the old, but the mechanical arrangements have been immeasurably improved. A new mounting and a new dome have been installed by J. W. Fecker of Pittsburgh. The eye-end of a large telescope varies in its distance from the floor of the observatory, depending upon whether the object observed is high or low in the sky. To reach it in all its positions a glorified step-ladder was the best expedient that the early designers for such telescopes could provide. When the Lick Observatory was erected on Mount Hamilton in the late eighties, this problem of reaching the telescope in all positions became acute on account of the great length of the tube. A distinguished amateur astronomer, A. A. Common, of London, England, suggested that the Lick Observatory floor be made movable in height like an elevator sixty feet in diameter. This expedient was adopted and proved so successful that it has been employed for almost all large telescopes erected or remounted since that time. Such a "rising floor" has been installed in the New Observatory at Princeton together with all the other mechanical improvements that modern practise has shown to be so conducive to rapid and accurate observation with one of these great engines of research. A novel feature of this telescope is an iris diaphragm in front of the lens, in principle like that on an ordinary camera. This will enable the observer to alter the effective aperture of the telescope at will.

The Princeton Observatory has had two distinct periods of fruitful activity. The first fell in the closing two decades of the last century when Charles Augustus Young pursued with such signal success his pioneer work in solar spectroscopy. The second began about a quarter of a century ago and is still in healthy progress. It was then that Professor Raymond S. Dugan, who is in immediate charge of the telescope, began a remarkably careful and thorough investigation of stars that vary in their light. More than to any other single factor we owe to his persistence in adhering under unfavorable circumstances to his original program our minute knowledge of eclipsing variables. It is a matter of satisfaction to all astronomers that he and his pupils are to continue this work under such vastly improved conditions.

In another field the observatory and the department of astronomy at Princeton have made a striking record. In spite of the difficulties of handling the old telescope, or possibly because of them, the institution has sent out a steady flow of competent astronomers. These include among others H. N. Russell himself, the eminent head of the department since 1912; J. Q. Stewart, also at Princeton; the late J. M. Poor, of Dartmouth; Daniel, at Allegheny; Joy and Dunham, at Mount Wilson; Shapley and Menzel, at Harvard; Kovalenko, at Swarthmore; Sitterley, at Wesleyan, and Bennett at Yale.

OCEANOGRAPHICAL WORK AT BERMUDA OF THE NEW YORK ZOOLOGICAL SOCIETY

By Dr. WILLIAM BEEBE

1934 marks the sixth year of oceanographic work at Nonsuch, Bermuda, by the Department of Tropical Research of the New York Zoological Society. Sponsored by the National Geographic Society, the bathysphere was again put into commission.

The great steel ball was brought from Chicago, where it has been on exhibition for a year, and completely overhauled. With the expectation of remaining submerged for several hours and reaching a depth of three thousand feet, it was found necessary to replace all the quartz windows and remodel the oxygen and purifying apparatus. Mr. Barton joined me, his special province being, at his request, an attempt at abyssal photography.

After several thorough tests in the field we made two deep dives, Numbers 30 and 32, on August eleventh and fifteenth, to depths, respectively, of 2,510 and 3,028 feet. These figures, merely as new records, are of little importance in themselves, but in the course of the dives several interesting generalizations came to notice.

The publicity given to these descents has been all by indirect reporting, and so confused in details that a brief, preliminary statement seems worth while. As I am still making dives to 1,500 and 2,000 feet as well as contour dives, no opportunity has offered itself of working over the specific observations.

The day of the first dive was an exceedingly brilliant one, and the surface of the sea very calm. In consequence, light was still visible to the eye at 1,900 feet, 200 feet farther than on any previous dive to this depth. At 2,000 feet not the slightest hint of illumination was observable.

A problem of color not yet explained is that from 200 feet down, through the spectroscope, the blue is gradually replaced by violet, until at a depth of 400 feet the latter color is dominant. Yet to the eye, at no time of the descent is there any trace of violet or lavender, only the strongest of blues, appearing brilliant long after it has lost all power for actually seeing anything in the bathysphere.

A new system of purification was devised by the Air Reduction Company, a small electric blower forcing a complete circulation of all the air in the bathysphere over soda lime and calcium chloride every minute and a half. The oxygen supply was cut to one liter per person. Two newly designed valves and two tanks were ready for use on each dive.

After three hours and ten minutes of complete sealing, air and water tight, in this four-foot-six sphere, we found the enclosed atmosphere fairly dry and perfectly fresh, and the accumulated pressure almost negligible, about equal to that at a depth of four fathoms in the diving helmet.

The observation facilities were excellent. The first animal lights were seen at 680 feet, and there appeared to be a slow but appreciable increase in number to the deepest depth, and in relative size to 2,500 feet. The most apparent fact was an increase in the number of large fish from 2,300 feet down to 3,000. By "large," I mean from three feet up. As on previous dives I saw indefinite shapes of unusual size near the farther end of the beam, but at 2,450 feet on August fifteenth I had a clear view of the outline of a really large fish or cetacean as it passed slowly through the electric light path. At a conservative estimate it was twenty feet long and six deep. It possessed no photophores whatever, as far as I could see, and the eye, mouth and fins were too faint for description. The skin was not black, but brownish.

Several detailed descriptions were obtained of new forms, sufficiently exact to allow reproductions to be made. Some belonged to known families, others were quite unlike any.

Luminescent plankton, so characteristic of surface waters, was totally absent at all considerable depths, and the passage even of fish of good size was indicated only by the light from our electric beam, or by flashes from definite organs on their own bodies. The clarity of the water and freedom from sediment did away with all dilution or refraction of light, and each photophore shone strongly and distinctly in the utter blackness. Reflection was marked, as when photophores were reflected on the eye or the skin of the owner, or when some brilliant flash lighted up my face and the inner sill of the window.

On dives of former years and on the early part of Number 30, I reported small, dim fish of uncertain form as not uncommon, although these were not far from the window. Also that from time to time, some organism struck the glass and exploded. I discovered on the last dive that the cause of these phenomena was the fluid ejected by shrimps, *Acanthephyra* and others. Two kinds of emanation were observed, one, a homogeneous, luminous cloud which diffused with great rapidity at first, and then hung suspended for considerable time as a faintly luminous area. The other was a discharge of a multitude of very bright sparks, which died out much sooner than the first type. These sparks were much more startling, making us jerk back our heads as from a blow when they occurred close against the glass.

The remarkable abundance of animal life which came within our exceedingly limited visual area at almost all depths was wholly unexpected. I have drawn over fifteen hundred meter nets in these very waters, from the surface to 1,200 fathoms, and the average per meter net for a four-hour haul, while not below the average oceanic catch, is negligible compared with what we saw on any single vertical descent or ascent. We can account for this either by the creatures being attracted from all directions to the bathysphere and our occasional strong light, or by an admission of the actual, wide-spread abundance of fish and other creatures in these Bermudian waters. If the latter is true, the trawling nets must be exceedingly ineffective.

The latter theory seems more tenable for a number of reasons. One is the very noticeable fact that no organism, small or large, vertebrate or invertebrate, at the greater depths, shows the slightest positive phototropism. Even when our light has been turned on for several minutes at a time, not a copepod, worm or fish is seen at or approaching the starboard, or lighted, window. The great number of organisms which constantly pass through or along the brilliant path or the beam shows no general tendency to turn toward or away from the source of illumination.

The distance to which the electric beam of light penetrates has been conjectured to be thirty to forty feet, judging by the appearance of fish of known actual size (such as *Argyropelecus*), when they first appear in the farthest end of the light. On Dive Number 32 I took down a pair of three-power Zeiss binoculars, and at 1,500 feet and again at 3,000 I focussed carefully on organisms at the very extremity of the light. I found the one focus was the same as the other. Without altering the glass, I brought it to focus on a given point on the deck, and found the distance to be forty-five feet.

While the pressures at all depths are well known, it may be interesting to note that at 3,028 feet, or 504 fathoms, the pressure was 1,360 pounds to the square inch; each quartz window sustained a weight of 19.2 tons; and the total pressure on the whole bathysphere was 7,016 tons.