Memoirs of the DANISH *GALATHEA* ROUND-THE-WORLD DEEP-SEA EXPEDITION 1950-1952

Prepared by Claude E. and Jean S. ZoBell

for the Scripps Institution of Oceanography Library Archives, 1985

University of California, San Diego, La Jolla, California 91093

Table of Contents

# Memoirs of the Danish *Galathea* Round-the-World Deep-Sea Expedition 1950-1952

by
Claude E. ZoBell
Professor of Marine Microbiology, Emeritus
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, Calif. 92093

**Foreword.**--The principal purpose of the Expedition was to determine the greatest oceanic depths at which living organisms occur. Emphasis was on animals living in or near bottom sediments. The Danes invited me to participate as a member of the Expedition primarily because of my experience in cultivating bacteria at deep-sea pressures and partly because bacteria are believed to play an important role in the nutrition of aquatic animals. Recently (1949), I had demonstrated the ability of certain bacteria from deep oil-well brines and the Puerto Rico Deep (9000 meters) to grow in nutrient media at high hydrostatic pressure. The invitation was received only after considerable correspondence and meetings with the leaders of the Expedition in Copenhagen. The fact that I am of Danish origin probably helped. My grandfather, Hans Jorgen Pedersen, was a seafaring Dane who migrated to America in 1868. At that time, he took the name ZoBell.

Other ancillary scientific objectives included (a) hydrography (water temperature, salinity, and oxygen tension at various depths as required for biological research), (b) determing water depths at all stations and continuously between stations while the ship was moving, (c) primary productivity and phytoplankton collection in the photosynthetic zone, (d) collection of zooplankton and motile animals at all depths, particularly animals living in, on, or near the sea floor, (e) fishing with long lines, traps, trawls, and like gear for large fish and cephalopods at depths exceeding 1000 meters, (f) oceanic bird life, (g) air-borne insects, (h) geomagnetic surveying in abyssal depths, say, more than 7000 meters, and (i) aseptically collecting samples of water and/or bottom sediments to analyze for the presence of living bacteria and allied microorganisms.

In addition to the scientific objectives, the Expedition did much to spread the knowledge of Danish culture and economy by means of lectures, films, and visits in overseas ports. Five full-time public relations (PR) people, headed by Hakon Mielche, were aboard or ashore in ports of call releasing news of discoveries by radio, television, or otherwise. On the expedition around the world, the *Galathea II* visited 26 countries and called at 70 ports where uncounted thousands of visitors were invited aboard the ship. In nearly every friendly port and in a few that were not so friendly, I was proudly introduced by the Danes as the "American bacteriologist." During a good part of the Expedition I was the only American on the ship.

**The R.D.N. *Galathea*.**--R.D.N. abbreviates Royal Danish Navy. Denmark has sent out three round-the-world oceanographic and marine biological expeditions. Two of these were on vessels named *Galathea* after the mythological Greek sea nymph Galatea. The first expedition on the rather large corvette *Galathea* circumnavigated the earth in 1845-47, primarily in the interests of Danish trade and secondarily for scientific studies. The studies consisted mainly of

charting waters in the vicinity of harbors and observing various kinds of animals, mainly fish. The first *Galathea* expedition failed to achieve much of scientific importance, mainly because the findings were not published for several decades. Much more hydrographical, chemical, and biological information was obtained (and published) by the Danish R/S *Dana* round-the-world expedition in 1928-30 (headed by Professor Johannes Schmidt) and by the *Galathea II* Deep-Sea-Expedition (headed by Professor Anton Fr. Bruun).

The research ship (R/S) employed by the 1950-52 expedition was formerly the British Navy frigate known for its first 15 years as the H.M.S. *Leith*. This ship was built in Devonport, England, in 1934 to serve as the official yacht of the Governor of Fiji. Later the H.M.S. *Leith* served with the New Zealand Navy as a survey and charting vessel. During World War II (1942-45), she engaged in various towing tests and minesweeping operations in the north Atlantic Ocean. After the War, she was disarmed except for three 57-millimeter (2.24 -inch) salute guns and sold for civil service. She was acquired by the Danish section of the World Friendship Association and renamed the *Friendship*. In 1949, the *Friendship* was purchased by the Danish Admiralty for the projected around-the-world deep-sea expedition. After being outfitted for oceanic research, her name was changed to *Galathea*. She is sometimes referred to as the *Galathea II* in order to keep her from being mistaken for the first *Galathea*.

Funds for the *Galathea II* Expedition came from many sources. The ship, her gear, and operating expenses (exclusive of personnel compensation) cost about 5,500,000 kroner (about $1,585,000). Largely through the Royal Danish Navy, the Danish Government provided about 4,250,000 kroner, leaving a balance of about 1,250,000 kroner to be provided by the Organizing Committee from the private sector. In 1950, 1,250,000 kroner was equivalent to about $180,000 in American currency. Having been impoverished during World War II and its sequelae, the little people of Denmark had little to contribute except an active interest in the expedition. School children were organized to contribute or collect öre (100 öre = 1 krone) and to sell bananas, coffee, pineapples, and other covetted commodities at black-market prices with official permission. American cigarettes alone netted more than a million kroner (about $75,000) for the Expedition Fund.

**Description of the Ship.**-- The *Galathea II* was about 80 meters (about 262 feet) long, 11 meters (36 feet) wide, and had a draught of 3.5 meters (11 feet). The dashed line at the bottom of Fig. 1, p.4, indicates the water line. The latter was about 60 cm (2 feet) lower when the fuel and fresh-water tanks were nearly empty.

The *Galathea* was powered by two 3-blade propellors geared to two Parson's high-pressure steam turbines having a combined horsepower of 2000. On both oil-fired boilers, her maximum speed was 12 knots (12 miles per hour). Fouling of the ship's bottom, which is both intense and rapid in tropical waters, soon resulted in a speed loss of one knot or more. In the interest of fuel economy, the *Galathea* usually operated on only one boiler, which provided for a speed of 8 knots. A fuel reserve of 314 tons (about 10,500 gallons) provided for 32 days' sailing at 8 knots, less than 16 days' sailing with both boilers fired.

While in port or on station, an 80-horsepower diesel dynamo produced electricity required for on-board machinery, appliances, lights, refrigerators, large deep-freeze, etc. At sea a station is a place where the ship is stopped to make various kinds of observations and to collect various kinds of samples. Rather than being named as are most railroad or mail stations, sea stations are identified by a consecutive number such as Danish Galathea 128, for example. In the ship's log and other records, the date and time are given along with the location expressed in terms of longitude and latitude.

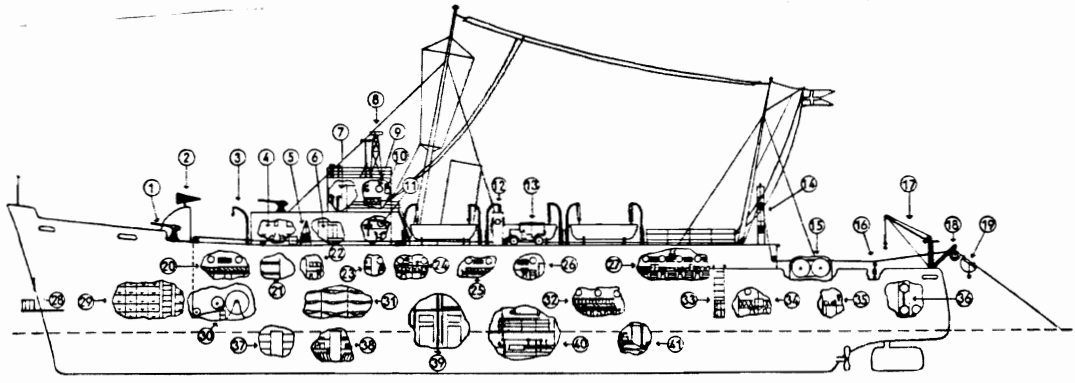


Fig. 1. *Rough lay-out of the Galathea. 1 Salute gun. 2 Fixed insect-catching net. 3 Starboard davit for hauling up bottom samples from shallow water. 4 Reception mess. 5 Hydrography winch on port side. 6 Commander's cabin. 7 Wheel house. 8 Radar. 9 Chart-house. 10 Echo-sounder. 11 Radio station. 12 Photographic tank for taking under-water films. 13 Jeep. 14 Accumulator for regulating tension of wire between winch and drum. 15 The big trawling winch. 16 Dynamometer for gauging tension of wire. 17 Crane for putting out heavy gear. 18 The big trawl gallows. 19 Angle gauge fixed to wire. 20 Orlop deck. 21 Sick cabin. 22 Consulting cabin. 23 Canteen. 24 Petty officers' cabin. 25 Petty officers' mess. 26 Leader's cabin. 27 Laboratory. 28 Removable harpooning platform. 29 Hold for scientific collections. 30 Drum for the large wire, course of the latter over the deck being as shown. 31 Sleeping deck. 32 Officers' and scientists' mess. 33 Removable angling chair. 34 Officers' cabins. 35 Dark-room. 36 Gear hold containing spheres for magnetic surveys. 37 Cold stores. 38 Pantry. 39 Stokehold. 40 Engine-room. 41 Deep-freezing store.* (From A. F. Bruun, Sv. Greve, H. Mielche, and R. Sparck, "The Galathea Deep Sea Expedition," Macmillan Co., New York, p. 21, 1956.)

My cabin/laboratory was on the starboard side in the area of the Officers' cabins (see 34 in Fig. 1 above).

The *Galathea* had no facilities for air conditioning except for natural sea breezes. When operating in tropical waters, say between 23.5° north or south of the Equator, the air temperature in most of the cabins and messes was often higher than 30°C (ca. 89°F). The temperature in my cabin/laboratory was nearly always warmer than 30°C, with little difference between night and day.

**Preventative Medicine and Provisions for Personal Health.**-- All participants of the Expedition were required to qualify for international health cards certifying current immunization for smallpox, yellow fever, cholera, typhus, typhoid, and tetanus. For the suppression or prevention of malaria, Galatheans were expected to ingest a 0.1-grain Paludrin (Chloroguenidine hydrochloride) capsule every day during breakfast while in regions infested with mosquitoes. Insect repellants for use on the skin were available on the ship.

The sick bay provided four bunks for the isolation of indisposed personnel. There were nearly always two medical officers aboard assisted by several corpsmen. Mal de mer was very rarely experienced on the *Galathea*. Much more common were skin lesions and stomach disorders, expecially after shore leaves in tropical ports of call. All participants were encouraged to take their meals aboardship where the food was ample, wholesome, and exceptionally good.

**The Microbiology Cabin/Laboratory.**--My cabin was located aft on the starboard (right-hand) side of the ship on the 3rd deck about ten steps forward from the stern (see Fig. 1). Ordinarily my cabin was partly below sea level and partly above. The porthole had to be kept closed during heavy seas in order to prevent water from flowing in when the ship rolled to the right. The roll was more pronounced when the fuel-oil and fresh-water tanks (located in the hold below the water line) were nearly empty.

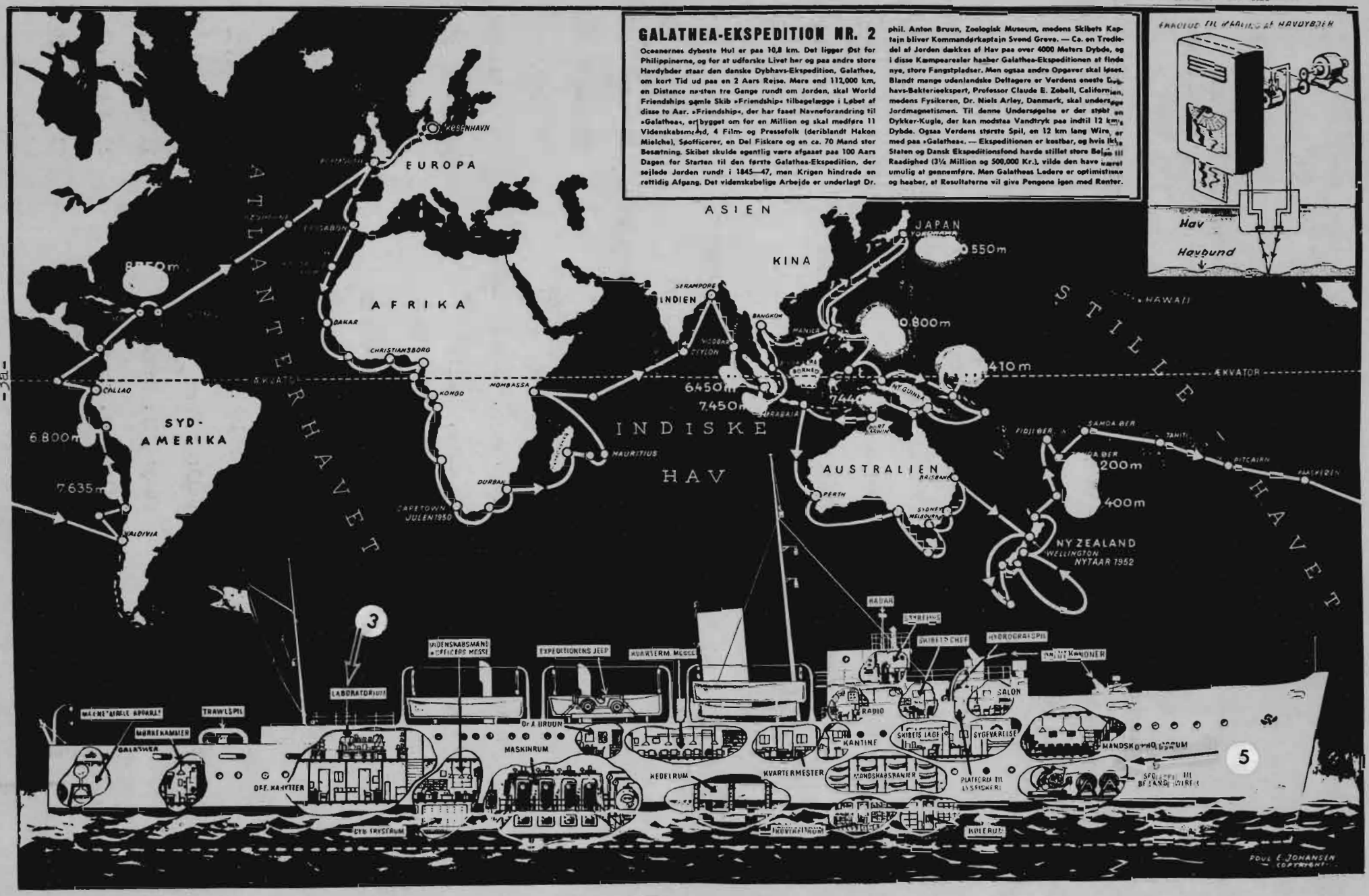
GALATHEA Expedition

Arrival and departure dates for parts of Danish Deep Sea Expedition on which Dr. Claude E. ZoBell plans to participate

| Arrive | Place | Leave |
|---|---|---|
| 23 June 1951 | Yokohama, Japan | 28 June 1951 |
| 12 July 1951 | Manila, Philippines | 15 July 1951 |
| 26 July 1951 | Manado, Celebes (Dutch) | 30 July 1951 |
| 8 August 1951 | Manokwari, New Guinea (Dutch) | 10 August 1951 |
| 17 August 1951 | Rabaul, New Britain (Austral.) | 19 August 1951 |
| 4 September 1951 | Solomons, Isls., Great Britain | 4 September 1951 |
| 15 September 1951 | Port Moresby, New Guinea (Austr.) | 17 September 1951 |
| 2 October 1951 | Port Darwin, Australia | 4 October 1951 |
| | Intermission followed by phase 2 | |
| 1 March 1952 | Auckland, New Zealand | 5 March 1952 |
| 10 March 1952 | Kermadec Island, New Zealand | 10 March 1952 |
| 17 March 1952 | Suva, Fiji (British) | 21 March 1952 |
| 28 March 1952 | Tonga Islands (British) | 28 March 1952 |
| 4 April 1952 | Pago Pago, Eastern Samoa (USA) | 6 April 1952 |
| 14 April 1952 | Papeete, Tahiti (French) | 18 April 1952 |
| 28 April 1952 | Pitcairn (British) | 28 April 1952 |
| 5 May 1952 | Easter Island, Chile | 9 May 1952 |
| 19 May 1952 | Valdivia, Chile | 21 May 1952 |
| 1 June 1952 | Juan Fernandes, Chile | 1 June 1952 |
| 5 June 1952 | Valparaiso, Chile | 9 June 1952 |
| 22 June 1952 | Callao, Peru | 26 June 1952 |
| 7 July 1952 | Guayaquil, Ecuador | 11 July 1952 |
| 22 July 1952 | Galapagos, Ecuador | 22 July 1952 |
| 30 July 1952 | Panama, Canal Zone (USA) | 1 August 1952 |

Fig. 1a. Starboard view of the Galathea showing rough layout of certain facilities, including the scientific laboratory (3) and the big trawling-wire drums (5). Note the Jeep in one of the life boats amidship. The dashed line beneath the ship illustrates its draught. The white lines from port to port show the original planned tract of the Expedition. Overleaf is the initial itinerary proposed by the Organizing Committee as of August 1950.

Echo sounder



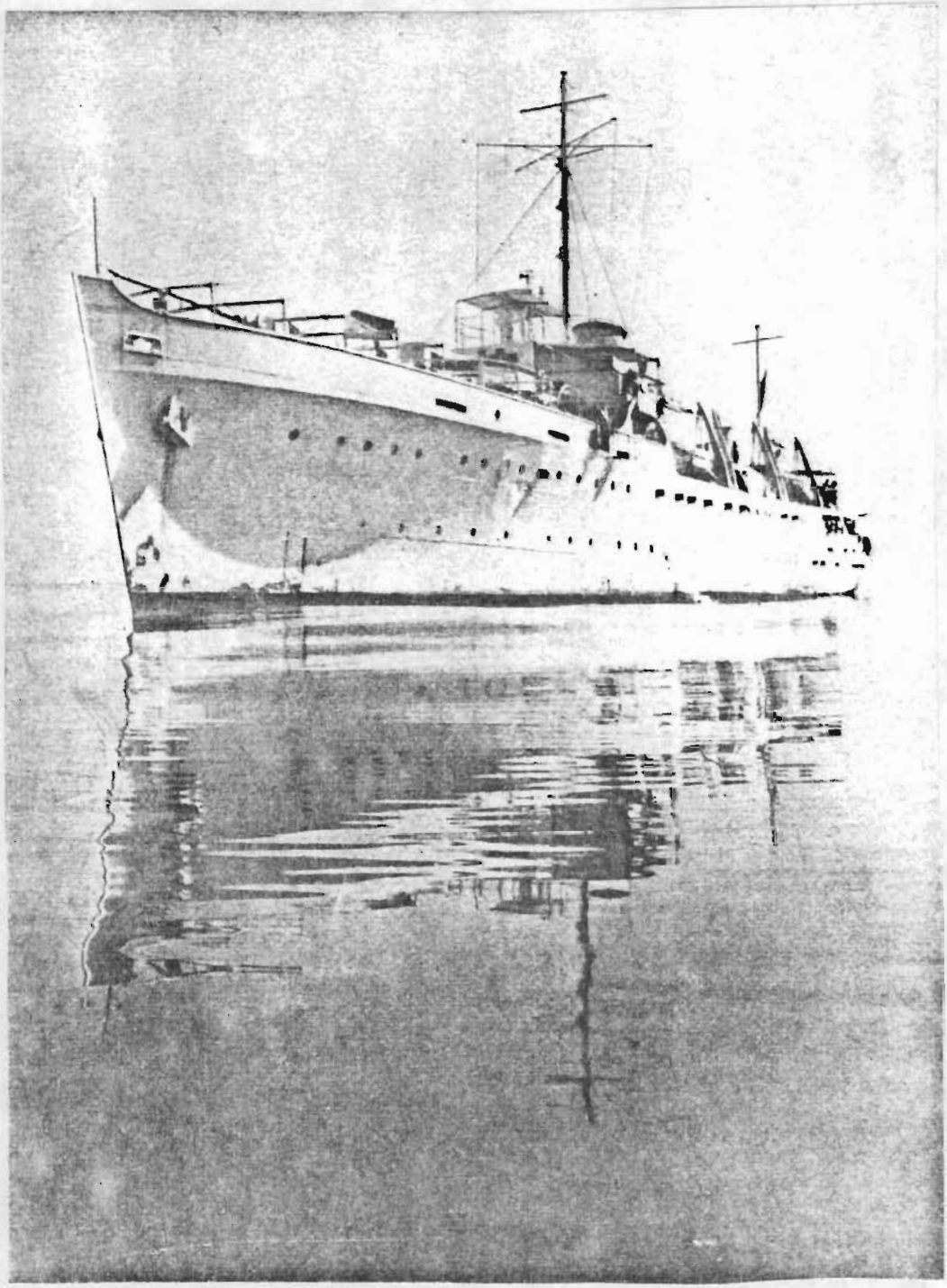


Fig. 1b. The Galathea in the Indian Ocean

My cabin had been designed to accommodate two officers. Besides a fairly large desk, it was fitted or furnished with cabinets, clothes closets, shelves, drawers, floor lockers, and a couple of chairs. A 30 x 30-cm (12 x 12-inch) wash basin did double duty for washing socks, underwear, culture tubes, flasks, bottles, pipettes, and other laboratory utensils. The head and shower baths were conveniently located a few steps aft down the passageway.

Shortly after I came aboard the *Galathea*, my cabin was converted into a microbiology laboratory, which could be fumigated with formaldehyde to provide for aseptic working conditions. The formaldehyde also discouraged cockroaches. It was much more difficult to free the cabin of mold fungi whose growth was encouraged by moisture and organic matter. It was necessary to shut the porthole and close the opening into the passageway by drawing the curtain in order to minimize contamination of samples and culture media.

The ship's carpenter installed a 4 x 8-ft piece of 3/4-inch plywood on the lower bunk to provide a laboratory table top. It was fitted with various devices to immobilize test tubes, bottles, flasks, barokams (high-pressure cylinders), and other tools of the trade. Unless these were immobilized, the movements of the ship (vibration, roll, and pitch) would cause such apparatus to move around, to tip over, or fall off the table. I slept in the upper bunk above the porthole, usually with the passageway curtain open in order to increase the circulation of air.

It was somewhat less than convenient for the sterilizing oven and autoclave to be located in the ship's sick bay forward on the upper deck (see 21 in Fig. 1 on p.4). The cold room (operated near 2°C or about 35.6°F), required for the cultivation of deep-sea bacteria, was located forward one deck below my cabin/laboratory (see 37 in Fig. 1). The deep-freeze storeroom (41) was a few steps forward and several steps down a ladder. My cabin/laboratory was near other cabins for officers (34) and the officers' mess (33).

I had free access to the main scientific laboratory. Actually this is where I worked for the first few days. It was satisfactory for microscopical studies, but it was not at all practical for cultural work requiring aseptic conditions. The scientific laboratory could accommodate 10 or 12 scientists. It was most conveniently located on the 4th deck almost immediately above my cabin/laboratory.

Most of the scientists were zoologists who were concerned with various kinds of animals ranging from protozoans to giant squid. The laboratory was equipped with various kinds of microscopes, including several modern Carl Zeiss research binoculars, microtomes, dissecting instruments, facilities for preserving specimines, a great variety of stains, chemicals, reagents, glassware, and laboratory hardware.

**The Ship and Her Complement.**-- The *Galathea II* was equipped with state of the art (1950) magnetic compasses, a gyro compass, an automatic steering compass, Decca radar, a Kelvin-Hughes echo depth-finder, and an Atlas navigational echo-sounder. The latter continuously indicated the approximate depth of water. Small corrections had to be calculated for the effects of temperature and salinity on the rate at which radiations were transmitted in the deep sea.

The *Galathea* carried 15,000 meters (49,200 feet) of braided hydrographic wire for collecting water samples and temperatures at various depths and angles. The hydrographic wire was also used for collecting bottom cores with either a Kullenberg or Phleger coring device. Several Nansen reversing water bottles and J-Z bacteriological water samplers were available

for collecting samples from any desired depth in the sea. A second spool of hydrographic wire was held in reserve for use in case of loss or damage of the one on the winch.

The ship commenced the expedition equipped with 8000 meters of trawling wire or cable. This was exchanged in Singapore for a 12,000 meter trawling cable preparatory to exploring the abyssal deeps in the Philippine Trench. This wire was specially spun to have a diameter of 22 millimeters (about 1 inch) at its inboard end and tapered to 9 millimeters at its other end. This decreased its total weight by a few tons without decreasing its breaking strength (7 tons) when virtually all of the cable was suspended in the sea. In other words, the wire was strong enough to support a "pay load" of 7 tons besides the weight of the cable itself (about 10 tons).

The storage drum for the trawling cable was located forward in the hold and the pulling winch was located astern in order to provide for a better distribution of weight aboard the ship.

The hydrographic wire, powered by an electric motor, was located on the rail port-side forward (5 in Fig. 1, p.4). A duplicate was installed on the starboard side as a reserve. It was impractical to use both hydrographic winches simultaneously.

The ship carried six well-provisioned life boats, each capable of holding at least 24 men. There were frequent (usually fortnightly) drills for abandoning the ship. This could be done within 15 or 20 minutes. It took several hours to get the men and life boats aboard again. Ostensibly the drills were designed to train the Royal Danish Navy seamen and officers, who also had semi-weekly marching drills on the upper deck.

**Personnel.**-- Besides an average of 70 R.D.N. seamen, the full complement of participants at any one time on the *Galathea* averaged 10 (16) R.D.N. commissioned officers, 5 (10) R.D.N. national service students, 3(5) public relations people, and 12 (57) scientists. The numbers in parentheses show the total number who participated in part of the expedition. Of the 57 scientists, only 7 were foreign, 22 were Danish, and 28 were "visitors" who came aboard primarily as observers for only a few days or weeks, in some cases, while in their respective territorial waters.

As shown on page 6b, I was one of the seven foreign scientists along with Drs. Rolf Bolin, Grace Pickford, and R. Y. Morita, all from the U.S. A., and three from Sweden: Drs. T. Gislén, B. Kullenberg, and O. Nybelin.

For further information regarding the nationality, principal field of study, and period (dates) of participation of all 88 participants see Bruun in the Galathea Report, Vol. 1, p.7-48, 1957. There are currently 15 volumes of the Report shelved in the Scripps Institution of Oceanography (SIO) Library, (call no. GC5, D35). The names of the R.D.N. seamen are not given.

Filipino visiting scientists aboard the *Galathea* while in was Filipino territorial waters were R. Mendina (zoology), T. Megia (hydrography), and J. N. Yapchiongcho (zoology). All three spoke English. This was also true of visiting scientists representing Indonesia: Dr. J. D. T. Hardenberg (zoology) and Ch. Veen (hydrography).

The best known Danish scientists included the Leader of the Expedition, Dr. Anton Fr. Bruun (zoology), Dr. A. Kiilerich (hydrography), Dr. P. L. Kramp (zoology), Dr. Henning Lemche (entomology), Dr. E. Steemann Nielsen (phytoplankton productivity), Dr. R. Spärck (zoology),

## 2. THE COMMITTEE OF THE EXPEDITION

*The Executive Committee:*

H. R. H. Prince Axel, President
Professor August Krogh, Vice-President, died 1949
Professor R. Spärck, Vice-President from 1949
Professor Niels Bohr
Dr. A. F. Bruun, Scientific Leader of the Expedition
Captain S. Greve, R. D. N., Commander of the Galathea.
Mr. C. C. F. Langseth, Ministry of Defence
Mr. E. Lindgren, Ministry of Defence
Mr. Hakon Mielche, Public Relation Officer of the Expedition
Vice-Admiral A. H. Vedel, R. D. N., D. Sc. h. c.

Mr. Verner Christiansen, Secretary of the Committee.

*Consultative Members:*

Dr. N. Arley, Physics
Dr. K. Birket-Smith, Ethnology
Dr. H. Blegvad, Director Danish Biological Station, died 1951
Mr. C. A. C. Brun, Ministry of Foreign Affairs
Dr. M. Degerbøl, Zoology
Mr. P. Jensen, Hydrographic Office
Professor Martin Knudsen, Hydrography, died 1949
Dr. P. L. Kramp, Zoology
Dr. Th. Mortensen, Zoology, died 1952
Mr. K. Paludan-Müller, Ministry of Education
Mr. H. Petersen, Director Meteorological Institute
Professor E. Steemann Nielsen, Phytoplankton
Mr. H. Thomsen, Hydrography

## 3. PARTICIPANTS IN THE EXPEDITION

*Danish Scientists:*

| Name | Field | Service |
|---|---|---|
| Andreasen, P., Engineer | Magnetism | 6.10.50 – 17.7.52 |
| Arley, N., D.Sc. | Magnetism | 6.9.50 – 8.10.50 |
| | | 25.10.50 – 20.12.50 |
| Benzon, B., D.Sc. | Zoology | 27.12.51 – 11.1.52 |
| Birket-Smith, K., D.Sc. | Etnology | 17.6.51 – 31.10.51 |
| Bruun, A.F., D.Sc. | Zoology | 1.9.50 – 17.7.52 |
| Degerbøl, M., D.Sc. | Zoology | 27.12.51 – 29.1.52 |
| Egedal, J., Ph.D. | Magnetism | 6.9.50 – 16.9.50 |
| | | 13.10.50 – 16.12.50 |
| Espersen, J., Ph.D. | Magnetism | 4.2.52 – 17.7.52 |
| Hansen, B., Ph.D. | Zoology | 1.9.50 – 17.7.52 |
| Jensen, E. Aabye, M.Sc.E. | Chemistry | 1.2.52 – 17.7.52 |
| Kiilerich, A., Ph.D. | Hydrography | 2.6.51 – 29.9.51 |
| Kirkegaard, J., Ph.D. | Zoology | 15.12.50 – 22.3.51 |
| Kramp, P.L., D.Sc. | Zoology | 19.3.51 – 29.9.51 |
| Lemche, H., D.Sc. | Zoology | 1.12.51 – 17.7.52 |
| Madsen, F. Jensenius, Ph.D. | Zoology | 22.6.51 – 17.7.52 |
| Nielsen, E. Steemann, D.Sc. | Phytoplankton | 25.10.50 – 19.1.51 |
| Olsen, J., Ph.D. | Magnetism | 6.9.50 – 16.9.50 |
| | | 13.10.50 – 16.3.51 |
| Pfaff, J. R., Ph.D. | Zoology | 15.12.50 – 26.5.51 |
| Spärck, R., D.Sc. | Zoology | 6.10.50 – 8.10.50 |
| | | 15.12.50 – 6.1.51 |
| | | 19.3.51 – 22.3.51 |
| Vilstrup, T., M.D., D.Sc. | Zoology | 2.2.52 – 16.4.52 |
| Volsøe, H., D.Sc. | Zoology | 19.3.51 – 26.5.51 |
| Wolff, T., Ph.D. | Zoology | 1.9.50 – 17.7.52 |

*Foreign Scientists*

| Name | Field | Service |
|---|---|---|
| **Bolin, R.L., D.Sc., USA** | Zoology | 8.1.52 – 11.4.52 |
| **Gislén, T., D.Sc., Sweden** | Zoology | 22.6.51 – 10.11.51 |
| **Kullenberg, B., D.Sc., Sweden** | Oceanography | 6.9.50 – 16.9.50 |
| | | 6.10.50 – 8.10.50 |
| | | 15.12.50 – 12.2.51 |
| **Morita, R.Y., M.Sc., USA** | Microbiology | 9.2.52 – 12.4.52 |
| **Nybelin, O., D.Sc., Sweden** | Zoology | 6.9.50 – 16.9.50 |
| **Pickford, Grace, D.Sc., USA** | Zoology | 16.4.51 – 9.7.51 |
| **ZoBell, C.E., D.Sc., USA** | Microbiology | 9.7.51 – 2.10.51 |

*Public Relation Service*

| | | |
|---|---|---|
| **Benzon, J.** | Journalist | 13.10.50 – 5.6.51 |
| **Høyer, M.** | Photographer | 22.6.51 – 17.7.52 |
| **Mielche, H.** | Head P.R.S. | 1.9.50 – 20.3.51 |
| | | 17.6.51 – 1.11.51 |
| | | 2.1.52 – 17.7.52 |
| **Nielsen, J.** | Photographer | 13.10.50 – 19.1.51 |
| **Rasmussen, P.** | Photographer | 1.9.50 – 17.7.52 |

*Officers of the Royal Danish Navy*

| | | |
|---|---|---|
| **Barfoed, S.H.L., Commander** | Executive officer | 15.1.51 – 17.7.52 |
| **Christensen, J., Ltnt.-comdr.** | Officer of the watch | 4.9.50 – 17.7.52 |
| **Crilsen, C., Ltnt.-comdr.** | Engineer | 11.2.51 – 17.7.52 |
| **Feddersen, T.G., Commander** | Medical officer | 1.9.50 – 29.9.51 |
| **Ferdinand, L., Ltnt.** | Medical officer | 15.9.51 – 17.7.52 |
| **Flemming, V.C.A., Count of Rosenborg, Ltnt.-comdr.** | Officer of the watch | 1.9.50 – 12.6.51 |
| **Greve, S.B.V.J., Commodore** | Commanding officer | 13.2.51 – 17.7.52 |
| **Hansen, N.E., Ltnt.** | Engineer | 1.9.50 – 17.7.52 |
| **Koch Jensen, G.A., Commander** | Chief-engineer | 1.9.50 – 21.11.51 |
| **Lessél, O., Captain** | Chief-engineer | 15.12.50 – 29.6.51 |
| **Madsen, C.H.A., Captain** | Commanding officer | 1.9.50 – 13.2.51 |
| **Seehusen, K.H., Captain** | Executive officer | 1.9.50 – 15.1.51 |
| **Thegler-Jensen, A.C., Ltnt.-comdr.** | Engineer | 1.9.50 – 28.6.51 |
| | Chief-engineer | 29.6.51 – 17.7.52 |
| **Thorsen, A.W., Ltnt.-comdr.** | Officer of the watch | 12.6.51 – 17.7.52 |
| **Thygesen, N.J., Petty officer** | Radio, echo-sounder | 1.9.50 – 17.7.52 |
| **Westergaard, I., Commander** | Navigating officer | 1.9.50 – 17.7.52 |

*University Students on National Service in RDN*

| | | |
|---|---|---|
| **Crossland, I., B.Sc.** | Chemistry | 1.9.50 – 17.7.52 |
| **Degerbøl, J., LL.B.** | Secretary of the Scientific Leader | 1.9.50 – 5.6.51 |
| **Horsted, Sv.Aa., B.Sc.** | Zoology | 1.9.50 – 26.5.51 |
| **Jacobsen, P. Holmelund, B.Sc.** | Zoology | 22.6.51 – 17.7.52 |

| Name | Field | Service |
|---|---|---|
| Jensen, E. Aabye, M.Sc.E. | Chemistry | 1.9.51 – 31.1.52 |
| Jensen, K.E., Ph.D. | Zoology | 22.6.51 – 17.7.52 |
| Kläning, U., B.Sc. | Chemistry | 1.9.50 – 17.7.52 |
| Knudsen, H., B.Sc. | Zoology | 22.6.51 – 17.7.52 |
| Marckmann, K.V., Ph.D. | Zoology | 1.9.50 – 26.5.51 |
| Nielsen, J., B.Sc. | Zoology | 1.9.50 – 26.5.51 |

*Visiting Scientists*

| | | |
|---|---|---|
| Batham, Elisabeth, Ph.D., New Zealand | Zoology | 12.1.52 – 22.1.52 |
| Bennett, Isobel, Australia | Zoology | 1.12.51 – 15.12.51 |
| Brodie, F.W., New Zealand | Oceanography | 11.1.52 – 22.1.52 |
| Cassie, R.M., M.Sc., New Zealand | Zoology | 24.1.52 – 27.1.52 |
| Chavernphol, Swarng, Thailand | Zoology | 18.6.51 – 9.7.51 |
| Davies, D., South Africa | Zoology | 19.1.51 – 9.2.51 |
| Dell, R.K., M.Sc., New Zealand | Zoology | 24.1.52 – 26.2.52 |
| Downie, R., Captain, Australia | Trawling | 1.12.51 – 15.12.51 |
| Falla, R., Ph.D., New Zealand | Zoology | 27.12.51 – 11.1.52 |
| Fleming, C.A., D.Sc., New Zealand | Marine Geology | 11.1.52 – 22.1.52 |
| Hardenberg, J.D.T., D.Sc., Indonesia | Zoology | 1.9.51 – 16.9.51 |
| Harry, R.R., Ph.D., USA | Zoology | 10.4.52 – 12.4.52 |
| Medina, R., Philippines | Zoology | 10.7.51 – 25.7.51 |
| Megia, T., Philippines | Hydrography | 10.7.51 – 11.8.51 |
| Moreland, J., M.Sc., New Zealand | Zoology | 27.12.51 – 8.1.52 |
| Powell, A.W.B., New Zealand | Zoology | 23.1.52 – 26.1.52<br>12.2.52 – 26.2.52 |
| Prasad, R., Ph.D., India | Zoology | 19.4.51 – 12.5.51 |
| Ramage, F., England | Echo-sounding | 20.10.50 – 24.10.50 |
| Rayner, G., Australia | Zoology | 10.11.51 – 14.11.51 |
| Ronquillo, I., Philippines | Zoology | 25.7.51 – 11.8.51 |
| Sidwell, P.M., England | Echo-sounding | 20.10.50 – 24.10.50 |
| Sparling, S.C., England | Echo-sounding | 20.10.50 – 24.10.50 |
| Turbott, G., Ph.D., New Zealand | Zoology | 12.2.52 – 26.2.52 |
| Veen, Ch., Indonesia | Hydrography | 1.9.51 – 16.9.51 |
| Whitley, G.P., Australia | Zoology | 8.11.51 – 15.12.51 |
| Willimowsky, N.J., Ph.D., USA | Zoology | 10.4.52 – 12.4.52 |
| Wood, F., Ph.D., Australia | Microbiology | 1.12.51 – 7.12.51 |
| Yapchiongcho, J.N., Philippines | Zoology | 27.7.51 – 11.8.51 |

and Dr. Torben Wolff (zoology). R.D.N. officers with whom I had the most contact were the ship's captain, Commodore Sv. Greve, Commander S.H. Barfoed (an executive officer), Commander T. G. Feddersen (a medical officer), Lt. L. Ferdinand (another medical officer), Commander A. W. Thorsen (officer of the watch), and Commander I. Westergaard (navigating officer). The medical officers often assisted me with my microbiological work.

Several of the officers and scientists mentioned above practiced speaking English with me. In group discussions, I was often called upon to defend American capitalism with particular reference to its effects on the economic conditions in Scandinavian countries. The best defense was to reply by asking them some questions. A major topic for evening discussions was the recent or pending independence of the Philippine Islands and the Republic of Indonesia in whose territorial waters there are great expanses of abyssal depths.

**About the Deep Sea.**-- On the *Galathea* Deep-Sea Expedition, any water having a depth of less than 3800 meters (about 12,450 feet or nearly 2.36 miles) was facetiously spoken of as being shallow. Actually the average depth of the hydrosphere is about 3800 meters. According to Menzies et al. ("Abyssal Environment and Ecology of the World Oceans," Wiley-Interscience Publications, p.229, 1973), the maximum depths reported from some trenches are as listed below. Those marked with an asterisk (*) were explored by the *Galathea*.

| Name of Trench | Maximum depth |
|---|---|
| 1. Mariana | 10,915 meters |
| 2. Tonga* | 10,882 " |
| 3. Japan | 10,554 " |
| 4. Kurile-Kamchatka | 10,542 " |
| 5. Philippine* | 10,487 " |
| 6. Kermadec* | 10,047 " |
| 7. Idsu-Bonin | 9,810 " |
| 8. Puerto Rico* | 9,200 " |
| 9. New Hebrides* | 9,165 " |
| 10. New Britain* | 9,140 " |
| 11. North Solomons* | 9,130 " |
| 12. Yap (West Caroline)* | 8,597 " |
| 13. South Solomons* | 8,310 " |
| 14. Palau (West Caroline)* | 8,138 " |
| 15. Peru-Chili | 8,055 " |
| 16. Aleutian | 7,679 " |
| 17. Nesei Shoto (Ryuku) | 7,507 " |
| 18. Java (Sunda)* | 6,662 " |

Most of the foregoing values for ocean depths are believed to have an accuracy ranging from ± 20 to 100 meters. The hydrostatic pressure of seawater increases almost as a straight-line function with increasing water depth. At a depth of 10 meters the hydrostatic pressure is 1.0 atmospheres (atm), equivalent to 14.496 pounds per square inch (psi). At a depth of 10,000 meters, the pressure is almost 1050 atm, equivalent to 15,220 psi or 7.6 tons per square inch. Such pressures have measurable effects on compressibility of materials, including water itself and living organisms. Indeed, only a specialized few bacteria and animal species can survive at such pressure at deep-sea temperatures, roughly from -1.0 to +3.5°C. The temperature of approximately 90% of the deep-sea water by volume is between 2 and 3°C. Deep-sea pressures

influence the density of seawater, its volume, the solubility of substances, ionization constants, the velocity of certain radiations (notably sound and supersonic waves), viscosity, chemical reactivity, thermal conductivity, electrical conductivity, physical strength, dielectric constants, permeability, specific heat, interfacial tension, hydrogen-ion concentration (pH), and redox potential (Eh). The relative volume of normal seawater at 0°C is 1.000 at 1 atm, 0.994 at 100 atm, 0.991 at 200 atm, 0.982 at 400 atm, 0.960 at 1000 atm, and 0.956 at 1100 atm.

Some effects of pressure on deep-sea bacteria have been summarized by ZoBell and Morita (see "Deep-Sea Bacteria" in Galathea Report, Vol. 1, p.138-154, 1959). Additional information is provided by ZoBell in his paper entitled "Bacterial Life in the Deep Sea," Bulletin of the Misaki Marine Biological Institute, Kyoto University, No. 12, p.77-96, 1968. This publication has 66 references, 17 of which are papers by ZoBell.

I had two closely related major objectives on the *Galathea* Expedition. The first was to investigate the occurrence, kinds, and biochemical activities of microbes in some of the greatest known ocean depths. The second objective was to study the effects of high hydrostatic pressure on marine gear such as mercury thermometers, depth indicators, and bacteriological samplers. Some of my findings are summarized in a paper entitled "Some Effects of High Hydrostatic Pressure on Apparatus Observed on the Danish *Galathea* Deep-Sea Expedition," Deep-Sea Research, London, Vol. 2, p.24-32, 1954.

**Tract of the *Galathea*.**-- The *Galathea* departed from Copenhagen 15 October 1950 and returned there 29 June 1952. During this period, the total distance traveled was 63,700 nautical miles, equivalent to about 118,000 kilometers (km). The tract crossed the Equator 12 times on the zig-zag course to ocean deeps between 58° N and 52° S Latitude. Approximately 42% of the time was spent sailing, 39% in ports, and 19% occupying hydrographic stations. "Sailing" is used in the sense of traveling. As stated in the section describing the *Galathea II*, she was propelled by two steam turbines. During the preliminary planning sessions, the Organizing Committee talked about exploring all of the greatest known oceanic deeps, including the Mariana, Japan, Idsu-Bonin, Kurile-Kamchatka, Aleutian, and Ryuku Trenches in the northwestern Pacific Ocean off the east coasts of Japan, Korea, and the USSR. However, unsettled geopolitical conditions made it unwise to venture into this war-torn region in 1950.

After leaving Copenhagen, the *Galathea* steamed north through the Kattegat and around The Skaw before turning southwest through the North Sea and the English Channel (see Fig. 2, p.8a). She continued on a southerly or sometimes southeasterly to east course along the west coasts of Spain, Portugal, and Africa enroute to Capetown, South Africa, where she arrived 19 December 1950. During this 64-day period, she stopped at 137 stations at which the water depth ranged from 400 to 5160 meters. At 32 of these stations, the water depth was more than 1000 meters.

Between Copenhagen and Capetown, the *Galathea* made short stops for fuel, fresh water, food, other provisions, and mail at Plymouth (England), Lisbon, Canary Islands, Dakar, Monrovia, Accra, Port Victoria, and Walvis Bay. At each port of call, the ship's officers were prepared in advance to provide postage stamps and currency of the realm at cost. At each port of call throughout the Expedition, mail was received and could be posted at domestic rates.

The ship operated off the Cape of Good Hope in the Indian Ocean in and out of Durban, South Africa, until 16 February 1951. During this 46-day period, she stopped at 35 stations. At 14 of these the water was deeper than 4000 meters. The greatest depth sounded in this region was 5480 meters.

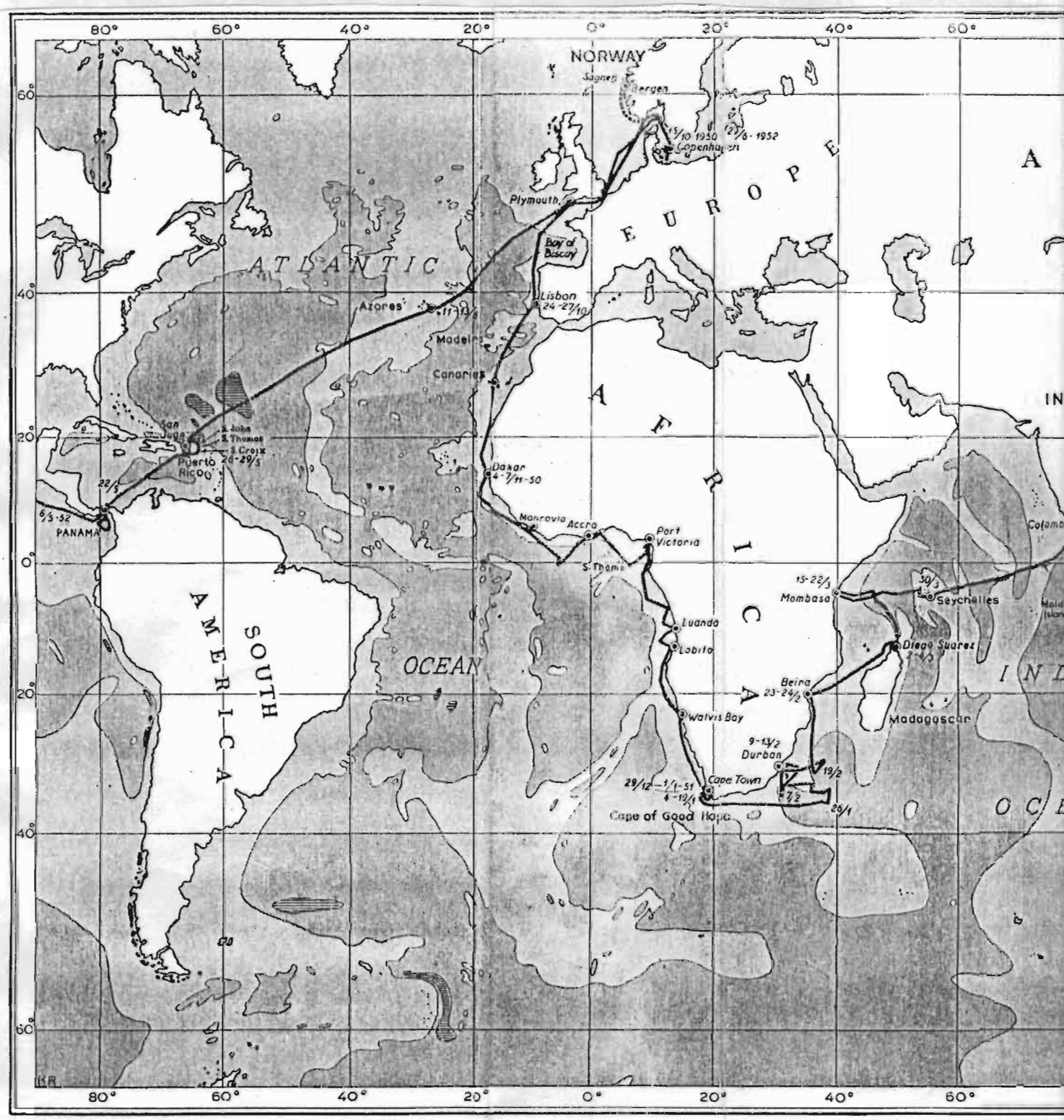
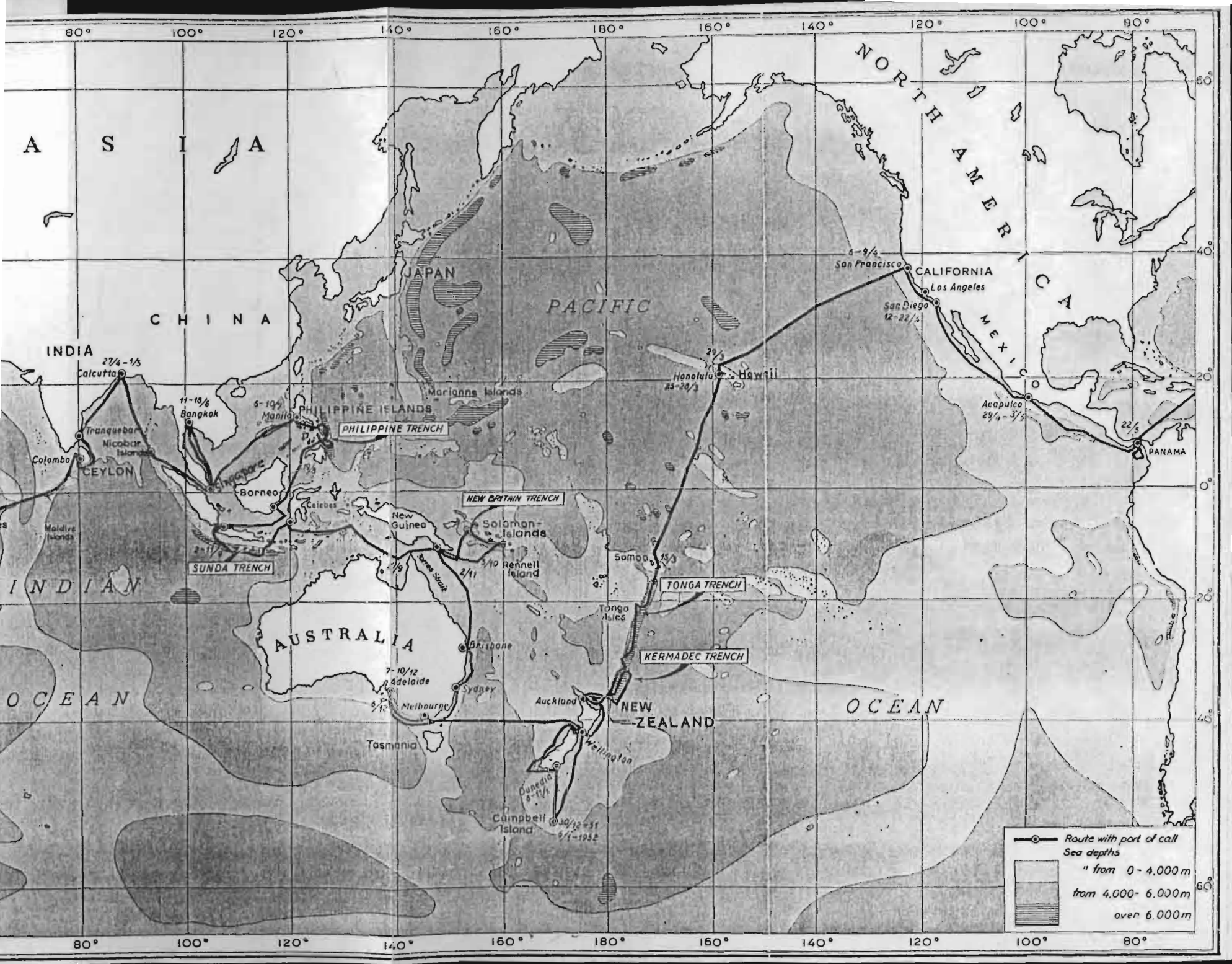



Fig. 2.— Tract of the Round-the-World *Galathea* Deep-Sea Expedition from Copenhagen, around Africa into the Indian Ocean to the Philippine Trench via Ceylon (now Sri Lanka), Calcutta, and Singapore, in and out of the Gulf of Siam, the Sunda Trench west of Java, the Great Australian Bight, around New Zealand, north through the Kermadec-Tonga Trench, the Hawaiian Islands, California Coast, through the Panama Canal, the Azores, and back to Copenhagen.

At the Equator, 1° latitude equals about 69.4 statute miles (111.64 km) and about 68.7 miles (110.53 km) near the Poles. At the Equator, 1° longitude equals about 69.2 miles (111.34 km) and decreases to zero at the Poles as the cosine of the latitude.


ASIA
NORTH AMERICA
CHINA
INDIA
JAPAN
PACIFIC
OCEAN
INDIAN
OCEAN
AUSTRALIA
NEW ZEALAND
MEXICO
CEYLON
Calcutta
27/4 - 1/5
Tranquebar
Nicobar Islands
Colombo
Maldive Islands
11-13/6
Bangkok
Singapore
Borneo
Celebes
5-10/9
Manila
PHILIPPINE ISLANDS
PHILIPPINE TRENCH
Marianne Islands
SUNDA TRENCH
New Guinea
NEW BRITAIN TRENCH
Solomon-Islands
Rennell Island
Torres Strait
Brisbane
Sydney
7-10/12
Adelaide
Melbourne
Tasmania
Samoa
TONGA TRENCH
Tonga Isles
KERMADEC TRENCH
Auckland
Wellington
Dunedin
Campbell Island
Honolulu
Hawaii
San Francisco
CALIFORNIA
Los Angeles
San Diego
12-22/4
Acapulco
29/4 - 3/5
PANAMA
22/5
Route with port of call
Sea depths
from 0 - 4.000 m
from 4.000 - 6.000 m
over 6.000 m

Moving eastward and northerly out of Durban, the *Galathea* put into port at Beira (southern Mozambique), Diego Surarec (northern tip of Madagascar), and Mombasa (southern Kenya). Between Durban and Mombasa (17 February to 24 March), the ship stopped at 63 hydrographic stations (No. 200-263). At 12 of these stations the water depth exceeded 3000 meters; more than 5000 meters at two stations.

From Mombasa, the *Galathea* sailed eastward to the Seychelles for a two-day stop after which she sailed east northeast to Colombo and Ceylon. (The name of this small island empire off the southwest corner of India was changed to Sri Lanka on 22 May 1972). After rounding Ceylon (Sri Lanka) to the south, the *Galathea* turned north northeast into the Bay of Bengal to put into port at Tranquebar on the east central coast of Madras, India. From there, she sailed northeasterly in the Bay of Bengal to the Nicobars. She stopped overnight in Nakowry Harbor, which is located between two small islands, Camarta on the north and Nakowry Island on the south. In 1951, the Nicobar and Andaman Islands belonged to India. Earlier, these islands had belonged to Denmark and later to Great Britain. Consequently, the Danes had an historical interest in the Nicobars located 7 to 9° north of the Equator, two or three hundred miles from the northern tip of Sumatra, Indonesia.

From the Nicobars, the *Galathea* sailed southeasterly through the Andaman Sea and then through the Strait of Malacca between Sumatra and Malaysia enroute to Singapore. Singapore is located at the southern end of Malaysia very near the Equator (see Fig. 2, p.8a). The ship proceeded eastward through the Singapore Strait into the South China Sea in which she sailed north northwest on a course almost parallel to the Malay Peninsula into the Gulf of Siam and on to Bangkok, Thailand. Damage to the dredging winch forced the *Galathea* to return to Singpore for repairs. The distance between Bangkok and Singapore is about 900 miles.

After the necessary repairs were made, the *Galathea* took the most direct route northeast through the South China Sea from Singapore to Manila, a distance of somewhat more than 1300 miles. Five stations (No. 405-409) were occupied enroute in water that ranged in depth from 2310 to 4390 meters.

**The Philippine Trench.**-- The *Galathea* tied up at Pier 9 in Manila Harbor around noon, 6 July 1951. I was there to meet and greet the Galatheans, along with my gear. The latter, having a total weight of 1200 pounds, consisted of high pressure apparatus, various kinds of deep-sea sampling apparatus, laboratory glassware, chemicals, reagents, and nutrient media for cultivating marine bacteria. The gear had been transported in 17 crates from San Diego by MATS. My gear and I had been waiting in Manila for the *Galathea* since June 21. I had been in transit by air from San Diego to Manila with business stops in New York City, London, The Hague, Rome, Cairo, Karachi, and Calcutta when information reached me in Cairo that the expected time of arrival of the *Galathea* in Manila would be delayed at least two weeks owing to the needed repairs in Singapore.

After four days in Manila, the *Galathea* sailed westerly out of Manila Bay and threaded her way southwesterly through the San Bernardino Strait north of Samar Island into the Philippine Sea immediately east of the Philippine Islands (P.I.). Within less than 40 miles east of Palapag, Samar (a P.I. province), the precision depth recorder (PDR) was registering more than 7000 meters. The 7000-meter (about 4000-fathom) contour marks the outer edge of the Philippine Trench. The trench, hugging the east coasts of Samar, Dinagat, and Mindanao (P.I. provinces) is about 1050 kilometers (570 nautical miles) long. For most of its length, the width of the trench ranges from less than ten to about 40 kilometers. Its depth ranges from 7000 to nearly 10,500 meters (32,000 feet).

Geographically, Manila marked the halfway point in the *Galathea* Deep-Sea Expedition. However, Manila was really the starting point for the exploration of abyssal deeps, meaning more than 7000 meters. Until the Expedition reached the Philippine Trench, the greatest water depth sounded was 5470 meters at Station No. 181 in the southern Indian Ocean southeast of South Africa (34°54' S x 38°01' E).

The *Galathea* worked day and night in the Philippine Trench from 12 July through 14 August 1951. For the most part, the sea was relatively calm except for a typhoon on July 16, which forced her to run for cover in Tubajon Bay behind Dinagat Island. We left the Bay at 6:00 p.m. on July 19. By 9:15 a.m. the following morning, she was in position over Johnson Deep (10,190 meters) lowering a mud-sampling device. It was hauled back to the surface 17 hours later at 2:15 a.m. on July 21.

On 23 July 1951, nutrient medium inoculated with minute amounts of mud aseptically collected on July 15 from a depth of 10,060 meters was found to be teeming with living bacteria, which had reproduced when incubated at deep-sea conditions (2°C and 1000 atmospheres). This observation was repeated several times with samples of bottom sediment collected from depths ranging from 10,160 to 10,210 meters (see ZoBell and Morita, "Deep-Sea Bacteria" in Galathea Report, Vol. 1, p.139-154, 1959).

Concurrently, and almost from the beginning of the Expedition, the zoologists had been finding numerous species of animals at many of the greatest depths sampled (see A. F. Bruun, "Animal Life of the Deep Sea Bottom" in Galathea Report, Vol. 1, p.149-195, 1959). In summarizing the achievements of the *Galathea* Expedition, Dr. Bruun points out that one or more species of 28 different animal groups were found at record-breaking depths of 5860 to 10,190 meters. These depths were from 100 to 4340 meters greater than the previously reported occurrence of the 28 animal groups. Incidentally, I found bacteria associated with several of these animals taken from abyssal depths of more than 7000 meters. Owing to the difficulty of collecting samples aseptically from deep-sea animals, one could never be sure whether the microbes found in or on animals were extrinsic contaminants or species indigenous to the deep sea.

On July 25, we made an overnight excursion to Cebu City on Cebu Island for mail, fuel, and supplies. The following day we returned by a more southerly route to the Philippine Trench. From Fig. 2, p. 8a, it will be observed that the *Galathea* worked only in the central part of the Trench. The boundaries and water depth at different stations were measured continuously by the ship's PDR. Day and night observations were made in the Philippine Trench until August 14 when the *Galathea* sailed southwest through the Philippine Islands into the Sulu Sea via the Mindanao Sea. The latter, having a depth of less than 2000 meters, is not the same as the Mindanao Deep (nearly 10,000 meters). The latter was one of the deepest known deeps in the Philippine Trench until the Galathea Deep was discovered there and so named by the Danes during the Expedition. Between July 12 and August 14, 1951, observations were made at 19 stations in the Philippine Trench. At 12 of these stations, the water depth was more than 10,000 meters.

Eight stations were occupied by the *Galathea* between the Philippine Trench and Balikpapan, Borneo (now called Kalimantan). These eight stations were in the eastern part of the Sulu Sea and the western end of the Celebese Islands. The water depth at these eight stations ranged from 4600 to 5160 meters. The greatest depth recorded in the Makassar Strait between Borneo and the Celebese Islands (now Sulawesi, Indonesia) was barely 2000 meters.

**Southeast Asia and Indonesia.**-- We stopped in Balikpapan, Borneo, for fuel and fresh water on 23 August 1951. Borneo was in a state of semi-revolution. Only Galatheans having essential business were allowed to go ashore.

Leaving Balikpapan, Borneo, the same day as we arrived, the *Galathea* sailed southward in the Makassar Strait between Borneo and the Celebese. Then she turned west and sailed almost due west for about 700 miles in the Java Sea to Priok, the seaport for Djakarta. This large city (6,500,000 in 1980) is about 10 miles inland from Priok. It is often called Jakarta and was called Batavia by the Dutch. Djakarta is the cultural center and capitol of Indonesia. During the three days (August 28 to September 1) we were there, we were royally received by national, educational, and civic leaders, including President Sukarno and some of his cabinet members.

Almost reluctantly, we sailed out of Priok Harbor, then westerly for about 700 miles in the Java Sea, and through the Selat Sunda (see Fig. 3 on p.11a). This narrow strait between Java and Sumatra took us into the Sunda Trench in the Indian Ocean off the south coast of Java (now called Djawa by Indonesians). The Sunda Trench is about 800 miles long and as much as 40 miles wide with water depths ranging from 4000 to 7250 meters. Between 3 and 21 September 1951, various kinds of observations were made at 14 stations (No. 461-474). Animals were found in bottom sediments from virtually all depths. Living bacteria were recovered in bottom sediments carefully collected from a depth of 7020 meters in the Sunda Deep and from 7250 meters in the Weber Deep.

Thin (5 to 20 millimeter) layers of geologically recent volcanic tuff were dredged from depths of 2810 to 2980 meters at the southern end of the Sunda Trench (10°26' S x 114°15' E). This was more than 600 miles from the Sunda Strait where the volcano Krakatoa erupted on 26 and 27 August 1883. It has been reported that the eruption caused tidal waves reaching heights of more than 15 meters, resulting in the death of 36,000 people.

We worked at six stations in shallow water (545 to 1555 meters) in the Bali Sea off the eastern end of Java and the south coast of Bali. The *Galathea* dropped anchor on 12 September 1951 in open water about four miles west of Bali to ferry personnel to land in relays in life boats. We were taken about 17 miles in official cars or busses on an unpaved road through a rain forest to Denpasar, the capitol of Bali. Bali is a very small island between Java and Lompok. Its people, their dress, customs, speech, ordors or fragrances, handicraft, and architecture could best be described as unique - different from any other island in South East Asia and different from any other place in the world that I have visited. Whereas the Balinese were predominantly Hindus, 90% of the inhabitants of other Indonesian Islands were Moslems. The Balinese people seemed to be almost as friendly as the Danes. Most of the Expedition scientists were able to go ashore. The officers and seamen had only one or two hours' shore leave. Shortly after dark when everyone was aboard, the *Galathea* headed through the Lompok Strait into the Bali Sea north of Bali and Lompok. We worked for a couple of days in relatively shallow (mostly less than 1500 meters ) water in the Bali Sea enroute to Makassar located southwest of Celebes.

**Makassar, Celebes (Sulawesi).**-- Not having been in a commercial harbor for more than a fortnight since leaving Priok on September 1, the *Galathea* was in need of fuel, food, fresh water, and mail when we stopped at Makassar on September 15. Armed guards were placed on the *Galathea*, but we were permitted some shore leave. Being a bacteriologist, I was particularly interested in observing the intake of water. Fresh water from the wharf was pumped aboard in a 2-inch canvas hose. Before entering the tank below, the water was passed through an open

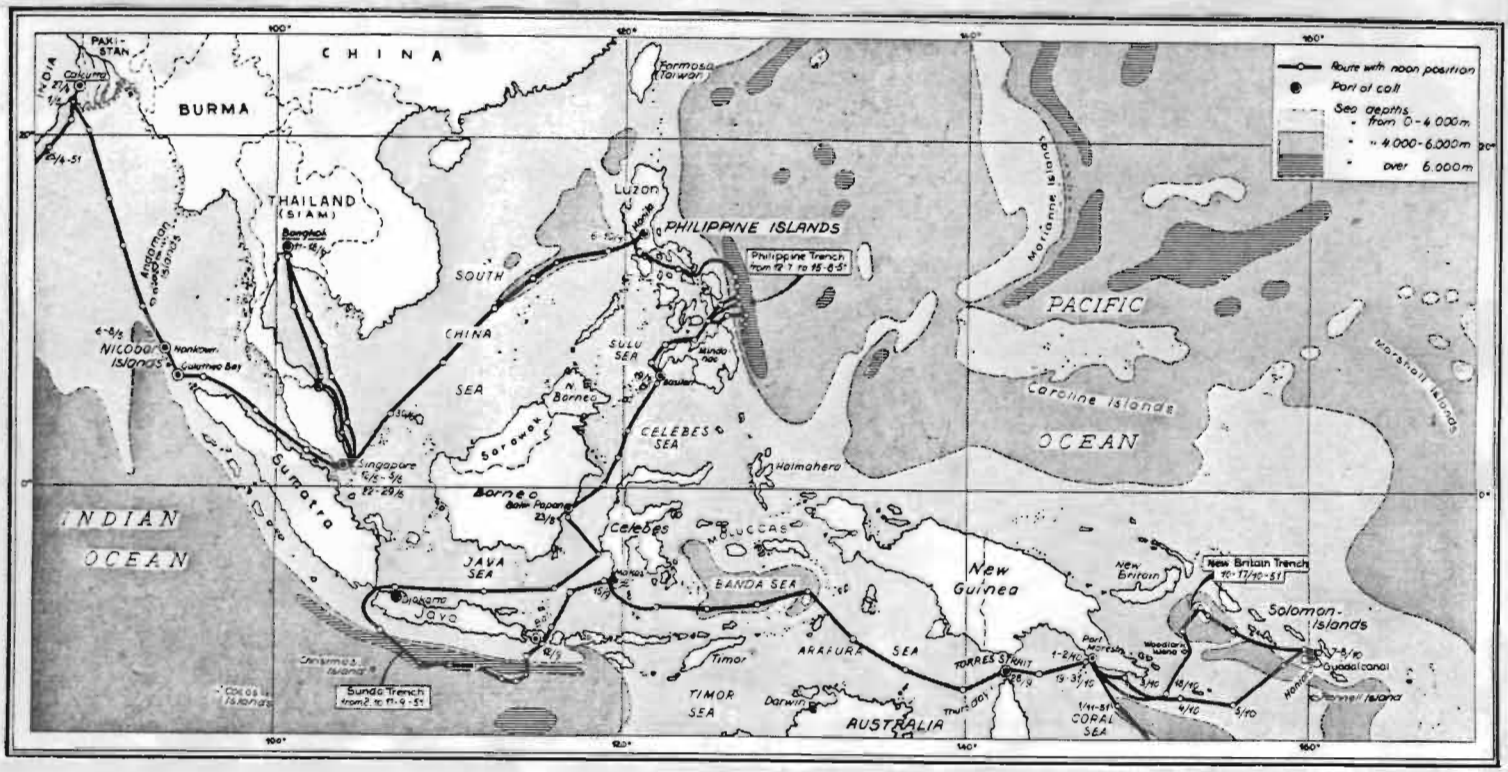



Fig. 3.-- Route of the *Galathea* to deeps in territorial waters of the Philippine Islands and the Republic of Indonesia from April 25 to November 1, 1951. (From A. F. Bruun, Sv. Greve, H. Mielche, and R. Spärck, "The Galathea Deep Sea Expedition," Macmillan Co., New York, p. 176, 1956.)

See under legend for Fig. 2 on page 8a for approximate distances represented by each degree of latitude and longitude.

2-millimeter (about 1/16-inch) wire screen to remove solids such as the remains of plants and animals and other particulate materials. As fast as such particulates accumulated on the screen, an attendent scraped the material off into the sea. The ship's medical officer chlorinated the incoming water to give a residual chlorine content of about one part per million. Free chlorine kills harmful bacteria and helps to oxidize organic matter. I recall hearing Commander Feddersen (medical officer on the ship) say, "Now you'll understand, why Danish seamen prefer to drink beer or black coffee."

The shopping list at Makassar included a ton each of potatoes and onions. Owing to their keeping qualities as well as their relatively high content of vitamins and minerals, large quantities of these vegetables were served nearly every day, either raw, boiled, baked, or oiled, preferably in schweinefett (hog fat). No potatoes were available in Makassar. After a long delay, the onions were delivered in various kinds of baskets, bags, and boxes. Instead of ordinary apple-size onions, they were tiny set-onions for growing bigger ones. They were much too bitter to eat raw, but when boiled with various kinds of soup or stew, they were relished by the Danes.

**Around Australia.**-- On September 15, the *Galathea* sailed south away from Makassar and then turned east into the Banda Sea in which it followed the 5°31'-36' S parallel almost due east to 133°58' E Longitude. Then it veered southeast into the Arafura Sea and the Torres Strait between New Guinea (an eastern Indonesian island) and the northern end of Cape York Peninsula (Queensland, Australia). The *Galathea* put into port at Thursday Island, Queensland, where there is an excellent deep-water harbor, a pier built by the U.S. Navy Seabees, a marine station, and the center of the pearling industry. We arrived there on 29 September 1951.

Between Makassar and Thursday Island, we stopped at 12 stations. At seven of these stations in the Banda Trench, the water depth ranged from 7240 to 7290 meters. Living bacteria were recovered from three of these deeps. Negative results (no evidence for the presence of living bacteria) were obtained in numerous samples of bottom sediments collected from depths exceeding 4000 meters throughout this and subsequent deep-sea expeditions. Negative findings probably result from a lack of knowledge about the fastidious nutrient and environmental requirements of deep-sea bacteria.

From Thursday Island, the *Galathea* continued its course through the Torres Strait and into the northern end of the Coral Sea to Port Moresby, New Guinea. There I disembarked on October 2 for assignments in Australia. My Danish shipmates sailed away at midnight leaving me lonesome and alone on the wharf except for a few curious dark-brown native Papuans who were standing around there to see the big ship.

The *Galathea* proceeded south and then east through the Coral Sea and then northeast to Guadacanal, Noniora, one of the Solomon Islands. It stopped there for two days, October 7 and 8. Then she headed northwest into the New Britain Trench east of New Britain in the southwestern Pacific Ocean. In this trench, four stations were occupied where bottom sediment samples were collected from depths of 7890 and 8900.

Sailing southward for about 150 miles away from the New Britain Trench, the *Galathea* passed Woodlark Island (see Fig. 3, p.11a). Then she passed through the Louisade Archipelago toward Port Moresby where she put into port again, this time for 12 days (October 19 to 31).

This time out of Port Moresby, a southerly course parallel to the Great Barrier Reef was taken to the seaport of Brisbane, Queensland, Australia, a distance of 1600 miles. For the most part, the water depth was less than 3000 meters.

The *Galathea* made short stops in Sydney (New South Wales), Melbourne (Victoria), and Adelaide (South Australia). She occupied several stations in the Great Australian Bight south of Australia in the Indian Ocean. Enroute to Melbourne from Sydney, she passed through the Bass Strait between New South Wales and Tasmania. After an abbreviated survey of the Great Australian Bight, the *Galathea* retraced her tract almost due east near the 40th parallel through the Bass Strait and across the Tasman Sea between southeastern Australia and New Zealand. Eleven stations were occupied between 40° and 42° S Latitude and 160° to 170° E Longitude. The greatest depth sounded on this trip from Tasmania to Cook Strait, N. Z., was 4670 meters.

**Polynesian Waters.**-- Besides New Zealand and Hawaii, Polynesia includes Samoa, Fiji, Tonga, and numerous other islands. After a short stop for fuel in Wellington at the southern end of North Island, N.Z., the *Galathea* steamed southeasterly through Cook Strait into the South Pacific Ocean and then almost due south for about 1100 miles to Campbell Island, N.Z. This is the farthest south (52°33') that the ship ventured during the Expedition. She was there in midsummer from 31 December 1951 until 6 January 1952.

One of the objectives of going to Campbell Island was to take aboard some stuffed elephant seals for the Copenhagen University Museum. Also taken aboard as a mascot, was a healthy elephant seal pup. It was named Sir Anton after the Expedition Leader, Dr. Anton Bruun. Sir Anton thrived for a few weeks but he became ill while the *Galathea* was enroute from Hawaii to San Francisco. His symptoms were described to Dr. ZoBell by radiogram. By this time, ZoBell had returned to the Scripps Institution in La Jolla. He was requested to obtain vital information concerning medication from the San Diego Zoo and to make arrangements for a veterinarian from Steinhart Aquarium in San Francisco to examine Sir Anton as soon as the ship arrived there. Sir Anton survived the long boat ride, but he died a few days later on a plane enroute from San Francisco to Copenhagen. There he joined his stuffed relatives in the Museum.

From Campbell Island, the *Galathea* sailed north about 550 miles to Dunedin, located on South Island, N.Z., and about 200 miles southwest of Christchurch. After refueling at Dunedin, she sailed south around the southern end of South Island and then west for about 250 miles into the Tasman Sea nearly to the 160th meridian where samples were collected from water depths as great as 4670 meters.

While the *Galathea* was working in the Tasman Sea 17 January 1952, a fierce gale forced her to run for shelter into Milford Sound on the west side of South Island. This was almost like a homecoming for the ship, because 15 years earlier (1937), when she was flying the British flag as the H.M.S. *Leith*, she was in Milford Sound serving in the New Zealand Navy as a survey and charting vessel.

After a day in Milford Sound, the *Galathea* returned to the Tasman Sea and proceeded northeast back to the Cook Strait and Wellington, North Island, for fuel oil. Again she sailed eastward through the Cook Strait, this time turning north in the South Pacific Ocean off the east coast of North Island into Hauraki Gulf and Auckland. This was a 700-mile voyage.

The *Galathea* remained in Auckland for a fortnight, during which time the boilers and bottom were cleaned and she was painted. The original cruise plans called by my rejoining the Expedition in Auckland. However, duty in the Marine Biology Department at the SIO had made it necessaery for me to return to La Jolla from Sydney, Australia. Arrangements were made for my place on the *Galathea* to be taken by Richard Morita, one of my advanced Ph.D. students. He boarded the *Galathea* in Auckland 9 February 1952. Also boarding the ship at this time was Dr. Rolf L. Bolin,

professor of zoology from Stanford University and the Hopkins Marine Station, Pacific Grove, California.

Dick (Ph.D. since 1954) occupied the cabin/laboratory in which I had worked earlier. He examined deep-sea sediments, water samples, and various kinds of benthic animals for the presence of living bacteria. In the Kermadec Trench at stations two or three hundred miles north northeast of Auckland, Dick found significant numbers of bacteria. These bacteria were detected in samples of bottom sediments collected from water depths of about 7000 and 8500 meters. They grew at deep-sea pressures (700 and 850 atm) and temperatures (near 3°C).

Mechanical difficulties forced the *Galathea* to return to Auckland for repairs after which she sailed north again, this time to the Tonga Trench and the Tonga Islands north of the Kermadec Trench. Living bacteria were demonstrated in several samples of bottom sediments taken from the Tonga Trench at water depths of 6720 and 9820 meters.

Continuing a north northeast course, the *Galathea* sailed away from the Tonga Trench on 25 February 1952. She passed the Samoan Islands and arrived in Honolulu, Hawaii, 12 March. There the ship was in port for four nights and five days. On the tract from the Samoan Islands, through the Hawaiian Islands, and on to San Francisco, the greatest water depths sounded were 3180 meters in a depression between the Equator and Honolulu and a depression of 3400 meters east of Honolulu near the Tropic of Cancer and the 150th meridian.

From Polynesian waters forward, it became necessary to curtail the Expedition by about three months owing to a shortage of funds caused by unanticipated high costs of ship repairs, high dock charges, required detours, and the high cost of fuel oil in the Pacific. As a result, most of the abyssal deeps off the west coasts of the Americas and the western Atlantic Ocean were not explored by the *Galathea*

**San Francisco to Panama.**-- The *Galathea* put into port in San Francisco Bay on 6 April 1952. The Galatheans received a royal reception. A good many of them visited the Steinhart Aquarium in Golden Gate Park, Chinatown, and other places of interest. On April 10th, the ship sailed south southeast into Monterey Bay for a day at Pacific Grove, the site of the Hopkins Marine Station. Dr. Rolf Bolin disembarked there.

Three days later, Dick Morita disembarked at San Pedro, the seaport of Los Angeles. Dick supervised the transfer of all of our marine microbiology material, including apparatus, bottom sediment samples, and bacterial cultures to La Jolla in a Scripps Institution truck. As on the ship, the cultures and deep-sea samples were maintained in barokams (steel pressure cylinders) at deep-sea pressures 700 to 1000 atm) refrigerated at 2 to 3°C. The total weight of the microbiology cargo was nearly one ton, about 25% of which consisted of samples.

While the ship was in port at San Pedro, a good many of the Galatheans visited the Danish colony at Solvang near Santa Barbara. In relays, most of them were guests at Disneyland and Knotts Berry Farm. The leader of the Expedition, R.D.N. officers, and some of the scientists were greeted by the Mayor and other Los Angeles dignitaries in City Hall. Arrangements were made for SIO staff members to transport a good many of the Galatheans to La Jolla. Several were house guests for a night or two. On April 12 and 13, Claude and Jean ZoBell had Poul H. Jacobsen and Ingolf Crossland, both of whom had been very helpful on the Expedition. The night of April 14, we had E. Aabye Jensen, Bent Hansen, and Ulrich K. Kraning, all graduate zoology students. On April 18, Dr. Henning Lemche signed our guest book. Anomalously, Dr. Lemche was an entomologist, who found no insects at appreciable depths in the sea, but his net, hung from the spars high up on

the ship, caught air-borne insects at nearly all distances from land. On April 21 our guest book was signed by Dr. Anton Fr. Bruun, his son Erik, and J. Hans Legind, a graduate student from Denmark.

Most of the Galatheans were eager to visit the Borrego Desert, attracted there by the unique flora. Nearly every one wanted to be photographed near the Salton Sea beside an Imperial Valley highway sign saying, "240 feet below sea level." More than one Galathean jested, "After looking for deeps around the world, this is the deepest we've been." Incidentally, the surface of the Dead Sea is nearly 1300 feet below sea level. The deepest place in Death Valley in California is 282 feet below sea level. The surface of the Caspian Sea between Asia and Europe is between 85 and 90 feet below sea level.

On 22 April 1952, the *Galathea* steamed from San Pedro to La Jolla. She anchored for several hours a thousand feet or so off the end of the SIO pier. All day, one of her life boats and an SIO motorboat ferried personnel back and forth between the pier and the famous ship. In the evening, she departed for Acapulco. Along the way, she occupied two deep-water stations (3570 and 4830 meters) off the southwest coast of Mexico.

Between Acapulco and Panama (May 6 to 17), the *Galathea* occupied 29 stations off the west coast of Central America. The greatest depth sounded was 3670 meters, 130 meters less than the average depth of the ocean. At 20 of these stations, the water depth ranged from 400 to 915 meters. From these shallow depths, it will be apparent to most oceanographers that the ship was sailing relatively close to shore. Less than a hundred miles off the shore of Central America there is a narrow, 450-mile long Middle America Trench much of which exceeds 6000 meters in depth. This trench runs parallel to the coast from the Gulf of Tehuantepec, Mexico, to the Gulf of Fonseca at the southeast end of El Salvador.

From May 12 to 17, the *Galathea* occupied 26 stations in the Gulf of Panama between 5°38' to 7°28' N Latitude and 78°43' to 89°48' W Longitude between the Azuero Peninsula, Panama, and the Gulf of Cupica, Colombia. The water depth at these 26 stations ranged from 400 to 3570 meters. Seven of the stations were deeper than 2950 meters.

**Panama Canal to Copenhagen.**-- After passing through the Panama Canal on May 18, the *Galathea* sailed northeast through the Colombian and Venezuelan Basins to San Juan, Puerto Rico, a distance of 1200 miles. Before proceeding northeast to the Puerto Rico Trench, some of the Galatheans visited what used to be called the Danish West Indies or the Danish Virgin Islands. St. Thomas, St. Croix, and St. John with some smaller islets belonged to Denmark until 1916 when they were purchased by the U.S.A.

The greatest depth sampled in the Puerto Rico Trench was only 2840 meters, although the Puerto Rico Deep is 9200 meters. The Trench is deeper than 8000 meters for most of its 160-mile length. It is located some 70 or 80 miles north of Puerto Rico and the Virgin Islands.

Between Puerto Rico and the Azores in the northeastern Atlantic Ocean, the *Galathea* sailed through the Sargasso Sea. This famous sea is located roughly between the Tropic of Cancer and 33° N Latitude extending from the 40th to the 60th meridian. The western end of the Sargasso Sea is north of Puerto Rico and south of Bermuda. On June 5, the *Galathea* occupied a station (No. 761) in the Sargasso Sea where the water depth was 6300 meters. Most of the water in the Horse Latitudes ranges in depth from four to five thousand meters. Ships that rely upon the wind for propulsion avoid the Horse Latitudes owing to the frequent calms, baffling winds, and high atmospheric pressure.

The steam-propelled *Galathea* made a short stop in the Azores, a possession of Portugal some 800 miles west of Lisbon. From there, she continued her north northeast course to the Gulf of Biscay off the west coast of France. Five stations were occupied in this Gulf at water depths ranging from 855 to 1680 meters. Then the *Galathea* proceeded to Plymouth, England, and back to Copenhagen on 29 June 1952.

Eighteen days later, 17 July 1952, the *Galathea* was de-comissioned by the Royal Danish Navy. Circumnavigating the earth seeking information about the deep sea, she traveled 63,700 miles, equal to about 2.5 times the earth's circumference at the Equator. She stopped at 70 ports and occupied 774 stations. At 625 of these stations, the water depth exceeded 400 meters. At 355 of the stations, the water depth exceeded 1868 meters. At 216 stations, the water depth exceeded 3800 meters, the latter being the mean depth of the ocean. Only seven R.D.N. officers and two scientists (Dr. Anton Fr. Bruun, Expedition Leader, and Dr. B. Hansen) were aboard during the entire 560-day voyage. I was aboard the *Galathea* for 88 days, during which time she traveled 6560 miles. During the 63 days that Dick Morita was on the *Galathea* from Auckland N.Z., to San Pedro, California, via Hawaii and San Francisco, the ship traveled 6660 miles.

**World's Records for Life at Great Depths.**-- According to Anton Fr. Bruun, Expedition Leader, and Torben Wolff, Deputy Director, one or more species of the following kinds of animals were for the first time found at the stated water depths by Galatheans:

| Animal group | Water depth | | Animal group | Water depth | |
|---|---|---|---|---|---|
| Actinia | 10,460 meters | | Brachyura | 7,200 meters | |
| Amphipoda | " | " | Cirripedia | " | " |
| Holothurioidea | " | " | Hydroidea | " | " |
| Lemellibranchiata | " | " | Isopoda | " | " |
| Sipunculoidea | " | " | Spongia | " | " |
| Tanadacea | " | " | Ascidea | 6,900 | " |
| Crinoidea | 8,500 | " | Scyphozoa | " | " |
| Gastropoda | " | " | Gorgonacea | 6,800 | " |
| Asteroidea | 7,500 | " | Madreporaria | " | " |
| Echinoidea | 7,400 | " | Ophiuroidea | " | " |
| Echiuroidea | " | " | Pennatulacea | " | " |
| Polychaeta | " | " | Pycnogonia | 6,000 | " |
| Pisces | 7,300 | " | | | |

Living bacteria were recovered for the first time from depths exceeding 9000 meters, some in bottom sediments from depths of 10,210 meters. The ability of these bacteria to grow at deep-sea pressures and temperatures (2-3°C) suggests that they are probably indigenous to these abyssal oceanic depths.

**Published Papers Resulting from Expedition.**-- To date (1985), 85 papers by Galatheans have been printed in 15 volumes of the periodical Galalthea Report. Some representative titles follow:

Bruun, Anton Fr. 1959. General introduction to the report and list of deep-sea stations. Galathea Report, Vol. 1, p.7-48.

Steeman Nielsen, E., and E. Aabye Jensen. 1959. Primary oceanic production. The autotrophic production of organic matter in the oceans. Galathea Report, Vol. 1, p. 49-136.

ZoBell, C. E., and R. Y. Morita. 1959. Deep-sea bacteria. Galathea Report, Vol.1, p. 139-154.

Kiilerich, A. 1959. Bathymetric features of the Philippine Trench. Galathea Report, Vol. 1, p. 155-171.

Wolff, Torben. 1962. The systematics and biology of bathal and abyssal *Isopoda aseloita*. Galathea Report, Vol. 6, p.6-320.

Kiilrich, A. 1964. Hydrographical data. Galathea Report, Vol. 7, p.7-28.

Larsen, Berger. 1968. Sediments from the central Philippine Trench. Galathea Report, Vol. 9, p. 7-21.

In addition to the 85 papers published to date in the Galathea Report, by 1981, another 209 papers resulting in whole or in part from the Expedition, have been published in other periodicals. The authors, titles, and references to these supplementary papers are given in four issues of the Galathea Report: (a) Vol. 1, 1959, p. 18-19, (b) Vol. 9, 1968, p. 255-256, (c) Vol. 12, 1973, p. 145-146, and (d) Vol. 15, 1981, p. 79. Of the 209 papers resulting in whole or in part from the Expedition, 31 were authored by ZoBell and his SIO associates. These papers are listed below in the copy of a letter addressed to Dr. Torben Wolff, editor of the Galathea Report, 24 March 1982.

**The *Galathea* Visitors' Book.**-- The voluminous scientific literature resulting from the *Galathea* Expedition was supplemented by an amusing Visitors' Book authored by Hakon Mielche. He was one of the three leaders of the Expedition headed by Dr. Anton Fr. Bruun. Mielche, a popular, fun-loving author and artist, was in charge of public relations before, during, and after the Expedition. He has published 33 books in 27 years.

The Visitors' Book was created during the Expedition. For nearly every noteworthy event, discovery, or port of call, Mielche prepared a four-color cartoon and obtained the signatures and sometimes comments of distinguished personalities. The total number of signatures was restricted to 3000 as was the total number of printed copies of the book. By popular demand, Hakon Mielche himself personally autographed each copy of the book. Representative of other signatories were King Frederik IX of Denmark, Prince Axel of Denmark, the President of Liberia, Queen Islow of the Nicobars (who could not write but gave her fingerprint), prime ministers, or other dignitaries of nearly every country visited, famous scientists, Admirals, and motion picture stars.

The copyright stipulates that the *Galathea* Visitors' Book is not to be reprinted. Permission, however, may be granted to reproduce a restricted number of certain pages in black and white. Facsimiles of three such pages (No. 74, 99, and 171) are attached. An original copy of the book is shelved in SIO Special Collection (call No. GC5 D36). Facsimile No. 74 shows a fingerprint of Nicobar Island Queen Islow. No. 99, labeled "Philippine Trench," depicts the recovery of living bacteria (in the culture tube) from a recorded depth of 10,328 meters (corrected depth 10,210 meters) and a single sea anemone attached to a stone from a recorded depth of 10,462 meters (corrected depth 10,336 meters). The caricature of the anemone appears above the signature of Anton Fr. Bruun, who is caricaturized on top of the stone waving the Danish flag.