge. East of Airai</td>
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## Appendix 3

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