

THE NAGA EXPEDITION TO SOUTH CHINA AND AUSTRALASIAN SEAS 1959-1961

With Special Reference to the Participation of Claude and Jean ZoBell
Who Prepared this Report in February 1986

Scripps Institution of Oceanography
University of California, San Diego 92093

Table of Contents

	Page
1. Introduction -----	2
2. Birth of the Expedition -----	2
3. Personnel -----	3
4. The R/V <i>Stranger</i> -----	4
5. Track of the <i>Stranger</i> -----	4
6. Naga Cruise S-11 -----	5
7. Ocean Hopping to Southeast Asia -----	6
8. To Nhatrang and Back to Saigon -----	6
9. Our Participation on Naga Cruise S-6 -----	7
10. Our Activities in Bangkok, Thailand -----	8
11. Bangkok to Cairns via Singapore and Brisbane, Australia --	8
12. Cairns to Thursday Island, Australia -----	9
13. More About Thursday Island -----	11
14. Microbial Biomass in Tropical Seas -----	11
15. Marine Yeasts -----	12
16. Our Return Trip to La Jolla -----	12
17. Some Natural Wonders -----	14
18. Published Papers -----	17
19. Acknowledgments -----	17
20. Appendix	

THE NAGA EXPEDITION TO SOUTH CHINA AND AUSTRALASIAN SEAS 1959-1961

With Special Reference to the Participation of Claude and Jean ZoBell
Who Prepared This Report in February 1986

Scripps Institution of Oceanography
University of California, San Diego 92093

Introduction.-- The Naga Expedition was a cooperative tripartite undertaking of U.S.A., Thailand, and Viet Nam to survey the hydrography and natural resources of the Gulf of Thailand and portions of the South China Sea adjacent to South Viet Nam. An important part of the project was to train native scientists and technicians in that area. The well-equipped 124-foot research vessel, the R/V *Stranger* as well as several smaller craft and land-based laboratories were used during the Expedition. James M. Faughn, a professional marine engineer, was a Project Officer, Captain of the ship, and Leader of the Expedition. The famous Danish oceanographer, Dr. Anton F. Bruun, was appointed Scientific Leader. More than a hundred scientists, seamen, officers, and trainees participated in the Expedition.

Although primarily a South China Sea and Gulf of Thailand expedition, a few participants traveled south to Thursday Island, Cape York, Queensland, Australia, for observations in and around Torres Strait and the Great Barrier Reef. They were members of the "Public Health" group, so-called because it was subsidized largely by the U.S. Public Health Service through the National Institute of Health. Jean and I were members of the "Public Health" group.

The R/V *Stranger* sailed from San Diego, California, 15 June 1959 and returned there 24 June 1961. The Expedition lasted much longer.

Birth of the Expedition.-- The Expedition was implemented early in 1958 by Dr. Roger R. Revelle, director of the Scripps Institution of Oceanography (SIO), University of California. He was also a member of the UNESCO International Advisory Committee on Marine Science. Revelle collaborated with Dr. Harold J. Coolidge who was executive director of the Pacific Science Board of the National Academy of Sciences. After conferring with government officials in Thailand and South Viet Nam, Dr. Revelle proposed sending an SIO ship to the South China Sea for three years for the dual purpose of collecting oceanographic information and to train Thai and Vietnamese technologists and scientists in hydrography, marine biology, and marine geology. All parties concerned, including the Regents of the University of California, agreed to a two-year tripartite expedition. It was named NAGA for the mythological sea serpent of Vishnu, worshipped as sacred by many Indo-Chinese tribes.

Through the International Cooperation Administration (ICA), the U.S.A. contracted for its part in the Expedition to be managed mainly by the SIO, University of California. The U.S.A. subsidized most of the cost (about \$500,000) via the Office of Naval Research (ONR), the National Science Foundation (NSF), and the U.S. Public Health Service (USPHS). Considerably less financial support was provided by general funds from the University of California and the George Vanderbilt Foundation (GVF) of Stanford University. The corporate GVF had facilities in Hawaii and also in the Bangkapi district of Bangkok, Thailand. Laboratory accommodations, office space, and other shore facilities, including small boats, were provided by the Nhatrang Oceanographic Institute in South Viet Nam and by the Chulalongkorn University in Bangkok, Thailand. Other cooperating agencies included The Royal Thai Navy (hydrographic technicians, officers and petty officers to act as crew as well as scientific assistants and trainees), the Thailand Department of Fisheries (office and laboratory space), and the Australian CSIRO marine station on Thursday Island, Cape York, Queensland (for the "Public Health" group).

Personnel.-- Besides the masterminders mentioned above, others who had important decision-making responsibilities included:

Captain Amporn Penypol, Royal Thai Navy, Bangkok, Thailand
Mr. Boon Indrambarya, Department of Fisheries, Bangkok, Thailand
Rector Nguyen Quant Trinh, University of Saigon, Viet Nam
Dr. Le Van Thoi, University of Saigon, Viet Nam

Listed in alphabetical order on page 3a are most of those who participated for various periods of time in the Naga Expedition on the R/V *Stranger*. The following were aboard during Cruise S-6 from June 19-28, 1960:

James M. Faughn	Captain, Senior Engineer, and Chief Project Officer
Charles H. Smith	First Mate and Engineer
Louis J. Gonyea	Chief Engineer
Raymond M. Blei	Senior Laboratory Mechanician
John Van Landingham	Marine Chemist
Richard H. Greenbaum	Marine Technician
Tetsui Matsui	Marine Biologist
Claude E. ZoBell	Marine Microbiologist
Jean S. ZoBell	Laboratory Technician
Satcha Yongyuen	Thai Navy Officer
Lt. j.g. Cha-Erb	Thai Navy Officer
Thai cook and a steward	Names not available
Nguyen Dinh Bas	Vietnamese Trainee
Nguyen Van Luomi	Vietnamese Trainee
Tram Viet Quang	Vietnamese Trainee

Most of the crew members were rotated from cruise to cruise and served for different periods of time. With few exceptions, the membership of the crew that took the ship from San Diego to Bangkok (Thailand) via Honolulu, Guam, and Manila (a distance of 11,079 nautical miles) was quite different from the crew that brought the *Stranger* back to San Diego two years later. The return voyage of about 16,337 miles with stops in Darwin (Australia), Manila, Guam, and Hawaii required about three months.

According to Faughn (Naga Report, Vol. 1, p. 9, 1974), 58 of the 69 participants on the Expedition were from Thailand and Viet Nam. Of these, 16 made four or more cruises and were selected for four additional months of experience. They filled staff billets on board the *Stranger* during her return voyage to San Diego and spent two to four weeks at SIO before returning home. Thus, these 16 were gaining experience in the marine sciences for periods of 12 to 24 months.

The following participants on the Naga Expedition were members of the "Public Health" group:

Mr. Walter Gary,	Science Teacher, La Jolla High School
Dr. Malcolm Gordon	Instructor in Zoology, UCLA
Mrs. Diane Gordon	Musicologist, Los Angeles
Dr. Harold T. Hammel	Asst. Prof. Physiology, University of Pennsylvania
*Dr. Francis T. Haxo	Assoc. Prof. Biology, SIO
Mr. Edward Hemmingsen	Graduate Research Biologist, SIO
Mr. Hamilton Kelly	Research Assistant Zoology, UCLA
Mr. Roy E. King	Research Assistant Zoology, U.C. Berkeley
Dr. Knut Schmidt-Nielson	Prof. Zoology, Duke University
*Dr. Per F. Scholander	Prof. Physiology, SIO
Dr. Beatrice Sweeney	Asst. Research Biologist, SIO
*Dr. Claude E. ZoBell	Prof. Marine Microbiology, SIO
*Mrs. Jean S. ZoBell	Laboratory Technician, Microbiology, SIO

Those whose names are marked with an asterisk (*) did work on the *Stranger*.

Participants in the Naga Expedition on the RV *Stranger* were:

Ba, Nguyen Van	King, M.	Scholander, Dr. Per F.
Banasopit, Thien	Knudsen, Dr. Jorgen	Sdubbundhit, Lt., j.g. Cha-Erb
Banner, Christopher	Llarco, M	Serene, Dr. Raoul
Blei, Raymond M.	Loi, Tran Ngoc	Shipek, Carl J.
Bolin, Dr. Rolf	Luom, Nguyen Van	Smith, Charles H.
Boonlapo, Bhaisai	Matsui, Tetsui	Smelser, Clifford E.
Boonma, Bunya	Mero, Dr. John	Songnark, Jumngong
Boonyuen, Vicharn	Miller, Capt. Frank	Sripajumpiya, Bhaisai
Brinton, Dr. Edward	Mingmitra, Chamnarn	Srivirojna, Lt., j.g. Amnuay
Bruun, Dr. Anton Fr.	Moodharasint, Kosol	Subagjo
Buphavesa, Chaiyos	Muus, D.	Suboon, Lt., j.g. Anan
Calvert, Stephen	Nam, Sompong Mim	Sunpanich, Thumnoon
Chaitiamwong, Supachai	Nam, Tran Dinh	Suwanarit, Prachuab
Chalernpol, Lt. Cmndr. Sawang	Na-Nagara, Yong Yudh	Tanthikul, Soontorn
Chamsuksai, Bundith	Nhon, Tran Dai	Thien Tu Trinh
Chomsukprakit, Bhinyo	Nugulrak, Likit	Thompson, Robert W.
Clampitt, Clanton W.	Onnom, Songsukdi	Trac, Cao Xuan
Curray, Dr. Joseph R.	Pankasem, Narong	Tu, Tran Van
Debananda, Lt. Sg. Chuta	Penyapol, Capt. Amporn	Ucharatana, Chavalit
Faughn, Capt. James L.	Phoonsavad, Sompong	Vajrasthira, Chai
Gallardo, Ariel	Pinyoying, Sujet	van Andel, Dr. Tj. H.
Gonyea, Louis J.	Pirmoi, Sathuen	Van LANDINGHAM, John W.
Greenbaum, Richard H.	Piyakarnchana, Twesukdi	Varothai, Siri
Hai, Nguyen	Potibutra, Wong	Veevers, J.J.
Haxo, Dr. Francis T.	Prakitsri, Rangsarit	Villarta, R.
Hongkolohandha, Ens. Suchat	Quang, Tran Viet	Wooster, Dr. Warren S.
Hoodharasint, Kosol	Sach, Nguyen Van	Worawoothi, Pasok
Indrambarya, Kanok	Saichua, Pairat	Yamsri, Chala
Jacobs, William S.	Sainampuurg, Boonsong	Yuenyong, Satcha
Kasijan	Saisithi, Prasert	ZoBell, Dr. Claude E.
Khang, Nguyen Duc	Saomain, Asani	ZoBell, Mrs. Jean S.

In addition to cruise participants were those specialists who came to Southeast Asia to give instruction in their respective fields or to give special laboratory or cruise-planning assistance: Dr. Theodore Chamberlain, Professor Eugene La Fond, Mrs. Margaret K. Robinson, Dr. Douglas L. Inman, Dr. Robert Parker, jr., Mrs. Marcia Rottman, Dr. Garth Murphy.

Members of the George Vanderbilt Foundation in Bangkok were: Dr. Adair Fehlmann, Mr. Herbert Frey and Dr. R. R. Rofen.

The R/V *Stranger*.-- This 325-ton 123-foot long yacht had a beam of 24 feet, a draft of 15 feet, a speed of 12 knots, and a cruising range of 6,000 miles. She was powered by two 400-horsepower (each) Washington diesels. She was built in 1938 in Seattle for a wealthy Wyoming rancher, Fred Lewis, who owned a small island off the coast of British Columbia. Despite her having 60 tons of lead ingots on her keel, the *Stranger* had a reputation for rolling in rough seas.

After being obtained in 1955 by the University of California for use as a research vessel for the Scripps Institution of Oceanography, she was refitted as such and called the R/V *Stranger*. Her trawl winch was outfitted with 7,000 meters of new 3/8-inch braided wire rope. Two reels of 3/16-inch hydrographic wire were aboard for Nansen bottles, small plankton nets, J-Z bacteriological samplers, gravity corers, bathythermographs (BTs), and other small gear. Her rather crowded laboratories were conveniently located amidship immediately behind the bridge. The *Stranger* could accommodate a crew of 14 and 10 scientists.

Having carried aboard our portable laboratory for field work, Jean and I were able to collect and analyze water and bottom sediment samples during most kinds of weather. We had a cabin located forward with one bunk beneath the other and both below sea level. It was comfortable enough except during rough seas such as we experienced sometimes on Cruise S-6 (see p. 7a) during the monsoon season between 19 and 28 June 1960 when we were working at Hydrographic Stations 29 to 42 located up to 250 miles offshore between 5 and 10° N. Latitude. Much of the time the ship's inclinometer was indicating a roll angle of 10 to 45 degrees.

Despite much rolling during storms, none of the *Stranger's* crew members or scientists (see p. 3), including the ZoBells, were afflicted with mal de mer. None of us missed a meal or lost one. Excessive rolling tended to retard manual manipulations, including walking, but not enough to result in our skipping a scheduled station. At its worst, excessive rolling thwarted sound sleep. Side boards helped to keep one from rolling out of one's bunk, but the side boards abraded one's elbows. All of the Vietnamese trainees on Cruise S-6 (see p. 3) were confined to their bunks or otherwise suffered seasickness during foul weather.

Track of the *Stranger*. -- The westward voyage of the *Stranger* from San Diego, California, to Bangkok, Thailand, was not part of the routine survey. The distances traveled on each westward leg of the voyage are given below in nautical miles:

<u>Dates (1959)</u>	<u>Leg of voyage</u>	<u>Miles</u>
June 15-29	San Diego to Honolulu	2,427
July 3-21	Honolulu to Guam	3,526
July 24-Aug. 8	Guam to Manila, P.I.	2,810
Aug. 3-17	Manila to Nhatrang, Viet Nam	,718
Aug. 19-24	Nhatrang to Sattahip, Thailand	1,530
Aug. 28	Sattahip to Bangkok, Thailand	68
	Total nautical miles	11,079

Sattahip is a Thai Naval Base near Bangkok. Exploratory geological investigations, concerned mainly with deep-sea manganese nodules, were made only on the first leg from San Diego to Honolulu. Net tow, hydrographic, BT, and certain other observations were made only occasionally on the voyage from San Diego to Bangkok primarily to test the ship's equipment.

The first student training cruise was in the northern Gulf of Thailand, September 8-17, 1959. It was followed by the first scientific survey cruise (S-1). Odd-numbered cruises (S-1, S-3, S-5, S-7, S-9, and S-9A) designate Gulf of Thailand surveys. Even-numbered cruises (S-2, S-4, S-6, S-8, and S-10) designate South China Sea surveys. In the latter, the *Stranger* departed from Bangkok and put into port at either Nhatrang or Saigon. Hydrographic stations were

numbered consecutively by cruises, e.g., S-1-1 designates hydrographic station No. 1 on cruise S-1, and S-6-37 designates hydrographic station No. 37 on cruise S-6 (for examples see page 7a). Stations made enroute to pattern area are designated U to indicate underway.

The cruise pattern for the South China Sea consisted of stations aligned along six lines almost perpendicular to the eastern coast of South Viet Nam, extending from near-shore to approximately 250 miles off-shore. The northernmost line ran due east-west at latitude 15°40' N. The southernmost line veered south until it was almost parallel with the eastern shore of the Gulf of Thailand. The remaining lines were spaced at approximately 100-mile intervals. Along each line, hydrographic stations were spaced about 40 miles apart.

Sea miles as follows were traveled by the R/V *Stranger* on each of the Naga cruises in southeastern Asian waters and while homeward bound to San Diego. The first ten cruises started and terminated at Bangkok, Thailand. Cruises S-11A, B, C, D, and E were from Bangkok to San Diego via Darwin (Australia), Manila, (P. I.), Guam, and Hawaii.

<u>Cruise</u>	<u>Region or area</u>	<u>Dates</u>	<u>Distance</u>
S-1	Gulf of Thailand	October 19-31, 1959	1,885
S-2	South China Sea	November 16-30, 1959	3,200
S-3	Gulf of Thailand	January 9-31, 1960	2,000
S-4	South China Sea	February 15-March 21, 1960	3,500
S-5	Gulf of Thailand	April 21-May 3, 1960	2,063
S-6	South China Sea	May 23-June 28, 1960	3,697
S-7	Gulf of Thailand	August 2-15, 1960	2,021
S-8	South China Sea	September 5-October 8, 1960	3,586
S-9	Gulf of Thailand	November 9-25, 1960	2,024
S-9A	Gulf of Thailand	December 8-14, 1960	698
S-10	Gulf & S. China Sea	January 10-February 13, 1961	3,130
Total miles			27,804
S-11A	Bangkok to Darwin	March 15-April 21, 1961	6,331
S-11B	Darwin to Manila	April 13-May 3, 1961	1,870
S-11C	Manila to Guam	May 6-20, 1961	2,183
S-11D	Guam to Hawaii	May 23-June 10, 1961	3,671
S-11E	Hawaii to San Diego	June 13-26, 1961	2,282
Total miles from Bangkok to San Diego (eastbound)			16,337
San Diego to Bangkok (westbound)			11,079
Total miles traveled by the R/V <i>Stranger</i> on the Naga Expedition			55,220

Naga Cruise S-11. -- This was the last cruise of the *Stranger* on the Naga Expedition. The voyage consisted of five legs designated S-11A, B, C, D, and E. Naga Cruise S-11A departed from Bangkok on March 15, 1961. The ship sailed southeasterly out of the Gulf of Thailand and then through the South China Sea and the Sunda Strait into the Indian Ocean. There she proceeded eastward parallel to the south coast of Java (Indonesia) and the Lesser Sunda Islands into the Timor Sea to Port Darwin in northwestern Australia (see page 5a). The small marks on the track show where routine BT observations were made. The zig-zag tracks in the bottom right-hand corner of the chart on page 5b show a continuation of Cruise S-11A for a couple of weeks from and back to Darwin for observations in the Timor and Arafura Seas.

After two more days in port at Darwin, the *Stranger* started on Cruise S-11B. She sailed north by northeasterly to Manila, P.I., via the Timor Sea, Banda Sea, Malukka Sea, Celebes Sea, Sulu Sea, and the eastern side of the South China Sea. This was the last of the Naga Expedition cruises on which routine hydrographic, biological, chemical, and geological observations or collections were made. Only routine BT observations and infrequent stramin tows (indicated by small squares on page 5b) were made on Cruises S-11C, D, and E. between Manila and San Diego.

Fig. 5a.-- Naga Cruise S-11A and S-11B. Cruise S-11A was from Bangkok southward into the Indian Ocean through the Sunda Strait, then eastward to Darwin, Australia (Station V-165). S-11A continued for two weeks from Darwin into the Timor and Arafura Seas and back to Darwin before beginning S-11B from Darwin northward through the Sulu Sea to Manila, P.I.. Reprinted from James L. Faughn, "Naga Expedition: Station Index and Data," Naga Report Vol. 1, p. 118, Scripps Institution of Oceanography, University of California, San Diego, 1974.

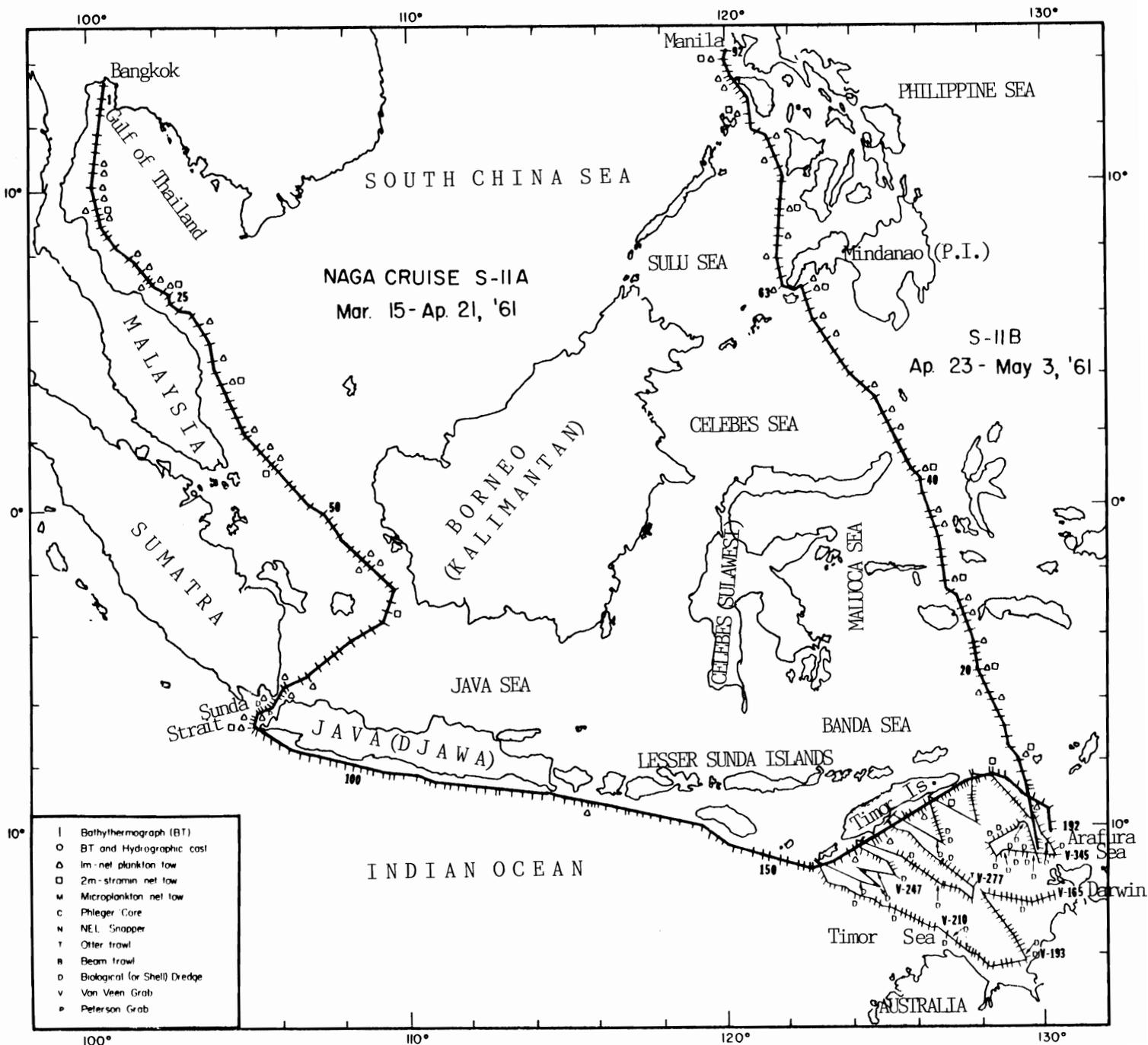
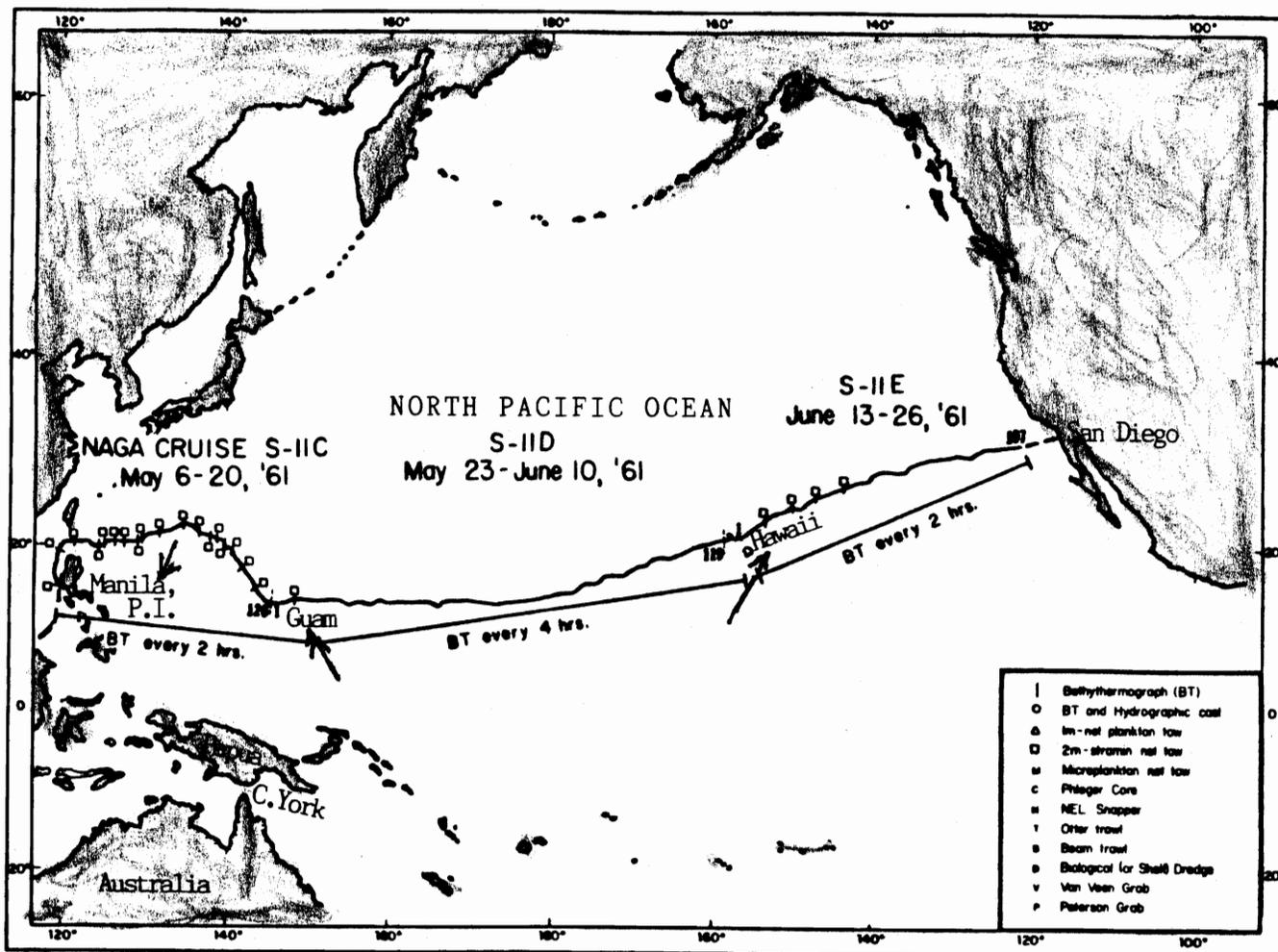


Fig. 5b.-- Naga Cruise S-11C, D, and E from Manila, P.I., to San Diego, Calif., via Guam and Honolulu, Hawaii. Reprinted from James L. Faughn, "Naga Expedition Station Index and Data," Naga Report, Vol. 1, p. 119, Scripps Institution of Oceanography, University of California, San Diego, 1974.



Ocean Hopping to Southeast Asia.-- Except for the few who traveled on the *Stranger*, Expedition participants were obliged to obtain other means of transportation to Southeast Asia. Jean and Claude Zobel traveled overseas by Pan American Airlines to Saigon, South Viet Nam. We departed from San Diego late in the day on May 26, 1960, enroute to Honolulu via Los Angeles. We stopped for six nights in Tokyo from which we made side trips by rail to Shizuoko, Yokohama, and Kamakura, primarily to visit former students and visiting investigators. We lost a day crossing the International Date Line between Honolulu and Tokyo. The plane schedule obliged us to stop overnight in Hong Kong where we had bed and board in the Peninsula Hotel on Kowloon. It was only a three-hour flight from Hong Kong to Saigon. There the Naga Expedition officers had made arrangements for our being accommodated in Hotel Majestic for four days, June 4-7, 1960.

Hotel Majestic was located beside the Saigon River not far from the port where the *Stranger* sometimes docked. It was within easy walking distance of the U.S.A. Officer's Club (called The Brink), the Railroad Station, the National Museum, the Saigon University campus, the Pasteur Institute, the South Viet Nam Division of Fisheries, and several other places of interest.

Our first rendezvous with other members of the Naga Expedition was in Hotel Majestic. Also stopping at the Majestic Hotel were Pete Scholander, Francis Haxo, and Roy King. The latter was a young Research Assistant Zoologist from the University of California, Berkeley. Professors Scholander and Haxo were SIO marine biology professors. These three, like Jean and I, were enroute to the Institut Océanographique in Nhatrang, one of the principal cooperating agencies for the Naga Expedition.

To Nhatrang and Back to Saigon.-- Drs. Haxo and Scholander, and Roy King departed from Saigon by train enroute to Nhatrang on June 7. This was about a 10-hour trip of some 250 miles along the east coast of South Viet Nam. The Zobel's elected to fly to Nhatrang in a Vietnamese Air Force plane. We had learned from a casual conversation with a U.S. Military Advisor at The Brink that such training planes made daily flights between Saigon and Nhatrang. The ONR card that Claude carried was accepted by the U.S. Military Advisor in charge of MATS (Military Air Transport) transportation and we were cleared for the training flight.

Before dawn on June 8, we were picked up at the Majestic Hotel by a military Jeep and driven through the dark streets of Saigon to the Tan San Nhut airport, passing through its heavily guarded gates in dawn's earliest light. We were escorted to our bucket seats aboard the plane. As the crew came on board, we were somewhat surprised to see that the pilot, co-pilot, and navigator were all Vietnamese. The U.S. Military Advisor, a sergeant, remained in the middle of the plane with us. After a short hop, the plane landed at an airstrip. We climbed out of the plane hoping to find some sanitary facilities, but discovered that the airstrip was little more than an open field surrounded by armed guards posted about a hundred meters apart. The flight soon continued on to Nhatrang.

Pete Scholander and Francis Haxo met us at the Nhatrang airport. In the Expedition Jeep, they drove us to the Institut Océanographique, where our party was housed in the Institute dormitory. We were welcomed by Mr. Nguyen Dinh Hung. We also met and later worked with Mr. Nguyen Hai and Mr. Ngoc Loi (jokingly referred to as Mr. High and Mr. Low). They showed us through the laboratory and library. The library shelved about a thousand volumes, most of which were textbooks and reports from other biological stations. Conspicuous were several paper-bound volumes of the SIO Contributions. I was pleased to see two copies of my "Marine Microbiology" shelved beside a well-worn copy of "The Oceans" by Sverdrup, Johnson, and Fleming.

Across the road from the Institute was a French restaurant, Chez François. François was a Frenchman who remained in South Viet Nam after the withdrawal of the French military forces in 1956. He was married to a North Vietnamese woman. The restaurant was clean and the food so good that we ate our meals there during our stay in Nhatrang. It specialized in fresh fish, crab, lobsters, and shrimp, and French cheeses and wines. François made delicious omelets.

On June 9, Capt. Jim Faughn escorted Pete Scholander, Francis Haxo, Roy King, and the Zobel's on an all-day reconnaissance cruise aboard the *Stranger*. We sailed around Hon Ngoai, Hon Lon, and Hon Mung Islands and fishing banks in Nhatrang Bay.

Not until June 13 was our "portable water laboratory" delivered to us by a South Viet Nam customs officer. It had been shipped to us a couple of weeks earlier from La Jolla by military air express. It was a 26 x 12 x 16-inch acrylic-coated fiber-glass box that weighed about 27 kg (60 lb) when loaded with Isopor membrane apparatus, six dozen Isopor filters, two dozen pipettes, six dozen small test tubes, sterilizing equipment, vacuum pump, a hundred small plastic Petri dishes and receptacles for their sterile storage and incubation. The portable laboratory could be assembled in a field or research laboratory in about 20 minutes and packed for transportation almost as rapidly. We used it on the *Stranger*, in hotel rooms, on an outboard motorboat, and elsewhere in the field.

The first entry made in my field notebook records on June 13, "Portable lab received at 3:00 p.m. from Viet Nam customs officer. Made tests on filtered dormitory drinking water." After 24 hours' incubation at 37°C, presumptive tests for enteric bacteria were positive, four-plus for *E. coli*.

During our two remaining days in Nhatrang (June 14 and 15), we examined 38 water samples for the presence of enteric bacteria of sanitary significance. Included in this quick survey were samples of drinking water from various places, melted ice water, "filtered" water, iodized water, and seawater collected from the beach and bay in the vicinity of the Institut, Chez François, and residences along the coast where raw untreated sewage flowed along the beach and into the bay. Demonstrating and employing such methods was one of my assignments from the U.S. National Institutes of Health (NIH).

On June 16, we returned from Nhatrang by commercial plane to Saigon. There we were lodged again in Hotel Majestic. That evening, Dr. Per Scholander treated the Public Health group and Jim Faughn to an escargot (snail) dinner in a fancy French restaurant. As is customary, the snails were served in the shell with a delicious sauce.

The following afternoon (June 17), we had a conference at Saigon University. The conference was arranged by Mr. Nguyen Dinh Hung and Rector Nguyen Quang Trinh. Besides these two, our Public Health Group, Capt. Faughn, and officers of the Pasteur Institute and the Thai Department of Fisheries participated in the conference along with Capt. Amporn Penypol, Royal Thai Navy Hydrographic Office, Bangkok. All seemed to be going well as the Naga Expedition approached its midway point.

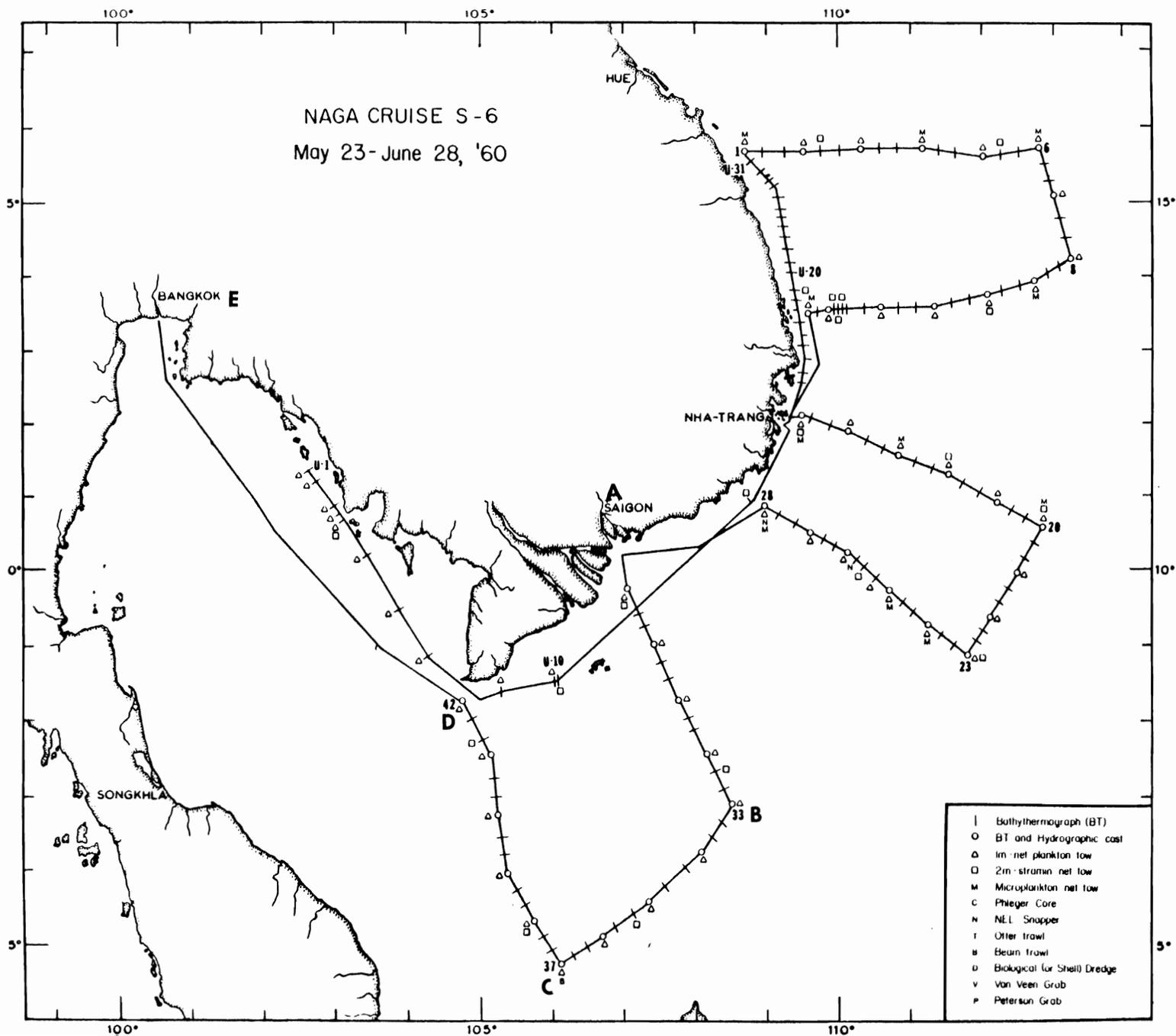
After having retrieved our passports the day before, we were cleared to exit Viet Nam on Sunday, June 19. We boarded the *Stranger* at 8:30 a.m. and began the trip down the Saigon River shortly afterwards. This was the beginning of Cruise S-6 for us.

Our Participation on Naga Cruise S-6. -- The return leg of Cruise S-6 is charted on page 7a. The R/V *Stranger* and her performance at sea have been discussed on page 4 and her personnel on Cruise S-6 on page 3. The ZoBells boarded the *Stranger* on June 19 in Saigon. She sailed down the Saigon River and out about 248 miles southwesterly in the South China Sea to station No. 33 (see page 7a). There the ship turned southeast for about 230 miles to Station No. 37, where she turned 90 degrees northward and continued 278 miles north northeast to station No. 42.

Hydrographic stations were occupied every four hours day and night on our 660-mile cruise from Saigon to station No. 42. The details are recorded in the Log of the *Stranger* (shelved behind locked doors in the SIO Library) and in the "Naga Expedition: Station Index and Data" by James M. Faughn, Vol. 1, p. 177, 1974 (SIO call number GC 5 N 147).

The ZoBells aseptically collected and examined by cultural methods 156 samples of water from 24 stations in the South China Sea. They collected these samples from near the surface, at depths of 10 to 20 meters, and from about one meter off the bottom (depth 30 to 90 meters). The water samples were examined for the abundance of bacteria and yeasts. Some of the data and their oceanographic significance were summarized by ZoBell in a lecture at a joint meeting of the Microbiological Society of Thailand and the Pasteur Institute in Bangkok, July 1, 1960. (See his paper, "Marine Microbiology with Notes on Bacteria in the South China Sea," Jour. Microbiol. Soc. Thailand, Vol 5:361-368, 1961.)

Fig. 7a.-- Claude and Jean ZoBell boarded the R/V Stranger at Saigon (A) and sailed 248 miles southeast to Station 33 (B), then 230 miles southwest to Station 37 (C), 278 miles northwest to Station 42 (D), and finally about 500 miles northwesterly to Bangkok (E), a total of 1255 miles. Reprinted from Naga Report, Vol. 1, page 112, 1974.



laboratory shared with Tets made it necessary for me to have some friendly conversation with him concerning the incompatibility of formaldehyde (commonly used to preserve fish and certain other marine animals) with marine microbes that microbiologists strive to keep alive.

Our Activities in Bangkok, Thailand.-- After completing Cruise S-6 at Station No. 42, we headed for Bangkok, a voyage of nearly 420 miles through the Gulf of Thailand and into the Chao Phraya River. The *Stranger* docked at the Police Dock in Bangkok on Tuesday, June 28. Jean and I simply walked off the ship and took a taxi to Hotel Playa. That proved to be a mistake inasmuch as by doing so, we had not legally entered Thailand. To correct this mistake, we had to appear before Thai immigration authorities. After several anxious hours, through the good offices of Capt. Jim Faughn, our passports were stamped to show that we had legally entered Thailand.

We were warmly welcomed by several faculty members at Chulalongkorn University and the Queen Saovabha Institute. Among those with whom we conversed were Choelon Purananda, Kloom Vejarabala, Twesukdi Peyakarnchans, and Jinda Thiemmedk. All of these were teaching microbiology, mainly medical and sanitary microbiology, with not much original research. They invited me to give a lecture on marine microbiology. I also gave a talk at the Pasteur Institute of Thailand and the Thailand Society for Microbiology. The latter elected me to honorary life membership. Most of the members seemed to be strongly oriented towards problems of public health and infectious diseases.

We were then taken to the Thailand Venomous Snake Farm and Research Institute located on the outskirts of Bangkok. For our benefit, attendants demonstrated the "milking" of four different kinds of venomous snakes said to be common in Thailand. The venom is used to produce anti-venom for the treatment of snake bites.

On several occasions, Dr. Edward Brinton was our host. Ed specializes on euphausiid crustaceans at SIO. He was spending a year with his family in Bangkok where he was serving as a liaison officer for the Naga Expedition. In close collaboration with the Rector of Chulalongkorn University, Ed directed expedition work in the University laboratory dealing with the biological field collections after each cruise of the *Stranger*. As a staff scientist, Ed also accepted teaching assignments, attended seminars, and participated in the final field cruises. He escorted Jean and me on a half-day boat ride on the Chao Phraya River and some of the adjoining klongs (canals) and to the Wat Trimitra in which the Golden Buddha is housed. It is said to contain eight tons of solid gold.

As permitted by our schedule, on our own we visited the Royal Palace Gardens, the famous Emerald Buddha at Wat Pra Kaew, the Reclining Buddha at Wat Po, and the Gallery of 1000 Buddhas. We were also intrigued by the numerous water markets, Thai handicraft factories, klongs, and city parks.

Bangkok to Cairns via Singapore and Brisbane.-- Our carefully planned itinerary called for our departing from Bangkok at 5:00 p.m. on July 3 with dinner to be served enroute to Singapore. However, owing to the delayed arrival of our flight, on-going passengers had dined before the plane arrived in Bangkok. Passengers like Jean and me who boarded the plane in Bangkok were informed that there would be no food served enroute to Singapore. The flight from Bangkok to Singapore, located nearly a hundred miles north of the Equator, was about 900 miles. It was nearly midnight when we arrived at the Cockpit Hotel in Singapore, too late for dinner.

We celebrated the 4th of July exploring Singapore. We were amazed by the polyglot population and by the seemingly endless packs of Chinese junks occupying so much space in the waterways. Tempting were the omnipresent open-air food stands lining the streets in midtown Singapore.

We spent most of July 5 walking around the famous Singapore Botanical Gardens, best known for the great variety of plants, attractive landscape architecture, and numerous unrestrained monkeys frolic about through the trees and on the ground. We checked out of the Cockpit Hotel and spent the remainder of the day at the Raffles Hotel, waiting for our 8:30 p.m. departure for Sydney, Australia, a distance of 4300 miles. There was snow on the ground in Sydney, it being midwinter there. We were grateful that our stop was brief, inasmuch as we arrived there dressed for the tropics. From Sydney we flew to Brisbane, some 450 miles to the north, where it was much warmer.

While in Brisbane, we visited several scientists, some of whom I had met in October 1951 while on the *Galathea* Round-the-World Deep-Sea Expedition. These friends included Dr. I. M. Mackerras, director of the Queensland Institute of Medical Research, and the following staff members of the University of Queensland: Dr. Edward Derrick, who discovered Q (for query) fever, Dr. V. B. Skerman, Dr. George T. Stevenson, and Dr. Dorthea Sanders. The latter took us for a long trip in the country on Sunday, July 10.

Early Monday morning, Ansett flight No. 104 took us to Cairns (see page 9a), a small coastal town on the northeast side of Queensland about 500 miles southeast of Thursday Island and 900 miles northwest of Brisbane. We were lodged for three nights in Cairns at the Palace Hotel.

While at Cairns, we took a four-hour tour of the Atherton Tablelands, a scenic volcanic plateau rising two to three thousand feet above sea level a few miles west of Cairns. Its chief attractions are its rain forest, fertile fields, two crater lakes, and other geological features.

The Green Island tour, taken the next day, is popular with tourists, particularly marine biologists. It is a coral cay near Cairns on the inner (western) edge of the Great Barrier Reef. It is one of the closest and most accessible of the true coral cays. Its special attraction is an underwater clear glass observatory about 3 meters high, 3 meters wide, and 20 meters long. A walk through the passageway provides a spectacular view of corals, fish, and many other kinds of organisms in their natural habitat (see page 9b).

Cairns to Thursday Island, Australia. -- Appropriately enough, the ZoBells took an Ansett plane from Cairns to Horn Island and there a water taxi to Thursday Island on Thursday, July 14. These two Torres Strait islands are located about 500 miles north by northwest from Cairns at 10°34' S. Lat. In 1960 the taxi fare from Horn Island to Thursday Island (T.I.) was five shillings per person or about 60 cents. As shown on page 9c, T. I. is closely surrounded by Prince of Wales I., Friday I., Hammond I., and Wednesday I. The latter is 3 3/4 miles northeast of T.I.; the other three islands are only about a mile from T.I. At the narrowest point, T.I. is only two-thirds of a mile from the 12 square mile Horn Island, which had the only airfield in the area.

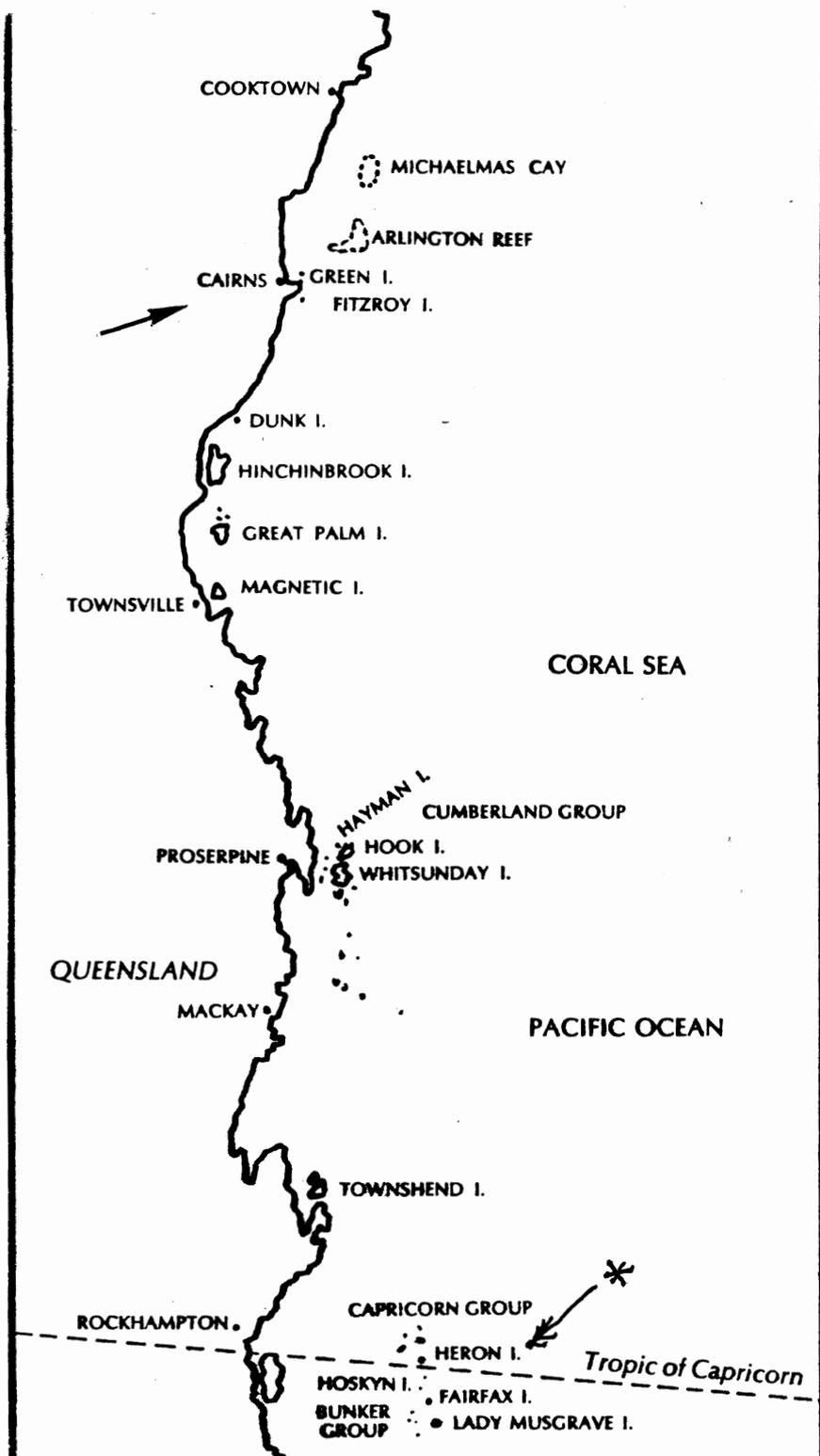
The other members of the Public Health group arrived in Cairns from Brisbane July 8, three days before the ZoBells. At that time this group consisted of Pete Scholander, Francis Haxo, Edvard Hemmingsen, Harold Hammel, Walter Gary, Beatrice Sweeney, and H. G. Le Messurier, Professor of Aeromedical Biology from the University of Adelaide, Australia. With the approval of all concerned, a 50-foot long motor vessel, the *Tropic Seas*, was chartered for a few weeks from Vince Vlasoff. He served as Captain and pilot. The ship had a beam of 13 feet, a draft of 6 feet, a speed of 7 knots, and a cruising range of 1500 miles. She carried a motor boat, a dinghy, a 2-way radio, and a 60 cubic-foot refrigerator. Her charter charge in 1960 was £24 (\$52.80) per day plus 16 shillings (\$1.75) per person for food.

The plan to have all of the Public Health group live aboard the *Tropic Seas* proved to be impractical, partly because of insufficient space to accommodate nine scientists and their gear, and also because the *Tropic Seas* made frequent overnight or longer trips to the pearl diving areas and to the Jardine River to study mangroves at the northern end of Cape York.

Drs. Haxo and Sweeney and the ZoBells resided in the Federal Hotel. It was somewhat less than first class, but it was the only hotel of the four on T.I. that had indoor plumbing. The other three had outhouses or "Chick Sales." The best double room, with full board, was only £12 or \$27 per week at the Federal Hotel.

Dr. Stan Hynd, the chief scientist at the CSIRO Department of Fisheries on T.I, provided acceptable laboratory and office space for Drs. Haxo and Sweeney in the main CSIRO laboratory located only a short distance southwest of the Federal Hotel. The ZoBells were given the use of a very well equipped 14 x 20-ft laboratory located at the end of the 600-ft Navy Wharf, about two-thirds of a mile from the Federal Hotel. The laboratory was available because the Japanese scientist who worked there on culturing pearls was away on extended leave. Thanks to our portable water laboratory, we were prepared to commence our microbial culture work almost immediately with very few innovations or acquisitions.

Fig. 9a.-- Principal islands in the Coral Sea off the east coast of Queensland, Australia, from Cooktown to Rockhampton near the Tropic of Capricorn. The black arrow points to the location of Cairns and Green Island. Brisbane is about 500 km (about 300 miles) south southeast of Rockhampton. (One inch = 100 miles). Reprinted from Douglass Baglin and Barbara Mullins, "Islands of Australia," Ure Smith, North Sydney, Australia, 1972.

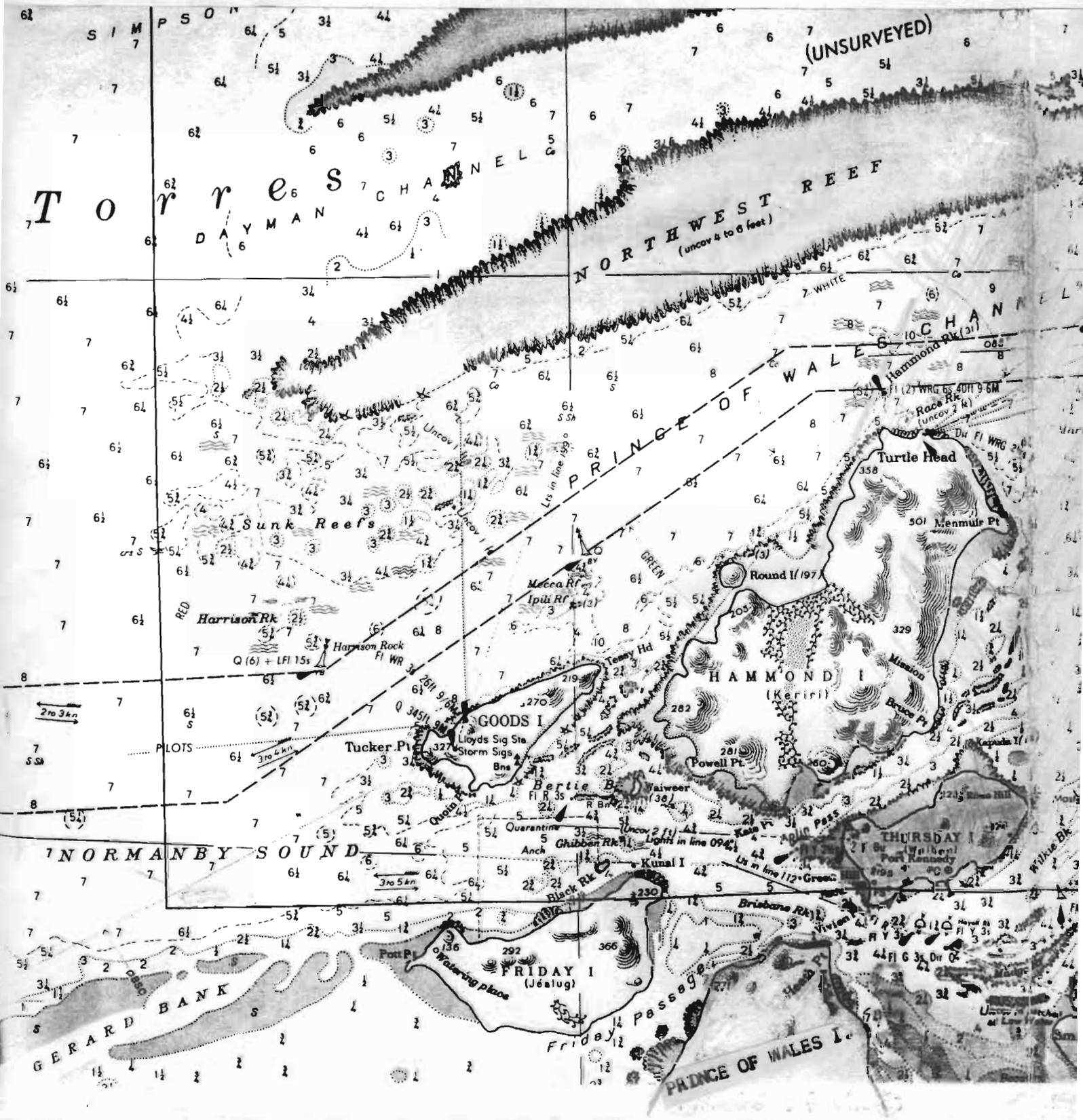


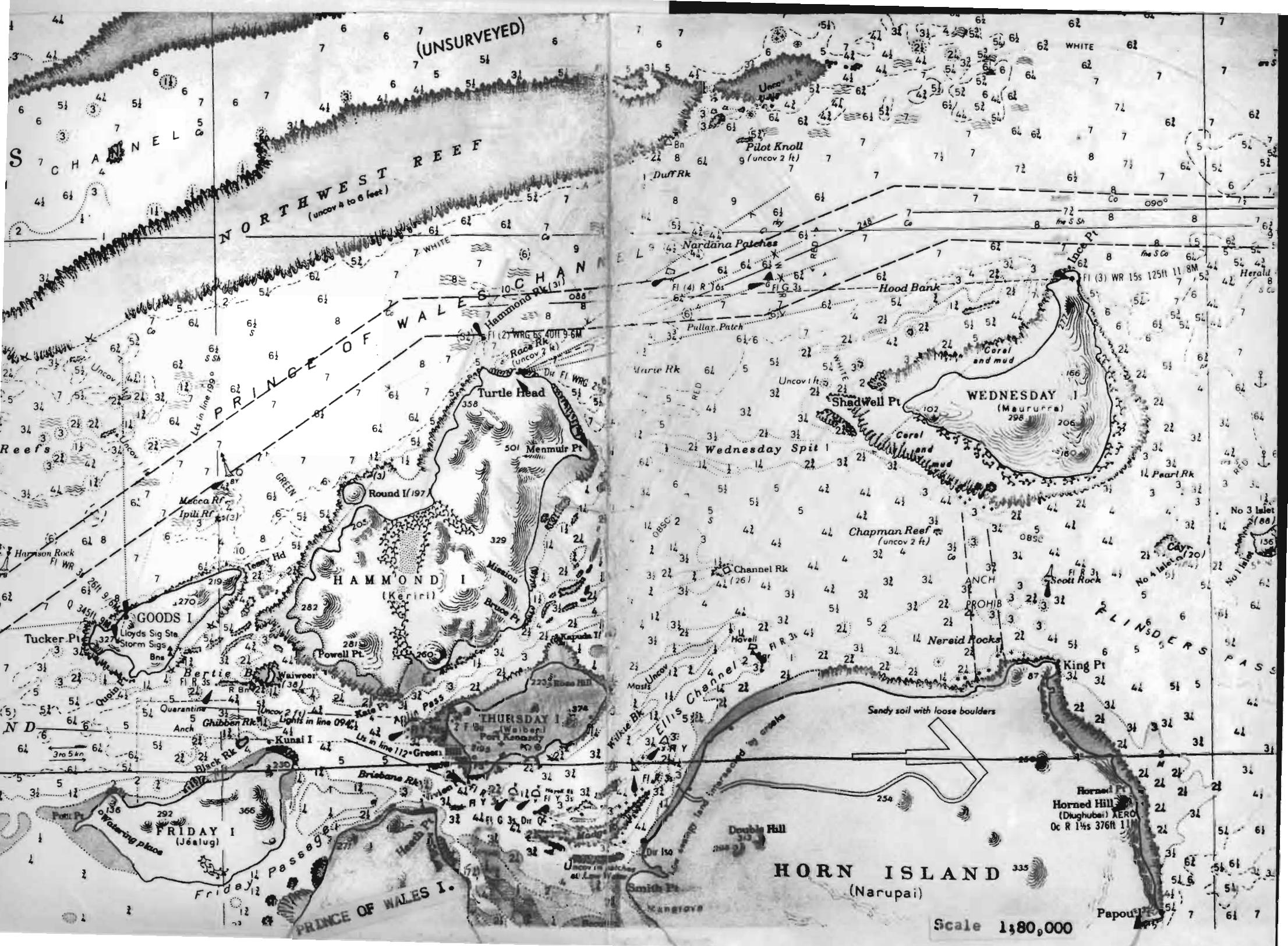
* I spent a week on Heron Island during the Danish *Galathea* Round-the-world Deep-Sea Expedition.

Fig. 9b.-- Green Island is a wooded islet located near Cairns within sight of land off the northeast coast of Cape York about 160 miles north of Townsville (Queensland, Australia) and some 600 miles south southeast of Thursday Island (in the Torres Strait). The underwater observatory is near the outer end of the approximately 900-ft long pier. Reprinted from Douglass Baglin and Barbara Mullins, "Islands of Australia," Ure Smith, North Sydney, Australia, 1972.



Fig. 9c.-- Navigation chart showing Thursday Island surrounded by Prince of Wales I. (ca. 1/3 mile S), Friday I. (ca. 1 mile SW), Hammond I. (ca. 1/2 mile NW), Wednesday I. (ca. 3 3/4 miles NE), and Horn I. (ca. 2/3 mile SE). The jagged lines surrounding some of the islands and reefs represent outer fringes that are not covered with water at the 3-ft tide level.





(UNSURVEYED)

S CHANNEL

NORTHWEST REEF
(uncov 4 to 6 feet)

CHANNEL OF WALE

PRINCE OF WALE I.

HAMMOND I
(Keriri)

THURSDAY I
(Wabapi)

FRIDAY I
(Jéalug)

PRINCE OF WALE I.

HORN ISLAND
(Narupai)

Scale 1:80,000

Papou



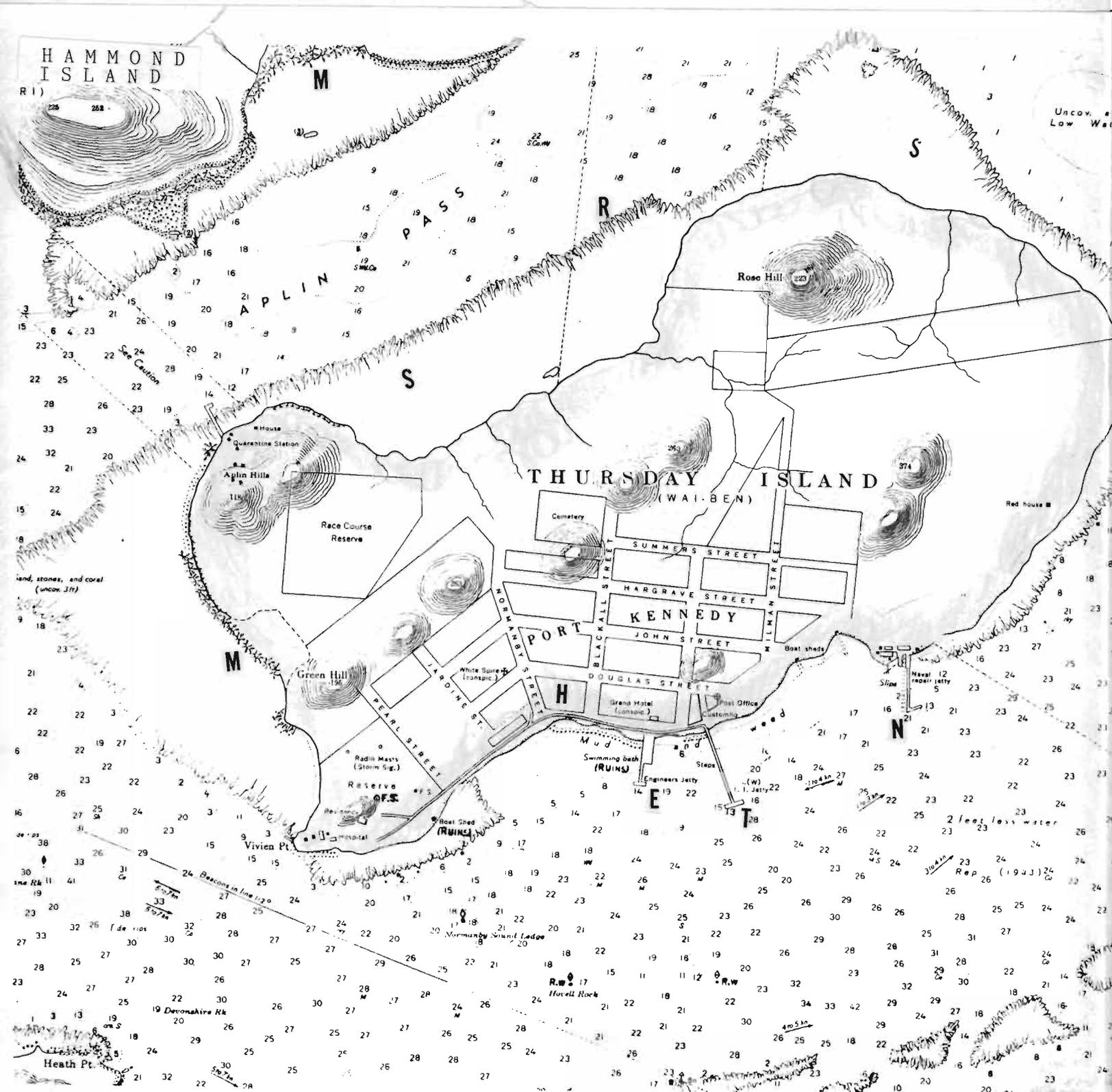
Federal Hotel, Port Kennedy, Thursday Island, Australia, 1960

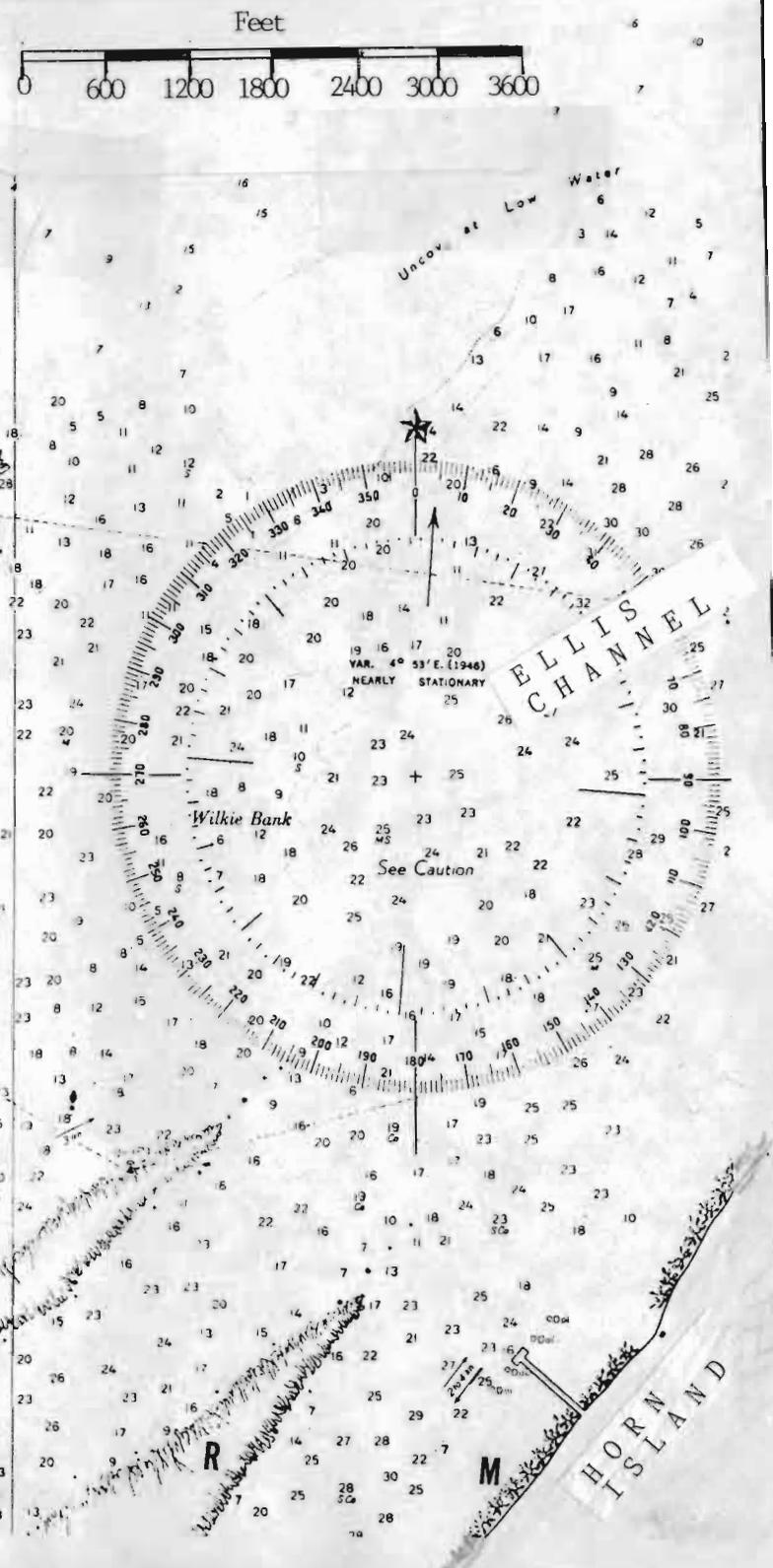
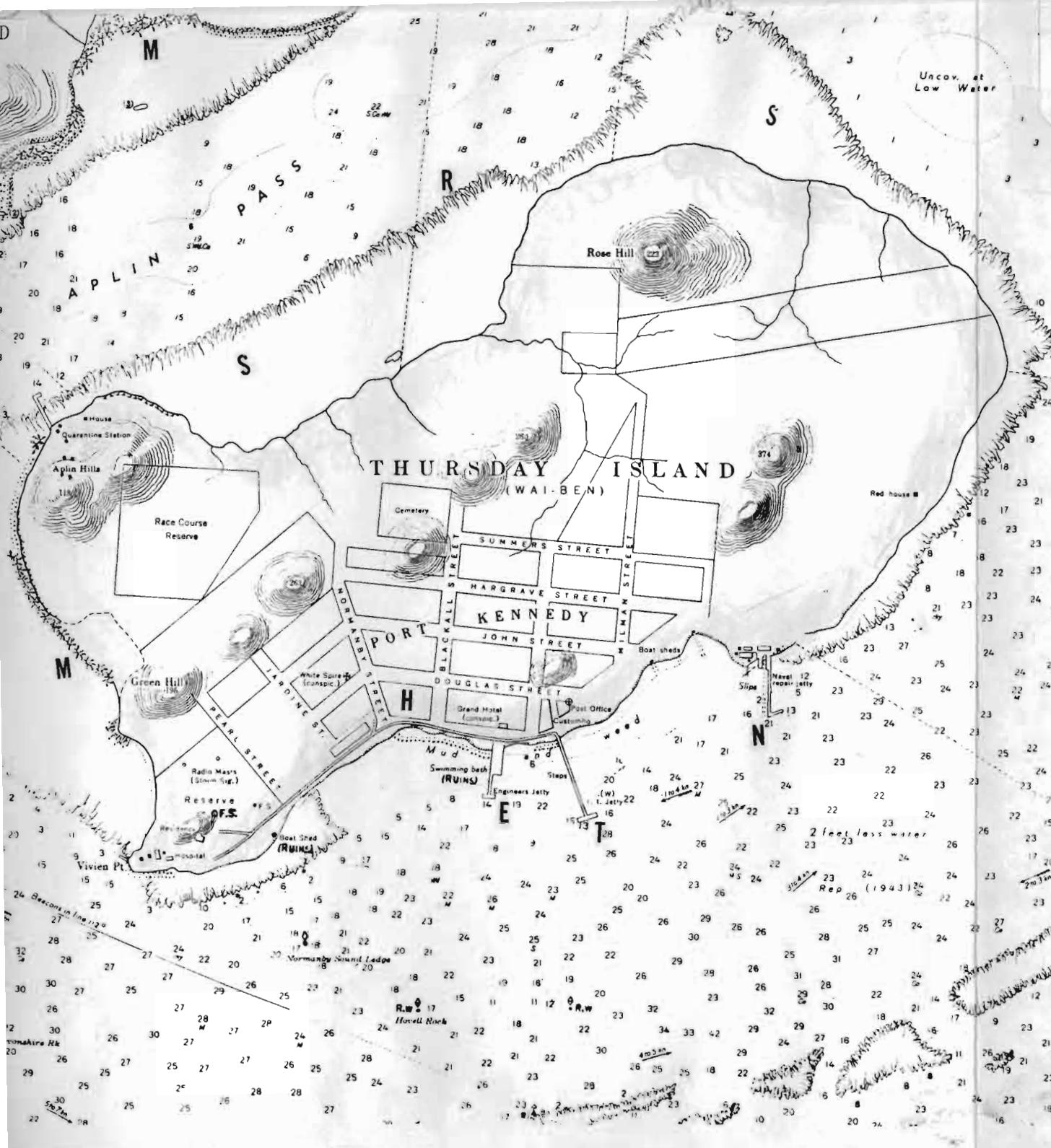
We came to love our Navy Wharf laboratory, where we had freedom from dust, mosquitoes, flies, and all except authorized visitors. Each day we lunched on fresh bread, bought at the local bakery on our morning walk to the lab, peanut paste (butter) and strawberry jam from the local general store, and fresh fish. Each morning as Claude sat on the deck recording data, he would throw a hook and line over the edge, wrapping the upper end of the line around his big toe. Within minutes there would be a tug on his toe and lunch would be on the line.



Claude ZoBell overlooking the Navy Wharf and our laboratory, T.I., Australia

Fig. 10a.-- Thursday Island (T.I.) is separated from Hammond Island by the Aplin Pass and from Horn Island by the Ellis Channel. Except for the harbor area where there are three piers;(E) 500-ft long Engineers Jetty, (T) 800-ft Main Pier, and (N) 600-ft Navy Wharf, T.I. is reef-fringed (R). Criss-cross lines (M) demark mangroves. (S) shows sandy beaches at low tide. (H) shows the location of the Federal Hotel where some of us resided. The hospital and CSIRO Fisheries Laboratory were located on the "Reserve" in the southwest corner of T.I. (From U.S. Hydrographic Chart No. 3471).





Ordinarily, arrangements could be made on weekends only for the use of a small (15-ft) CSIRO outboard motor boat, the *Maggie May*, for nearshore observations, collecting, and transportation out on the reef. These excursions required the assistance of Harry Mills, technical assistant at the CSIRO laboratory, to handle the boat and a native Thursday Islander, Barney Siegel. Barney would stand on the bow of the boat, guiding us along a safe passage through the reef. He would be on the lookout for sharks whenever we were snorkeling. Barney and Harry were always glad to accompany us on these trips because it gave them an opportunity to skin dive for fish and lobsters. One of the men would always remain in the boat when the other one was fishing.

More About Thursday Island. -- Thursday Island, commonly abbreviated T. I., is about 1.8 miles long and ranges in width from 0.6 to 0.9 miles (page 10a). Its area is about 800 acres, equivalent to 323 hectares or 1.25 square miles. Its maximum elevation is 374 feet. Native Thursday Islanders call the island Wai-Ben or Waiben. Its population of 2,280 in 1981 (2,000 in 1960) is composed of only a few native Thursday Islanders with a variable number of Caucasians (mostly Australian Government employees), Chinese, Japanese, and Malays. The village in which most of the people dwell is called Port Kennedy.

For many years T. I. has been known primarily as a center for the pearl industry with emphasis on mother-of-pearl from the large nearly flat shells of pearl oysters, particularly *Avicula* and *Pinctata* sp. When we were there in 1960, the prevailing price of prime rainbow shells was £1.0/1.0 lb, pronounced "one pound per pound." Somewhat like cowrie shells, pearl oyster shells were often used for money or exchange.

All except the southwestern side of the island is fringed with a rocky coral reef indicated by zig-zag lines (R on Fig. 10a) around most of T.I. and small coral reefs, most of which are immersed at high tide. Along the 0.8 mile on the southwestern (harbor) area, the coast is covered with mud and seaweeds. At low tide a sandy beach is exposed in this harbor area. The criss-cross lines (M on Fig. 10a) mark the locations of mangroves on the western end of Thursday Island, the reef off the south side of Hammond Island, and on both sides of the 600-ft long Horn Island pier.

The water taxi between Horn Island and T.I. plied between this pier and the 500-ft long Engineers jetty (E) on T.I. When stopping at T. I., the *Tropic Seas* moored at the Engineers Jetty. The main or middle pier (T) is 800 feet long. It can accommodate ships having a draft of up to 15 feet. Nine years earlier (29-30 September 1951), the R/V *Galathea* moored in this area for a couple of days during the Danish Round-the-World Deep-Sea Expedition.

Although T.I. is one of the smallest inhabited islands in Torres Strait, it has become one of the most important administrative, strategic, and economic centers in the region. It is situated on the best passage through the rocky treacherous Strait. T. I. is sheltered from storms or enemy invasion by five surrounding islands: Prince of Wales I., Friday I., Hammond I., Wednesday I., and Horn I. It has the safest port and it has ample anchorage space (see Fig. 10a).

James Cook is said to have named Thursday Island. The records indicate that Bligh, of "Mutiny on the Bounty" fame, is believed to have named Sunday and Wednesday Islands.

Recently (1985) the CSIRO Fisheries Laboratory has been moved from Thursday Island to Hobart, Tasmania

Microbial Biomass in Tropical Seas. -- We were particularly interested in determining the microbial biomass in and around coral beds, with particular reference to bacteria and yeasts. Several microorganisms have been shown to serve as a source of food for numerous kinds of aquatic animals. In order to ascertain the quantitative importance of edible bacteria and yeasts, it was necessary to determine their abundance in the environment, their volume or biomass per cell, and their generation time when incubated under normal environmental conditions. Most of our water samples were collected within the uppermost 30 feet and mostly from a distance of a mile or more from land inhabited by man.

Results obtained on the *Stranger* indicated that the dilute nutrient-enriched filter-pad method was superior to the conventional agar-plate method for determining the abundance of viable bacteria in seawater samples. Much to our surprise, our rather fragmentary results indicated that the microbial population in, over, or around coral beds was considerably lower than in the open ocean. Whether this apparent paucity of bacteria and yeasts in coral-bed water is

attributable to the efficiency of filter feeders in removing microbes or is a reflection of slow microbial growth is yet to be determined. We estimated that heterotrophic bacteria living in coral reefs may produce from 0.001 to 0.02 grams of biomass per cubic meter per year.

Marine Yeasts.-- Very few, if any, yeasts were found in Coral Sea water samples or in open channels of the Torres Strait, through which water flows from the Coral Sea into the Arafura Sea or the reverse, depending on the tide. Similarly, yeasts were sparse or absent in samples of seawater collected over sandy or rocky bottoms around Thursday Island. However, numerous and various kinds of yeasts were commonly found associated with living corals and sedentary algae growing in the coral beds. For further information about species of yeasts and their possible importance as food for animals, see progress reports or the attached paper by N. van Uden and C. E. ZoBell, "*Candida marina* nov. spec., *Tarulopsis tarresii* nov. spec., and *T. maris* nov. spec., three yeasts from the Torres Strait," *Antonie van Leeuwenhoek* 28:275-283, 1962. These three together with other species of marine yeasts are available from the American Type Culture Collection.

Dr. Nicholas van Uden, a specialist on marine yeasts from the University of Lisbon, was a visiting investigator at the Scripps Institution of Oceanography in 1960.

Our Return Home to La Jolla.-- We checked out of the Federal Hotel on Thursday, 25 August 1960, seven weeks after our arrival. It was only a short walk to the Engineer's Jetty where we boarded the water taxi to Horn Island. There we boarded a plane to Cairns where we spent the night in the Imperial Hotel. The following morning a commuter plane took us to Brisbane where we made connections with a larger plane to Sydney for three nights in Hotel Australia.

Most of the next day, Saturday, 27 August, we visited Taronga Park, an internationally known zoo and botanical garden, which has close working connections with our zoo in San Diego.

On Sunday we traveled 15 miles to Cronulla to renew acquaintances with employees of the CSIRO Marine Biology Laboratory, including E. J. Ferguson Wood and family. Nine years earlier I had spent several days in Cronulla while on the Danish *Galathea* Round-the-World Deep-Sea Expedition.

Shortly before noon on August 29 we checked out of the Hotel Australia to board a PAA jet plane bound for Honolulu. The flight was uneventful except for crossing the International Date Line, thereby gaining 24 hours time. We arrived in Honolulu in time for breakfast at the Moana Hotel.

Through Monday, August 26, until September 5, we explored Oahu and Kawai. Most of one day was spent at the University of Hawaii where two former SIO microbiologists had faculty positions. Dr. David E. Contois completed the requirements for a Ph.D. degree in 1957. Eventually Dr. Contois became Dean of Science at the University of Hawaii. Dr. Leslie Ralph Berger was a post-doctoral Research Associate in my laboratory for two years (1957-59).

A morning PAA plane carried us from Honolulu to Los Angeles, a distance of 2560 statute miles. There we transferred to Western Airlines for a 30-minute flight to San Diego, where we arrived at 8:50 p.m. on 5 September 1960, 112 days since leaving La Jolla on 25 May.

The distances traveled by air and water during the 112-day period are summarized below in four segments:

Segment I. San Diego, Calif. to Saigon, Vietnam:

	<u>Statute miles</u>
San Diego to Honolulu , Hawaii, via Los Angeles	2,560
Honolulu to Tokyo	3,854
Tokyo to Saigon, Vietnam, via Hong Kong	2,786
Round trip from Saigon to Nhatrang by air	330
Total of Segment I	<u>9,530</u>

Segment II. Saigon to Bangkok, Thailand:

Cruise S-6 on R/V <i>Stranger</i>	1,100
-----------------------------------	-------

Segment III. Bangkok to Thursday (Horn) Island, Australia:

Bangkok to Sydney, Australia, via Singapore	4,815
Sydney to Brisbane, Australia	450
Brisbane to Thursday (Horn) Island	1,375
Total of Segment III	<u>6,640</u>

Segment IV. Thursday Island to San Diego via Honolulu:

Thursday Island to Sydney via Cairns	1,825
Sydney to Honolulu	5,075
Honolulu to San Diego via Los Angeles	2,560
Total of Segment IV	<u>9,560</u>

Total distance traveled to and from Naga Expedition 28,670

Miles traveled on the *Tropic Seas*, *Maggie Mae*, smaller boats,
water taxis, limousines, city taxis, coaches, and trains 650

Some Natural Wonders: (i) Termites on Horn Island.-- The first Sunday (17 July 1960) after our arrival at Thursday Island, all interested members of Pete's party were taken on a field trip on the *Tropic Seas* with Vince Vlasoff at the helm. After exploring the mangrove swamps along the northwest coast of Horn Island (see Fig. 9c), we went ashore for a closer view of its termite mounds. From a low-flying plane, the termite mounds looked much like tombstones in a big graveyard.

Many of the almost perpendicular mounds on this 9,600 acre island were more than ten feet tall, the tallest being 18 feet. Horn Island has thousands of mounds, many being occupied by millions of termites (see "Termites and Soils" by K. E. Lee and T. G. Wood, Acad. Press, N.Y., 1971, 231 p.). The termites depend largely on cellulose as a source of food. The cellulose is digested by bacteria or protozoans, which live symbiotically in the termite's gut. Certain termites farm fungi (family Termitomycetes) as a source of food.

Certain termite species, most notably *Amitormes meridionales* are known as "magnetic ants," because the long axes of their wedge-shaped mounds always have a north-south alignment. Various species of bacteria are magnetotactic, ostensibly made so by the assimilation of magnetite, Fe_3O_4 (see "Magnetotactic Bacteria" by R. P. Blakemore, Ann. Rev. Microbiol. 36:217-138, 1982).

Although termites are often called "white ants," they are not true ants. The latter belong to the Order Hymenoptera, which also includes bees, wasps, and all other truly social insects except termites. Termites belong to the Order Isoptera. Their wings are of equal length and they have thick waists, whereas ants have wasp (constricted) waists. Termites are more closely related to cockroaches than to ants.



Jean ZoBell standing beside a small termite mound and in front of one of the medium sized ones on semi-arid Horn Island, Torres Strait, Australia, 17 July 1960.

ii) A Dugong Party:-- We were excited one morning to learn that a dugong was on the beach out by the Government Reserve. We hurried there to see this rare animal.

Dugongs are herbivorous marine mammals that inhabit shallow coastal waters of tropical seas. They live on marine algae and sea grasses. When resting they may "tail stand" in water of the proper depth, keeping their heads out of water. Sightings of dugongs by early seafarers are believed to have given rise to the mythology of mermaids and sirens.

Dugongs are from 6 to 12 feet long and weigh up to 600 pounds with much body fat. The two forelimbs are modified into flippers. They have a tail fin used primarily for propulsion. Much prized for their oil and meat, they have been hunted almost to extinction. They are now protected; in Australia only aborigines are allowed to take a limited number of them. The dugong breathes surface air and can remain submerged for 10 to 15 minutes. When one is captured by a Thursday Islander, it is held upside down in the water until it drowns.

Our dugong had been the object of study by Dr. Scholander's physiology group. This dugong drowned, seemingly having remained underwater too long in an effort to escape its "tormentors." Once dead, it became the property of the Thursday Islanders, to be butchered and parceled out according to ritual customs. Dr. Herman Rahn, briefly a member of Dr. Scholander's physiology group, asked to have the bladder for study. Though amused by the idea, the big Thursday Islander in charge of butchering, granted Dr. Rahn his request, but no bladder could be found!

A party atmosphere prevailed as a few dozen Native women and children gathered around chatting and waiting until it was their turn to step forward to pick up a green leaf on the ground bearing a sizeable chunk of meat. Each seemed to depart gloriously pleased.



Drowned dugong on Thursday Island beside the native T.I. butcher

iii) Bu Shells:-- Accompanied by Harry Mills (our CSIRO aide) and Barney Siegel (a native T.I. volunteer), Jean and I were far out on the Great Barrier Reef in the *Maggie Mae* at low tide looking for likely yeast habitats for sampling. We were wading in a narrow channel having a sandy bottom when what appeared at first to be a sizeable bundle of sea grass came slowly rolling along the bottom. I picked it up for closer examination. Barney shouted something that sounded like bu or boo shell. Facetiously, I shouted back to Jean, "Its a boo shell. Now you find one!" Indeed, in a matter of minutes, she did. Although said to be common in the Torres Strait region, these were the only two sighted during our seven week visit.

When cleansed in our Navy Wharf laboratory, both shells were glistening light yellow outside, with various shades of yellow merging with orange (apricot) inside. In the Torres Strait region these gastropods were known as orange buglers, popularly called "bu" shells, as in bugler, pronounced boo as in boom. The name derives from the sound they make when the natives blow into them as a means of communication. Some call it the Trumpet Shell or the Australian Band Shell. According to Stix, its generic name is *Syrinx aruanus*. It is one of the largest gastropods in the world, reaching a length of 24 inches. Ours were not full grown and measured 12 and 15 inches respectively.



Adult and juvenile bu shells. Reprinted from the 216-page book by Hugh and Marguerite Stix, "The Shell: Five Hundred Million Years of Inspired Design," Harry N. Abrams, Inc., N.Y., 1968.

iv) Pearls:-- The pearl luggers worked over the oyster beds for about a fortnight at a time. The shells were the product of commercial value, but the meat of the oyster was not wasted. It was hung on the rigging to dry and later eaten. Any pearls found nestled within the shells were supposed to belong to the owner of the lugger, but in reality a good many of the pearls were secreted away to be sold later on the "after-dark market." It was no coincidence that, when the pearl buyer from Perth was in residence at the Federal Hotel during one of his routine buying trips to Thursday Island, several small boats gathered off shore just after dark. The buyer would row out to make a deal. He boasted to us that he could detect the difference between a natural pearl and a cultured one.

We were given a large baroque pearl by our friend Mr. Robinson, a wheelchair-bound fish biologist with whom we became acquainted. John Klye, at CSIRO, gave us a beautifully polished golden oyster pearl shell.

Published Papers. -- More than fifty printed papers and numerous typed progress reports have resulted from the Naga Expedition. Most noteworthy is the *Naga Report*, an open-ended serial published by the Scripps Institution of Oceanography. Volume 1 (1974) has a 177-page article by James L. Faughn: "Naga Expedition: Station Index and Data." In the Literature Cited section, Faughn lists 40 references complete with titles and inclusive pagination. Twelve of these papers appear in the *Naga Report*:

- Vol. 2, K. Wyrki: Physical oceanography of Southeast Asian waters, 195 p.
- Vol. 3, M. K. Robinson: The physical oceanography of the Gulf of Thailand, p 5-110.
M. K. Robinson: Bathythermograph (BT) temperature observations in the Timor Sea, 41 p.
- Vol. 4, pt. 1, W. Stephenson: The portunid crabs (Crustacea: Portunidae) collected on the Naga Expedition, p.4-39.
- " " " M. C. Imback: Grammaridean amphipods from the South China Sea, 128 p.
- Vol. 4, pt. 2, A. Alvarino: The chaetognaths of the Naga Expedition (1959-61) in the South China Sea and the Gulf of Thailand, 197 p.
- Vol. 4, pt. 3, K. Fauchald: Nephthyidae (Polychaeta) from the Bay of Nhatrang, South Vietnam, 28 p.
- " " ", V. A. Gallardo: Polychaeta from the soft sublittoral bottoms of the Bay of Nhatrang, South Vietnam, 200 p.
- Vol. 4, pt. 4, R. Sèrene and P. Lohavanyaya: The Brachyura (Crustacea: Decapoda) collected by Naga Expedition, including a review of the Homolidae, 187 p.
- Vol. 4, pt. 5, E. Brinton: Euphausiid crustaceans of Southeast Asian waters, 287 p.
- Vol. 4, pt. 5, M. Rottman: Euthecosomatous pteropods (Mollusca) in the Gulf of Thailand and South China Sea, 117 p.
- Vol. 5, pt. 1, T. Matsui: Description and distribution of *Rastrelliger* (Mackerel) larvae and a comparison of the juveniles and adults of the species *R. brachysoma*, 33 p.

Listed as pending in the *Naga Report* is the 300-page Ph.D. thesis by Bui Thi Lang, "Taxonomic review and geographic survey of the copepod genera *Eucalanus* and *Rhincalanus* in the Pacific Ocean." Lang is a South Vietnamese student who worked on the SIO campus from 1961 to 1965 under the supervision of Dr. Martin Johnson.

My two Naga Expedition publications are mentioned herein above on pages 7 and 11. Both are in the following appendix.

Acknowledgments. -- Most helpful to Jean and me throughout the expedition was James Faughn, leader of the Expedition and captain of the R/V *Stranger*. Others to whom we were particularly grateful were first mate Charles Smith, chief engineer Louis Gonyea, laboratory technician Ray Blei, and marine biologist Tetsui Matsui. We are indebted to Professor Per Scholander for inspiration, the invitation to participate, and for encouragement. For assistance in the vicinity of Thursday Island, special thanks are due to Harry Mills (a CSIRO technician), his self-appointed helpmate, Barney Siegel, an Stan Hynd (officer in charge of the CSIRO Laboratory).

Along with Edward Brinton, Edward Hemmingson, and Tetsui Matsui, Dr. Haxo has contributed much to recalling certain happenings during the Expedition.

We also thank the SIO Library staff for their helpfulness. Especially helpful were Deborah Day, who provided us with archives material, and Paul Leverenz, who provided us with maps and other materials.