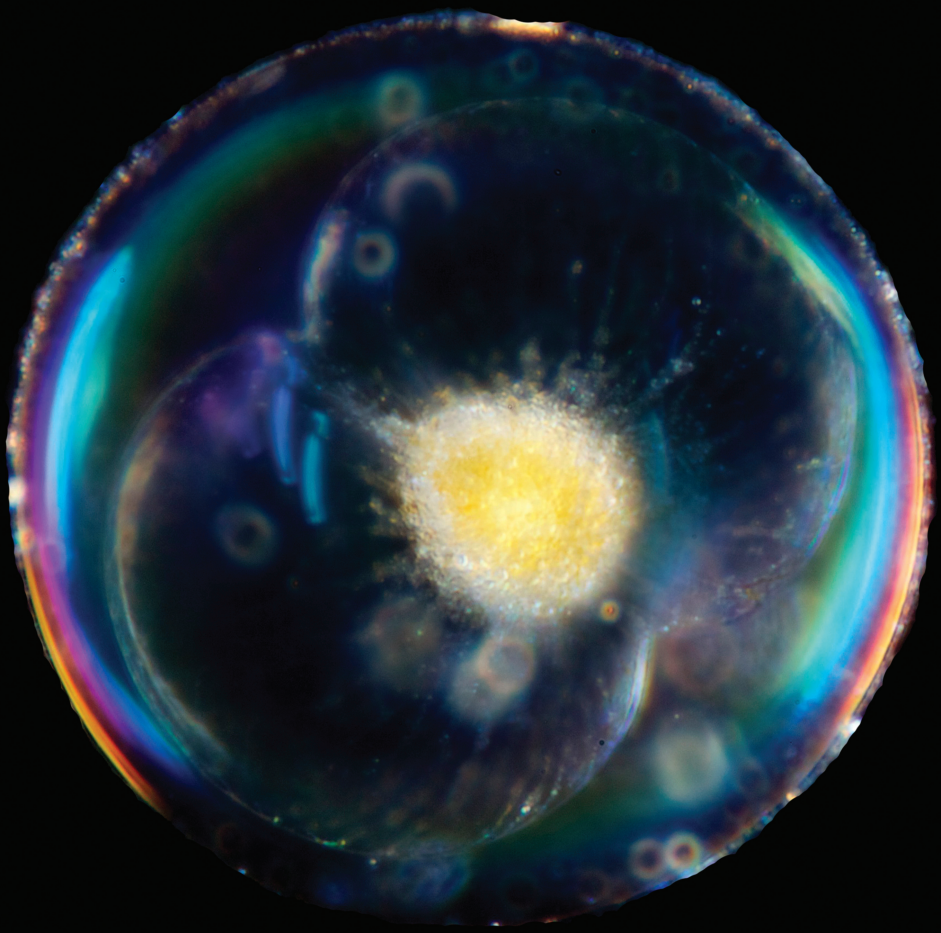

1
Under the Eye of Neptune: An Historical Perspective of Marine Creature Imagery

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Abstract

The ocean may have been filled by meteorites bringing water to Earth but its creatures were drawn by men. Sea shells were eaten in caves, dolphins drawn on cave walls. For a long time, though, its surface was the only visible thing, a glittering mirror for the human soul where Gods and Monsters fought over submerged empires, pulling down Atlantis and raising volcanic spires with thunder and smoke. Once the smoke had cleared and man learned to fish then dive, the marvels of the sea appeared and glittered even thousands of meters deep, revealing a magnificent world beyond our imagination. From the jellyfish's ballet to intricate glass houses of radiolarians, this introductory chapter presents a concise history of how man images the invisible oceanic world. Copyright © 2013 John Wiley & Sons, Ltd.

1.1
Introduction

Black and dark was the Universe. Then, the Big Bang lit everything, making energy flow, and amongst the billions of particles thrown across space was our planet, a tiny ball of orange fire. No blue, no green, no life. With time and changes, perhaps meteorite showers, water appeared on Earth and built up the marine world, or at least a place like an ocean, 4.6 billion years ago.

Many theories have been proposed, discussed, discarded, and buried about the origin of life; often the ocean or marine environment is a component of the magical mix that gave rise to the chance for life on our planet. Cells appeared, close to deep sea volcanoes, or perhaps it was in rock pools; in a shallow bay stromatolites used the blazing sun's energy to create food sources and deposits that mark the origin and began the continents. Life expanded and thrived in these early oceans but there was no one to record the creatures that inhabited it. Only bones and stones give us a glimpse of these creatures and for many millions of years there were no eyes to see them, and no arm and digits to draw them or to build cameras to picture this

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massive world up to 12 km deep and spanning 70% of our Earth, from the frozen lands of Antartica to blooming coral reefs.

Oceans covered the globe and currents carried organisms, continents emerged, and shades of green would have been seen from outer space. Blue was no longer the only color: brown, green, gray, and shades of sand were turning our world into a magnificent rainbow. Fishes grew limbs and left this ever moving world packed with predators, and along this line of evolution came the mammalians. They took over the world and even the oceans with the biggest of all those left alive: the whales.

They developed and, eventually, stood up to look at the world around them, trying to understand it. They started to draw and we can witness dolphins jumping out of the water (Figure 1.1) painted on rock faces. These are the first known images of an ocean creature painted by men, probably 30 to 10 000 years ago. They imaged marine life on rock faces with natural pigments, a beautiful first attempt to approach the Great Blue Beyond.

One of the most magnificent examples is L'Abri Poisson located in the valley of the Gorge d'Enfer, on the right bank of the Vézère River near Les Eyzies-de-Tayac. It was discovered in 1892 by Paul Girod, and dates from the Aurignacian (about 47,000 to 27,000 years). This salmon, 1.05 m long, is etched and carved in low relief on the ceiling of the vault, enhanced with red pigment. And it has been carved with such accuracy that is attitude can be seen as a characteristic of a male exhausted by spawning. This is one of the only ten Paleolithic cave art fish known.

Other examples of marine animals can be found in the Sierra de Guadalupe cave (Mulegé in Baja California, Mexico), Cueva de la Pileta cave (province of Málaga (Spain) or Misool (West Papua, Indonesia (Figure 1.1)).

Those fish drawings receive their origins from human's desire to feed, clothe, and equip themselves with useful implements. According to Michael Barton, a

Figure 1.1 Prehistoric rock art, Misool, West Papua, Indonesia. In the Misool area there are several sites decorated with extensive rock art or paintings. The paintings are thought to be between 3000 and 5000 years old and feature dolphins, fishes, whales, dugong, hands, abstract figures, and what may be representations of "Matuto," a half-man, half-lizard hero, or god. The sites are on sections of limestone cliff. © Matthew Oldfield 2009.

prominent ichthyologist and professor at Centre College, ''the earliest ichthyologists were hunters and gatherers who had learned how to obtain the most useful fish, where to obtain them in abundance and at what times they might be the most available''.

Fish were not the only marine organisms used by the first humans of the Upper Palaeolithic but never painted; molluscs or rather their remains: shells. They were certainly uses as food source, raw material, ornaments, containers or even currency.

1.2 Ancient Uses of the Oceans

For many years, the marine world was not only a source of food (fishes, shellfishes) but also, and mainly, a surface to move upon, a liquid pathway to new territories. But this dangerous blue world was deep and dark, feared as the house of Gods and Monsters able to swallow boats and seafarers in a single gulp.

1.2.1 Seafarers

Knowing your environment and mastering it was a major leap in human activity. Early seafaring activity have been recorded in Sicily and Cyprus and dated to the Upper Palaeolithic period (30,000 to 11,000 years ago) but the Phoenicians are the most established sea-faring community (1,200BC) using the stars for their oceanic voyages. But Europe and the Mediterranean sea were not the birth place of human maritime activity.

About 30 000 years ago, human cultures along the western coastline of the Pacific Ocean – in the area between what is now Australia and China – started to migrate eastward across the great expanse of the Pacific Ocean. We are not sure exactly why the migrations started, but tribal wars, disease epidemics, the search for food, or natural disasters, such as large volcanic eruptions and earthquakes, may have been factors.

Over about 25 000 years, these people, called *the Polynesians*, eventually colonized the islands of the south and western Pacific, from New Guinea in the west to Fiji, and Samoa in the middle. They then moved onward to Tahiti and, finally, to Easter Island in the eastern south Pacific. How did the Polynesians manage to travel across thousands of miles of ocean without compasses, sextants, clocks, or other tools of modern navigation? Their migration was truly one of the great achievements of early seafaring cultures, and it marks the start of oceanographic observations by people who lived in harmony with the ocean. The Polynesians were very observant. They noted the directions that waves came from and how they affected or rocked their canoes. They had a keen sense of ocean currents and variations in bird and sea life in different places in the Pacific. They also were among the first people to use astronomical observations of the stars to help them navigate across the ocean.

They made the earliest form of navigational or oceanographic map, called *stick charts*. These were made of pieces of bamboo or other wood that were tied together. The locations of islands were often marked with shells or knots, and curved pieces of wood represented the bending of ocean waves around the islands and the way waves rocked their canoes. Polynesians handed down their lore of the sea in both the oral and stick-map traditions.

We can suppose that they also recorded their world and discovery and a few petroglyphs of fishes and canoes can be found on Nuku Hiva, Marquesas Archipelago, France.

1.2.2 The Mediterranean Sea: the cradle of marine biology

The references to the sea and its mysteries are myriad in Greek civilization, in particular in *The Iliad* and *The Odyssey*. However, in those two books about ancient history the sea is seen as the territory of Gods or as a means of moving from one point to the next and as providing food. Early Mediterranean civilizations, including the Greeks, have passed down many myths that include gods and goddesses who ruled over nature, such as Poseidon and his son Triton. Many Mediterranean legends, such as Jason and the Argonauts, also involved adventures on large and dangerous seas.

About 2900 years ago, the Greeks began to venture outside the Mediterranean, past the Straits of Gibraltar at the western end of the Mediterranean Sea. This narrow channel separates Europe from Africa, and the Mediterranean from the Atlantic Ocean. Just outside of the Straits of Gibraltar, early Greek sailors noticed a strong current running from north to south. Because the sailors had only seen currents in rivers, they thought that this great body of water on the other side of the Straits was an extremely big river. The Greek word for river was *okeano*, which is the root of our word for ocean.

1.2.2.1 Aristotle and Pliny the Elder, the Founding Fathers

Birth of Natural History Observation With the Greek world came the Academy, a world of knowledge, teaching, and exchange. A pupil of Plato, Aristotle, was the first to make specific comments on sea life. He had collected and referenced a vast number of species, including echinoderms, molluscs, and fishes, and he wrote the founding book of biology: ''Animal stories.''

In 344 BC, he went to the neighboring island of Lesbos, at Mytilene, to visit one of his colleagues from the Academy, the philosopher and naturalist – another student of Plato–Theophrastus (371–287 BC). They studied together the botany and the zoology of the island and also the creatures from the sea, or Thalassa, around it. Aristotle found on this island his second school, for almost two years. In 343 BC, he went back to Macedonia, invited by King Philippe II (359–336 BC), to

become the preceptor of his son, the future Alexander the Great (336–323 BC). He was then appointed head of the Royal Academy of Macedonia.

In 346 BC, Aristotle went to Atarneus with Xenocrates (ca. 396–314) and Theophrastus (ca. 372–288) and moved to the little harbor of Assos (the Turkish village of Berhamkale). Here he pursued further his biological research and started to observe marine life. He was the first to recognize that cetaceans where mammals and that those marine vertebrates where oviparous or viviparous. He described many forms of marine life and deduced gill function. He was the first zoologist and also the first to establish a classification of life forms. He mentioned nearly 400 species. He divided them in two groups: the ones that have blood (*Enhoema*), more precisely red blood, the vertebrates, and the ones without: the invertebrates (*Anhoema*). Amongst the marine organisms described by Aristotle we find fishes and cetaceans and also the *malacostraca* (crustacean, crabs, etc.) as well as the Ostreioda (oysters) and the Mollusca: squids and octopus. The texts that have survived about biology, anatomy, and physiology seem to indicate that Aristotle performed dissections and probably drew them. But we have no record of the way zoology and marine biology was taught in the famous school of Alexandria during the Ptolemaic dynasty where the pupils of Aristotle further pursued his work.

Interestingly, he also discussed tides and thought that there were due to the compression of lower sea water by surface waters. This error was later corrected by the Roman Pliny the Elder (v 23–79 BC), another father of zoology and marine biology, in his ''Natural Stories.'' He described these regular movements of the sea water (twice a day) as being caused by the Sun and the Moon. He observed two tides a day and, to quote, ''In between two moon risings, the sea raises twice and 'gone' twice in a 24 hour period'' and he pointed out that the tides where never at the same time the following day.

As he was the first to pass on his observations to us, Aristotle is considered to be the father of marine biology and zoology, even though he did not leave any drawings, only description of his observations.

During the Roman Empire we only find zoological observations from Pliny, Solinus, and the agronomical writers. However, Pliny the Elder was mainly a ''collector'' of stories that he bound together in his ''Natural Stories;'' he does not provide much new knowledge. The only images of ocean creatures passed on to us are large fishes, dolphins in mosaics in the middle of Monsters, Gods, and Mermaids.

1.2.2.2 Understanding the Oceans

Early Science and Technology The oceans were a dangerous place to be and the lack of a reference point on this ever changing blue surface made it difficult to navigate. The Egyptians and the Phoenicians mainly used coastal navigation to conquer the Mediterranean Sea. Finally, the Greeks extended the range of their journey towards Gibraltar and in 325 BC Pytheas sailed from Greece to Iceland and following the North Star he observed latitude, correcting Aristotle. He also proposed that the tides were caused by the Moon. His followers, like Eratosthanes,

calculated the circumference of the Earth. Aristarchus independently calculated the diameter of the Earth from observations of the elevation of the Sun at noon at two locations along a north–south line between Greece and Egypt. Those first invisible reference lines using the stars made it possible to draw maps and Ptolemy, in 127–151 AD, produced the first world atlas, including the Pacific and Indian Oceans; he also showed the world as a globe. At the other side of the planet, the Polynesians developed advanced maps or stick maps that display key islands but mainly ocean currents that helped them to move great distances.

Finally, Hellenistic Greece developed coastal markers and lighthouses as navigational aids, one of which, the Pharos (lighthouse) of Alexandria, was one of the Seven Wonders of the Ancient World. They also probably established ways of accurately measuring time so as to be able to precisely determine latitude. However, such discoveries where only ways of using the surface of the ocean – the life striving in the ocean lay hidden under the waves, drifting with the Gods: Oceanus, Tethys, the nymph Eurynome, and the giant Ophion.

1.3 From Neptune to Animalcules

Poseidon and his daughter Charybidis were replaced by Neptune as the Roman Empire conquered the world, including the European coast lines. The desire to explore and to rule pushed ahead mainly on roads and oceans. Then there came trade and legends of gold and spices so far away by foot that European explorers turned to the sea to find faster trade routes to cities in Asia and Europe. Prince Henry the Navigator of Portugal (1420) recognized the oceans' importance to trade and commerce and he established the first school of navigation.

1.3.1 Age of European Discovery and Exploration

The fifteenth century saw Bartholomew Dias (1486) and then Vasco de Gama (1498) sailed around Africa and into the Indian Ocean while Columbus sailed the Atlantic and (re)discovered the Americas, becoming the first European to sail westward across the Atlantic Ocean and return home. Ponce de Leon ''discovered'' (for the European) the Pacific Ocean. Finally, the ultimate goal of circumnavigating the Earth was achieved by the Portuguese Ferdinand Magellan (1520) and later by Sir Francis Drake (1580).

It was not until the sixteenth century that zoology become a major subject of research and one of the earliest researchers was probably Guillaume Rondelet, known also as *Rondeletus*, in Montpellier who also, like Aristotle, performed dissection and explored not only fishes but also sea urchins and crabs. In 1556, he published ''The Complete Story of Fish.''

1.3.2 Voyages of Exploration and finally Science

In the early 1700s, several European countries sought to expand their empires and discover new lands for raw materials, colonies or trade, and for spices from the East Indies, which they believed would help cure the Plague. They launched expeditions to survey faraway lands across the Atlantic, Pacific, and Indian Oceans, and in doing so also explored the Arctic and Antarctic Oceans. But only the lands were concerned and the oceans were merely a roadway to move from one land to another to claim them for their king, queen and other empires. The only sailors concerned about the sea creatures were the whalers.

But in 1768, James Cook, on board the HMS *Endeavour* is sent to Tahiti on a scientific mission: to observe a rare eclipse caused by the interposition of Venus between Earth and the Sun. Passed through Cape Horn; he made his astronomical observations in June 1769. The British captain then took possession of the archipelago which he gives the name of the Society Islands, in honor of the Geographical Society of London which send him to Tahiti. Over 10 years, Cook led three world-encircling expeditions and mapped many countries, including Australia, New Zealand, and the Hawaiian Islands. He was an expert seaman, navigator, and scientist who made keen observations wherever he went.

James Cook was not only an explorer. His travels have marked the end of the Great Discoveries and have allowed significant progress in the knowledge of the Pacific Ocean, with the hydrographic surveys and thoroughness of this great observations and reports. His expeditions were a huge success in Europe, which became fascinated with the stories of Cook, published along with remarkable maps and drawings. Louis XVI, during the Franco-English war, ordered to befriend him. The Anglo-French competition, hosted by Bougainville and La Perouse, facilitated the expansion of geographical knowledge of the Pacific. James Cook began the era of scientific exploration.

1.3.3 A Glimpse at the Invisible

The eighteenth century was not only a time of expedition but also of a major breakthrough for the future of biology. The magnifying power of segments of glass spheres was known to the Assyrians before the time of Christ; during the second century AD, Claudius Ptolemy, an astronomer, mathematician, and geographer at Alexandria, wrote a treatise on optics in which he discussed the phenomena of magnification and refraction as related to such lenses and to glass spheres filled with water. Despite this knowledge, however, glass lenses were not used extensively until around 1300, when an anonymous person invented spectacles for the improvement of vision. This invention aroused curiosity concerning the ability of lenses to magnify. In Holland in 1673, Anton Van Leeuwenhoek prepared quality lenses so that he could better examine garments. However, his insatiable curiosity led him to built one of the first microscope and use these lenses to examine many

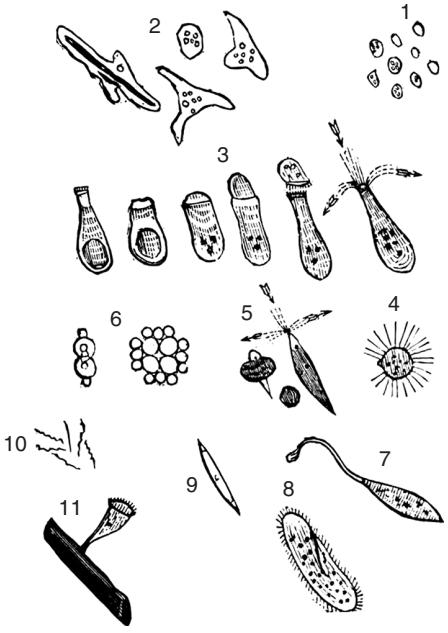

Figure 1.2 Antonie van Leeuwenhoek "Animalcules." The first pictures ever drawn of planktonic species defined by Antonie van Leeuwenhoek as "animalcules" or very tiny animals, which will become ciliates, algae, *Paramecium*, and so on.

biological items, including pond water. What he discovered in the water was a microscopic world of life. He described moving "animalcules," later described by Christiaan Huygens in 1678 as paramecium (Figure 1.2). He described rotifers, *Euglena* and *Spirogyra* and paved the way to the use of microscope in biology and the extensive description of the invisible life in each drop of fresh or sea water.

1.4 The Birth of Oceanography (The Nineteenth Century)

1.4.1 Drawing the Jellyfish

Nicolas Baudin in the *Geographe* and Emmanuel Hamelin on the *Naturalist* left Le Havre on October 19, 1800 for what will be called the Baudin expedition (1800–1804). Francois Peron (1775–1810), a French naturalist and physicist, aboard the *Geographer*, alongside the artist Charles-Alexandre Lesueur (1778–1846). Only a few scientists and crew members survive dysentery, fevers, deprivation and navigation in the southern storms. The journey ends at Port Jackson the 20th of June 1802. But before, the *Geographer* had to leave hurriedly King Island to escape a storm, and left Peron and Lesueur behind. They will be collected twelve days later by

an English ship. The return of the expedition, March 25, 1804 in Lorient, takes place in the utmost discretion, politics and rivalries in Europe monopolizing Napoleon. But the expedition brought a hundred unknown live animals to Europe (presented to the Empress Josephine) and nearly 100,000 samples. Of these, more than 2,500 new species were described for the first time, Peron included in a rational and logical classification of high modernity. Also, Charles-Alexandre Lesueur realized the most vivid paintings based on live animals of jellyfishes, siphonophores and other fishes. Those were the first accurate depictions of those nearly invisible species, decades before Forbes, Agassiz or Haeckel books on the subject but the Napoleon wars and the political situation obscured their beauty and the expedition reports were greatly ignored.

1.4.2 The H.M.S. Challenger Expedition

The nineteenth century was an important time for the development of marine biology. However, the oceans were still mainly treated as a motorway where the priority was to establish safer and faster routes for good transports. The only experienced sailors exploring unknown territories for economical reason were the whalers. Those ''biologists'' by needs observed the whale behaviors, charted new routes and brought back astonishing legends such as the depth to which those animals could dive far below the scientifically approved limits of life in the deep oceans. Those observations and their books were used by Americans and well as British Admiralty to improve their charts. For example, Matthew Fontaine Maury, (1806–1873) the American father of modern oceanography, compiled analyses of wind and current logs, and published maps of wind and current patterns. He wrote the first oceanography textbook in 1855, ''The Physical Geography of the Sea''.

On the other side of the Atlantic, the Voyage of HMS *Beagle* (1831–1836) with Charles Darwin led to the publication of ''The Origin of Species'' but brought little to the history of marine biology apart from the theory of coral reefs formation.

In 1852, the United States Navy Department decide to conduct a naval and commercial survey of those parts of Bering Straits, the North Pacific Ocean and the China Seas frequented by American whaling ships and by trading vessels in their routes between the United States and China. This was an economical expedition but Captain Cadwallader Ringgold was placed in command of the expedition, which departed from Norfolk, Virginia, in June 1853. And William Stimpson was appointed Chief Zoologist alongside naturalists such as Alfred H. Ames, Assistant Naturalist, and Charles Wright, Botanist. From 1853 to1856, they collected an extensive natural history collections were made. For nine years after the completion of the expedition, Stimpson utilized the facilities of the Smithsonian Institution while preparing a report based on the collections gathered during the expedition. While at the Smithsonian, he also helped classify and name specimens which the Smithsonian had been collecting. This great collection, including all the manuscripts being prepared by Stimpson, was destroyed in the Chicago fire of 1871, an event from which Stimpson never fully recovered.

Those expedition reports were largely ignored by the European and mainly British scientists. Their main concern in oceanography was the ''Azoic theory''. Edward Forbes, a distinguished British naturalist sailed with the British Survey on the HMS *Beacon*, charting the waters of the Mediterranean and Aegean Sea, where he was able to dredge for samples from the deepest waters examined to date based on European records ignoring American dredging n the North Pacific and the whaler tales. After these explorations, he developed his theory that below 300 fathoms (~600 meters) the mysterious dark depths of the seas was a lifeless area and he named this the Azoic (lifeless) zone. His theory was accepted by the public but not by his colleagues such as Charles Wyville-Thomson who followed him in the Edinburgh Chair of Zoology.

C. Wyville Thomson and W.B. Carpenter started large oceanographic cruises (HMS *Lightning* and HMS *Porcupine*) and started to falsify the ''Azoic theory'' bringing animals from below the Forbes 300 fathoms line with their dredges. These discoveries persuaded the British government to launch a worldwide expedition to explore the ocean depths not only because they wish to disprove Forbes theory but also because another important economical endeavour was a stake: the telegraph.

The *Challenger* Expedition (1872–1876) – sponsored by the Royal Society and Royal Navy – left Portsmouth, England, just before Christmas 1872. The ship had many different types of samplers to grab rocks or mud from the ocean floor, and nets to capture animals from different levels in the ocean. It was the first expedition organized specifically to gather data on a wide range of ocean features, including ocean temperatures, seawater chemistry, currents, marine life, and the geology of the seafloor. The H.M.S. *Challenger* also had different winches – mechanical engines used to lower and hoist sounding lines to measure how deep the ocean was. At each sampling station, the crew lowered trawls, nets, and other samplers to different depths, from the surface to the seafloor, and then pulled them back on board loaded with animals or rocks. This British Navy corvette (a small warship), was converted into the first dedicated oceanographic ship with its own laboratories, microscopes, and other scientific equipment onboard (Figure 1.3). The expedition was led by British naturalist John Murray and Scottish naturalist Charles Wyville Thompson.

H.M.S. *Challenger* first traveled south from England to the South Atlantic, and then around the Cape of Good Hope at the southern tip of Africa (Table 1.1). It then headed across the wide and very rough seas of the southern Indian Ocean, crossing the Antarctic Circle, and then went on to Australia and New Zealand. The expedition then headed north to the Hawaiian Islands, and then south again around Cape Horn, at the southern tip of South America where the Pacific and Atlantic Oceans meet. After more exploration in the Atlantic, they returned to England in May of 1876.

It visited all of the world oceans, except the Arctic, covering 127,000 km. Scientists on board studied the physical conditions of the deep ocean, the chemical composition of seawater, the physical and chemical characteristics of the seafloor deposits, and the distribution of organic life at all water depths. As part of the

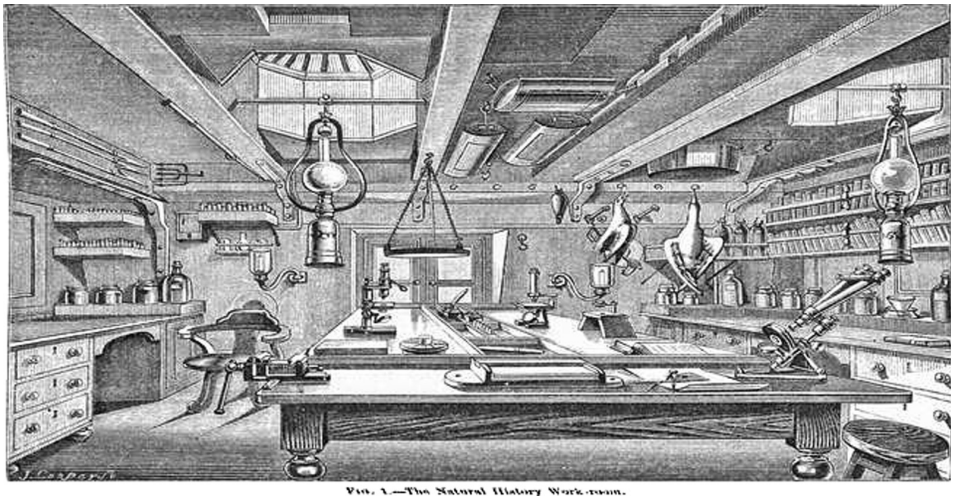

Figure 1.3 *H.M.S. Challenger* biological laboratory – This is a drawing of the first embarked biological laboratory to dissect, image, and analyze freshly collected planktonic and marine species – it would take 30 years to fully record and publish the results.

Table 1.1 Some facts about the H.M.S. *Challenger* Expedition.

Expedition crew	243
Scientists	6
Duration of expedition	4 years
Distance sailed	127 000 km (68 890 miles)
Number of sampling stations	362
Number of depth soundings made	492
Number of dredges taken	133
Number of new species of animals and plants discovered	4700

cruise, scientists measured the water depth of the Marianas Trench (8185 m); some 4717 new marine species were netted and classified.

The expedition also tested and disproved Haeckel's *Bathybius theory* (primordial slime) (Figure 1.4). Even though, Ernst Haeckel worked extensively on the samples brought back by the *Challenger* Expedition and will draw them to great length showcasing to the world new planktonic unicellular species: radiolarian, acantharian . . . Those marvelous illustrations and drawing made by Ernst Haeckel were used by Leopold and his son Rudolf Blaschka to create the unique marine glass invertebrate models displayed across Europe in Museums and used in many universities to teach marine biology and influence the new generation of biologists and microscopists (Figure 1.4). The later publication of his book "*Art Forms of Nature*" will influence artists of the Art Nouveau movement introducing the planktonic life forms in the general public. Rene Binet, a French painter and architect, studied extensively the works of Ernst Haeckel and his study of Haeckel's lithographs of

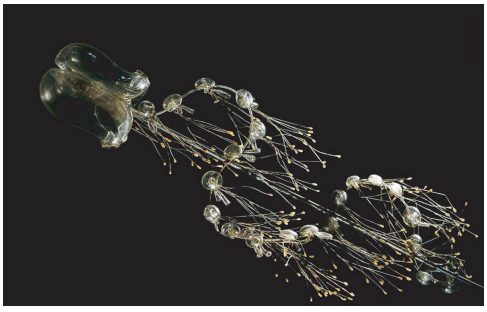

Figure 1.4 Blaschka glass jellyfish – Leopold and Rudolf Blaschka designed a unique way to display in a full three-dimensional manner marine invertebrate such as jellyfishes, ctenophores, and microscopical planktonic organism (radiolarians). Courtesy of Francis Latreille.

radiolaria culminated in the design for his Monumental Gate, located on the Place de la Concorde, at the Eastern entrance of the World Fair held in Paris in 1900. The design was heavily based on one radiolaria illustration alone – the Cyrtoidea *Pterocanium trilobum*.

Most of all, the *Challenger* Expedition encouraged other countries to take an interest in the oceans and to mount their own expeditions such as the ones led by Prince Albert I of Monaco (Expeditions *Princesse Alice* I and II, *Hirondelle* I and II), who founded the Oceanographic Institute, which was later led by Jacques Cousteau. Prince Albert of Monaco led several expeditions and also developed an extensive knowledge of currents and collected maps. His institute knowledge of currents proved valuable during World War I as it allows military officials to predict how explosive mines would drift in the ocean and where they would land as in the twentieth century the oceans turn into battlefields.

The German Empire was not left out of the Ocean Race for Knowledge and led two important expeditions: 1889 – National Expedition and 1898–1899 - *Valdivia* expedition.

1.4.3 Stations and Institutions

But one major step forward was the establishment of stations and institutions that will foster marine biology imagery and progress.

The College de France founded the first ever marine stations in Concarneau in 1859 which later extended to Roscoff on the northwest of France. Originally established for the cultivation of marine species, such as Dover sole, because of its location near marine estuaries with a variety of marine life, it evolves towards research on molecular biology, biochemistry, and environmental studies.

A few years late, the Stazione Zoological was founded in 1872 by the German zoologist Anton Dohrn (1840–1909), a former student of Ernst Haeckel. Dohrn thought of the Napoli institute as a pilot centre of a worldwide network of research

facilities for studies in marine biology. He envisioned a railroad system where scientists could stop, collect material, make observations and conduct experiments, before moving to the next 'station': therefore the name "Stazione (=Station)".

At Woods Hole (USA) in 1888, the Marine Biological Laboratory (MBL) was established by Alpheus Hyatt, a student of Harvard naturalist Louis Agassiz who had established the first seaside school of natural history on an island near Woods Hole. MBL was designed as a summer program for the study of the biology of marine life for the purpose of basic research and education. The Woods Hole Oceanographic Institute was created in 1930 in response to the National Academy of Science's call for "the share of the United States of America in a worldwide program of oceanographic research". An independent biological laboratory was established in San Diego in 1903 by University of California professor Dr. William E. Ritter, which became part of the University of California in 1912 and was named the Scripps Institution of Oceanography after its benefactors. The MBL was also the first oceanographic institution to build the first oceanographic research vessel: "*Atlantis*" specifically for interdisciplinary research in marine biology, marine geology and physical oceanography. From 1931 to 1966, the "A- boat" made 299 cruises and covered 700,000 miles, doing all types of ocean science.

Interestingly the same year: 1888, a marine biological laboratory was established in Plymouth, England. This laboratory was established by the Marine Biological Association of the United Kingdom.

Finally, the Monaco's Oceanographic Museum and Laboratory opened in 1906 and was followed by an extensive network of stations across the Globe.

1.5 The Twentieth Century: Institutions and moving images

The twentieth century was a century of wars and technological developments. One of them, the sonar gave images of the ocean sea floor based on acoustic measurement. The possibilities to observe the marine creatures in their habitat rather than in specimen jar even at great depth was another important step especially when using moving images or video.

1.5.1 New tools – new images:

Technology brought the study of marine biology to new heights. In 1934 William Beebe (1877–1962) and Otis Barton descended 923 m/3,028 ft below the surface off the coast of Bermuda in a bathysphere designed and funded by Barton. This depth record was not broken until 1948 when Barton made a bathysphere dive to 1,372 m/4,500 ft. During the interim, Beebe was able to observe deep sea life in its own environment rather than in a specimen jar. Although he was criticized for failing to publish results in professional journals, his vivid descriptions of the bathysphere dives in the books he published inspired some of today's greatest oceanographers and marine biologists.

In 1960, a descent was made to 10,916 m/35,813 ft in the Challenger Deep of the Marianna trench – the deepest known point in the oceans, 10,924 m/35,838 ft deep at its maximum, near 11° 22'N 142° 36'E – about 200 miles southwest of Guam. The dive was made in the bathyscape ''The *Trieste*'' built by Auguste Piccard, his son Swiss explorer Jean Ernest-Jean Piccard and U.S. Navy Lieutenant Don Walsh. The descent took almost five hours and the two men spent barely twenty minutes on the ocean floor before undertaking the 3 hour 15 minutes way up.

Several technological developments allowed the marine biologists to record images *in situ* but also with better resolution (microscopes) and allowed the publications of pictures, photographs and videos. Remotely Operated Vehicle (ROV) and the development during the Second World War of scuba diving brought men further into the oceans as well as the establishment of ocean observatories, permanent stations connected to shore with optical cable.

1.5.2 Jean Painleve

Jean Painlevé (1902–1989) was raised by his aunt, Mary, widow and sister of Paul Painlevé, after his mother, Marguerite Petit de Villeneuve is carried by puerperal fever shortly after his birth. He was not the best at school and skipped classes to go to the Zoo where he helps the guardian to care for animals. He managed to attend the Lycée Louis Le Grand, Paris and began studying medicine in 1921. Two years later, he slams the door in the face of Professor Delbet after a disagreement over the treatment of hydrocephalus patients that he estimated a cruel treatment. He turned to biology and begins to attend the Station Biologique de Roscoff where he met Alexander Calder and the surrealist movement. He also started to experiment with cameras and from 1927 he spent all his time making documentaries whose subject is the world of marine animals, shrimp, octopus, sea urchins and other shellfish. Between 1928 and 1930, he shot a dozen films, including several for the general public: ''The Octopus'', ''The Urchin'', ''The Hermit Crab'', ''Crab and Shrimp'', ''Caprelles and Pantopodes'' and ''Hyas and Sténorinques''. Some of those films were presented in Paris and the press was very generous but also artists such as Fernand Léger or Marc Chagall. One of his movies ''The SeaHorse'' was distributed by Pathé and established Jean Painlevé as an artist but also the first scientific filmmaker and a movie maker of marine organisms. Painlevé, through film, wanted to show the bustling life of the underwater world to the ''unsuspecting public''. He realized more than 200 films and inspired not only artists but also scientists the ever expanding use of cinema and videos in marine biology.

1.5.3 The Writers and the Explorers

The twentieth century was a time of media and communication that reached out and gave the unique opportunity to show to the public the oceans and its creatures

with books, novels than movies, TV series and online pages. Some people are well-known for their dedication to the marine world.

Rachel Carson (1907–1964) was a scientist and writer who brought the wonders of the sea to people with her lyrical writings and observations about the sea. Although she was a biologist for the US Fish and Wildlife Service, she devoted her spare time to translating science into writings that would infect the reader with her sense of wonder and respect for nature. She published a book in 1941 titled "*Under the Sea-Wind*." These publications described the sea and the life within it from a scientist's point of view, but in the words of a naturalist. In 1951, she published "*The Sea Around Us*" a prize-winning bestseller on the history of the sea.

Dr. Robert Ballard (1942–), a deep-sea explorer, may be best known for finding the Titanic, and helping James Cameron, using technologies he helped to develop, including the *Argo/Jason* remotely operated vehicles and the technology that transmits video images from the deep sea. His earlier deep sea explorations led to the first discovery of hydrothermal vents during an exploration in a manned submersible of the Mid-Ocean Ridge. Ballard spent 30 years working on the use of manned submersibles. Ballard has devoted a great deal of time to furthering the field of deep sea exploration. He created a distance-learning program with more than one million students enrolled, taught by more than 30,000 science teachers worldwide.

Jacques Cousteau (1910–1997) was determined to safely breathe compressed air underwater in order to lengthen dive times. His work with Emile Gagnan ultimately led to the invention of the regulator which releases compressed air to divers "on demand" (as opposed to a continuous flow). The combination of the Cousteau-Gagnan regulator with compressed air tanks allowed Cousteau the freedom to film underwater, and by 1950 he had produced the Academy Award winning "*The Silent World*." By the 1970s he was bringing the underwater realm into millions of homes with his PBS series "*Cousteau Odyssey*." Cousteau's television documentaries won 40 Emmy Awards. Like other oceanography pioneers, Cousteau was criticized for his lack of scientific credentials; however his legacy fostered a greater knowledge and understanding of the devastation caused by threats to ocean health such as pollution of marine resources and resource exploitation.

Dr. Hans Hass (1919–2013), the Cousteau's Austrian counterpart, also helped introduce the wonders of the underwater world to the public. Hass and his wife Lotte were both passionate about underwater exploration and protection of the marine environment, and together they produced numerous documentaries and wrote a variety of books on their underwater experiences. During his career as an underwater explorer, Hass also made significant contributions to diving technology. He invented one of the first underwater flash cameras and contributed to the development of the Drager oxygen rebreather which he and Lotte used in 1942 to film "*Men Amongst Sharks*" and continued to use on diving expeditions aboard their research vessel "Xarifa" in the Red Sea and Caribbean. Hass is also known as one of the first humans to interact with a sperm whale underwater which helped him become a pioneer in the study of marine animal behavior.

1.5.4 The Future

Today, the possibilities for ocean exploration and imaging are nearly infinite. In addition to scuba diving, fast computers, remotely-operated vehicles (ROVs), deep sea submersibles, reinforced diving suits, and satellites, other technologies are also being developed. In spite of ongoing technological advances, it is estimated that only 5% of the oceans have been explored. Surprisingly, we know more about the moon than we do the ocean. Many new discoveries await us as we use new instruments and deep submergence vehicles to explore the ''inner space'' in the twenty-first century.

In future, oceanographers want to go beyond learning about what is down there in the ocean to learning about what is going on down there. They want to observe oceans processes that change over days, weeks, seasons, years, or decades. However, it is difficult and expensive to send research ships back to the same site for repeat measurements. Sometimes rough seas and stormy weather make it impossible to send ships to certain parts of the oceans at certain times.

Consequently, oceanographers are launching a new era of ocean exploration. They want to establish long-term ocean floor observatories with arrays of sensors and instruments that make continuous measurements of various ocean properties and events. Data from the observatories will be sent to shore-based laboratories via submerged fiber-optic cables or via cables linked to moored buoys that can transmit data via satellite. The data can then be made available via the Internet.

Oceanographers will, in future, use different types of ROVs and AUVs that can ''fly'' in the oceans or along the seafloor, collecting measurements. The data can be downloaded when the AUVs surface, or when they dock at an underwater docking site. Oceanographers are also developing instrumented buoys moored thousands of miles from shore, and free-floating drifting instruments that can transmit data to scientists in their laboratories using satellites and the Internet.

1.6 Time Line of Ocean Imagery

- **30,000 BC (Upper Paleolithic Period)**: Cave painting and carving of fishes and marine mammals in Europe and South East Asia
- **30,000 BC −3,000 BC**: Polynesians then Mediterranean civilizations sailed the oceans and master currents, star guided navigations and named the Great Salted River, *okeanos*.
- **384 BC −322 BC**: Aristotle, Greek philosopher and polymath wrote the first treaty of marine zoology.
- **323 BC −32 BC**: Hellenistic Period. Marine mammals such as dolphins and fishes are represented in mosaics, vases but also in sculpture as gods mounts. Greek sailors further extended Thalassa limits.

- **27 BC–AD 476**: Roman Empire. Marine mammals such as dolphins and fishes are represented in mosaics, vases but also in sculpture as gods mounts.
- **1507–1566**: Gulielmus Rondelet wrote *libri de piscibus marinis*, whose works are almost entirely limited to Mediterranean and European fishes.
- **1530**: The first longitude is established but it will not be until 1737 and John Harrison that the first precise marine chronometer will appear.
- **1632–1723**: Antonie Philips van Leeuwenhoek: He described and draw for the first time ''animalcules'' found in a drop of water (rotifers, *euglena, spirogyra*).
- **1728–1779**: **James Cook**: The famous British explorer is well-known for his extensive voyages of discovery for the British Navy. He introduce the presence of scientists onboard expedition vessels who defined the modern day study of marine biology.
- **1842**: Darwin publishes *The Structure and Distribution of Coral Reefs*, in which he suggests that coral atolls are the final stage in the subsidence and erosion of volcanic islands.
- **1843**: Edward Forbes (1815–1854), after sailing on the HMS *Beacon* in the Mediterranean, develops the *Azoic theory* (no life deeper than 300 f = 1800 ft). This is the first marine scientific hypothesis! It started a 20-year debate on the presence of the lifeless (azoic) zone.
- **1857**: Charles Darwin (1809–1881) – Voyage of the HMS *Beagle*: circumnavigated the world; theory of coral reef subsidence (drilling in the Enewetak atoll partially confirmed the hypothesis); barnacle classification.
- **1859**: The first oceanographic station is established at Concarneau in France.
- **1868–1869**: Wyville Thomson dredges from HMS *Lightning* and *Porcupine* and discovers life as deep as 2400 fathoms, exploding forever Edward Forbes' theory of a lifeless (azoic) zone below 300 fathoms.
- **1872–1876**: The *Challenger* Expedition circumnavigates the globe in the first great oceanographic expedition. Research is conducted on salinity, density, and temperature of sea water as well as ocean currents, sediment, and metrology. Hundreds of new species are discovered and underwater mountain chains documented. Modern oceanography is based on this research. The British *Challenger* expedition was led by Sir Wyville Thomson, who died before all of the results are compiled. Sir John Murray finished the great work, publishing 50 volumes of the *Challenger's* results and discoveries.
- **1872**: The Stazione Zoological was founded in by the German zoologist Anton Dohrn (1840–1909)
- **1888**: Marine Biological Laboratory (MBL) was established by Alpheus Hyatt, a student of Harvard naturalist Louis Agassiz at Woods Hole (USA).
- **1888**: The Marine Biological Association of the United Kingdom established the marine biological laboratory Plymouth, England.
- **1890–1898**: First Austrian–Hungarian deep sea expedition on board the ship SMS *Pola* led by Franz Steindachner in the eastern Mediterranean and the Red Sea.

- **1898–1899**: First German deep sea expedition on board the ship SMS *Valdivia* led by Carl Chun; found many new species from depths greater than 4000 m (13000 ft) in the southern Atlantic Ocean.
- **1906**: Establishment of the Monaco's Oceanographic Museum and Laboratory
- **1930**: Jean Painleve shot the first movies of marine organisms
- **1930**: William Beebe and Otis Barton are the first humans to reach the Deep Sea when diving in the so-called Bathysphere, made from steel. They reach a depth of 435 m (1430 ft), where they observed jellyfish and shrimp.
- **1930**: Establishment of the Woods Hole Oceanographic Institute and build the "*Atlantis*" the first oceanographic vessel dedicated specifically for interdisciplinary research in marine biology, marine geology and physical oceanography.
- **1934**: Edward Beebe is lowered in a tethered bathyscaph to a depth of 3028 ft, marking the advent of manned exploration of the sea. William Beebe dives in his *bathysphere* to a depth of 908 m on 14 August 1934. He is the first to observe firsthand life at great depth.
- **1942**: Hans Hass film and present the movie: "*Men Amongst Sharks*"
- **1950**: Jacques Cousteau produced the Academy Award winning "*The Silent World*."
- **1960**: Bathyscaph Trieste dives to what was believed to be the deepest point in the Mariana Trench: a depth of 10 915 m was observed. Since then, in 1998, a Japanese research vessel measured 10 938 m in the same area. The trench was first sounded by *H.M.S. Challenger* in 1875, and again by H.M.S. *Challenger II* in 1951.
- **1970**: Jacques Cousteau brings the underwater realm into millions of homes with his PBS series "*Cousteau Odyssey*."

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