2Va for five wave-lengths, obtained from the measurements of the apparent acute and obtuse angles in monobromnaphthalene by the use of accurately orientated section-plates, are so close together that it was considered advisable to ascertain in some other manner whether the order of dispersion was truly represented; that is, whether the angle for one end of the spectrum was really very slightly greater than that for the other end, or whether the amount of dispersion thus indicated did not really fall within the limits of experimental error, thus leaving it possible that the dispersion might even be of the contrary order. By immersing a plate perpendicular to the first median line in a liquid of refractive power equal to the medium refractive index of the crystal, the interference figure in white light usually at once indicates, by the colours exhibited on the margins of the axial brushes, the order of dispersion, and measurements of the axial angle for the two extreme wave-lengths afford an immediate check upon the accuracy of the calculated angles. It is a considerable source of satisfaction to be able to confirm such calculated optic axial angles in so simple a manner.

Prof. Klein further describes how admirably the new apparatus is adapted for the determination of the extinction angles upon the various faces of a zone, in parallel polarised light. For this purpose the converging lenses are removed, and the eyepiece analysing nicol is employed, so that the polarising and analysing nicols may be arranged for simultaneous rotation. The measurements are carried out while the crystal is immersed in the liquid as in case of the determinations of optic axial angle. The only precaution necessary is that the crystal should be uniformly illuminated in order that the exact position of extinction may be ascertained by use of one of the usual half-shadow stauroscopic plates.

The memoir concludes with a description of the general mode of investigating a biaxial crystal immersed in a liquid of equal refractive power, indicating how the principal planes of optical elasticity may be found, the positions of the optic axes ascertained, and the true internal angle of the latter measured. One of the most important advantages of the method is the simplification which it introduces into the study of triclinic crystals, hitherto almost dreaded by the crystallographer for the trouble they involve. It would appear that their optical investigation by the immersion method offers but slightly more difficulty than that of crystals of higher symmetry, the positions of the optic axes being readily found, and the true angle at once afforded. This alone would entitle Prof. Klein to the thanks of crystallographers and mineralogists for perfecting so admirable an aid to investigation.

A. E. TUTTON.

MICROBES AND METALS.

THE effect of metals on the growth of bacteria has been examined by Miller, Behring, and others, and another contribution to this subject has lately been published by Dr. Meade Bolton, in the December number of the *International Medical Magazine*. According to Uffelmann, who smeared the surface of copper coins with liquefied jelly-cultures of cholera bacilli, the latter were destroyed in seventeen minutes; whilst on a brass coin they were alive after thirty hours, but dead after sixty hours. Bolton employed Miller's method of inoculating a tube of melted jelly with particular microbes, and pouring the contents out on a sterilised glass-plate, after which bits of the metal under examination were laid on the jelly whilst it was still soft. If the metal has an inhibitory action on the microbes, then a clear zone is left around the metal after the colonies have developed in the other parts of the jelly. The width of this zone, Dr. Bolton found, varied very considerably with different organisms, as well as with different metals. Thus carefully purified bits of silver produced in the case of cholera bacilli a clear zone 5 millimetres broad, in the case of typhoid bacilli a zone of about 1 millimetre, whilst with the closely allied colon bacillus a zone of about 5 millimetres was produced. In the case of purified gold, no inhibition was observed with the staphylococcus pyogenes aureus, colon bacillus, typhoid bacillus, or cholera bacillus. Freshly "glowed gold" had invariably no inhibitory action; and in the few cases where inhibition was observed, the gold had not been glowed for several weeks. Pure nickel, platinum wire, and platinum black aluminium, silicon, and niobium, again, also failed to give any reaction with most of the microbes examined. Throughout the investigations it was found that those metals that are resistant towards chemical reagents in general, failed to produce any effect on microbes; whilst, on the other hand, those metals which are readily attacked by chemical reagents, all exhibited a marked inhibitory action upon the growth of bacteria. This result is probably due to a solution of the metal taking place in the medium. The length of time it is necessary to leave the metals in contact with the jelly, to produce an effect on the microbes present, was tried with brass, copper, cadmium, and zinc, on the staphylococcus pyogenes aureus. The metals were put on and removed at various intervals. When cadmium was left on for a minute, there was a clear space underneath where it had rested, which extended to 1 millimetre round; when it was left on for three or four minutes, the clear space usually extended over 3 millimetres. Very similar results were obtained with zinc. With brass no effect was produced when it was left on thirty-six minutes, but after this there was more and more marked inhibition up to fifty minutes; but to produce a clear space, it was necessary to leave it on for still longer. Copper produced no visible effect under thirty-six minutes, and fifty minutes was required to produce a clear space.

G. C. FRANKLAND.

PROFESSOR JAMES DWIGHT DANA.

BY the sudden death of Prof. J. D. Dana, from heart-failure, on April 15, America has lost a veteran man of science, who in his time has not only played many widely varied parts, but has reached the highest excellence in each. As a mineralogist he published, so long ago as 1837, the first edition of a "Descriptive Mineralogy," which by reason of its completeness and accuracy soon became a standard work of reference throughout the civilised world, and of which the sixth edition (1134 pages), issued in 1892 under the superintendence of his distinguished son, Prof. Edward Salisbury Dana, still maintains the high reputation attained by the original work. As a geologist and palæontologist, he published in 1863 a similarly excellent and well-illustrated "Manual of Geology," having special regard to the geology of the North American continent, and of which the fourth edition (1087 pages) was issued only two or three months ago. Of his work as a zoologist, we may cite as example his elaborate report on the zoophytes, collected by an expedition in which he took a very active part. The report is illustrated by 61 plates, and in it are described no fewer than 230 new species. Attainments so diverse belong only to the few.

James Dwight Dana was born on February 12, 1813, at Utica, in the State of New York, U.S.A., and was therefore in his eighty-third year at the time of his death. He was educated at Yale College, New Haven, Connecticut, receiving there a sound training in mathematics, physics and chemistry, which was of the greatest service to him in his subsequent career; he proceeded to his degree in the year 1833. His appointment as Instructor of Mathematics to the midshipmen of the United States Navy gave him splendid opportunities for the study of nature in various parts of the world, particularly in France, Italy, and Turkey, opportunities of which he was not slow to avail himself; more especially was his attention attracted to the study of volcanic phenomena by an ascent of Vesuvius, a sight of Stromboli, and an excursion in the Island of Milo in the year 1834. Settling down for a short time, he acted as chemical assistant at Yale College to his old teacher and friend, Prof. Silliman (1836-38); but an opportunity again presenting itself of making a long voyage of marine observation, he accepted the appointment of mineralogist and geologist to the United States exploring expedition, which was to proceed round the world. This expedition, under Charles Wilkes as Commander, was admirably equipped for the objects in view, and consisted of two sloops-of-war, a store-ship, and a brig; the cruise extended over four years (1838-42), and the scientific staff included, in addition to Dana, Pickering, Couthoy, and Peale as zoologists, Rich and Breckenridge as botanists, and Hale as philologist. The memory of the events, scenes and labours of this cruise was a constant joy to him during the remaining fifty-three years of life. On at least two occasions, however, he was in imminent peril: at one time his vessel narrowly escaped destruction on the rocks of Southern Fuegia, when the sea was dashing up the cliffs to a height of two or three hundred feet, and all the anchors had given way; at another time his party had to take to the boats empty-handed, and some hours afterwards they saw the last vestige of the vessel which had been their home for three years disappear beneath the waves.

The study of the material collected by the expedition and the preparation of his reports occupied all the available time during the next thirteen years. The first two or three years were spent at Washington, but after his marriage to the daughter of Prof. Silliman he removed back to New Haven, where he passed the rest of his life. In 1850 he was appointed Silliman Professor of Geology and Natural History at Yale College. In 1846 Mr. Dana had become associate-editor of the *American Journal of Science*, and after the death of Prof. Silliman, in 1864, he became the principal editor of that important scientific organ.

Dana gave special attention to corals and coral islands, and also to volcanoes. The Wilkes expedition of 1838-42 followed in part the course taken by the *Beagle* in 1831-36, and even where it diverged from that route visited coral and volcanic islands such as have been carefully described by Charles Darwin. When the Wilkes expedition reached Sydney in 1839, Dana read in the papers a brief statement of Darwin's theory of the origin of the atoll and barrier forms of reefs; this mere paragraph was a great help to him in his later work, and he afterwards regarded Darwin with feelings of the deepest gratitude. A visit to the Fiji Islands in 1840 brought before him facts such as had been already noticed by Darwin elsewhere; but there they were on a still grander scale and of a more diversified character, thus enabling him to speak even more positively of the theory than Darwin himself had thought it philosophic to do. On other points the conclusions arrived at by Darwin and Dana, independently of each other, were for the most part the same, and differed only in comparatively unimportant details. Dana's special labours relative to corals ceased with the publication of his report on the zoophytes collected by the expedition, but an elaborate account (406 pages) of Corals and Coral Islands was prepared by him and issued in 1879: this was an extension of his expedition-report on Coral Reefs and Coral Islands, which had been separately published in 1853. In 1890 appeared another considerable work (399 pages) entitled "Characteristics of Volcanoes, with contributions of facts and principles from the Hawaiian Islands," which placed on record much useful information collected by him during his travels.

In addition to these larger works, he was the author of about two hundred separate papers. Some of them are of a physical character: his first paper, published as far back as 1833, dealing with the connection of electricity, heat and magnetism; subsequent papers treated of galvano-magnetic apparatus and the laws of cohesive attraction as exemplified by crystals. Other papers, of a purely crystallographic character (1835-52), treated of the drawing and lettering of crystal figures, of crystallographic symbols, and of the formation of twin growths; a series of volcanic papers discussed both lunar and terrestrial volcanoes, the latter including those of Vesuvius, Cotopaxi, Arequipa, Mauna Loa, and Kilauea (1835-68); a set of coral papers treated of the temperature limiting the distribution of corals, on the area of subsidence in the Pacific as indicated by the distribution of coral islands, on the composition of corals and on fossil corals (1843-74).

About forty papers are on mineralogical topics: many of them are descriptive of particular mineral species; others treat of general subjects, such as nomenclature, pseudomorphism, homœomorphism, the connection between crystalline form and chemical constitution, and the origin of the constituent and adventitious minerals of trap and the allied rocks. As illustrations of the variety met with in his geological publications, we may cite his papers on the origin of the grand outline features of the earth, the origin of continents, mountains and prairies, the early condition of the earth's surface, the analogies between the modern igneous rocks and the so-called primary formations, on erosion, on denudation in the Pacific, on terraces, on southern New England during the melting of the great glacier, on the degradation of the rocks of New South Wales, and the formation of valleys. The remaining papers, about seventy in number, deal with biological subjects, both recent and fossil, and have a similarly varied character; some being descriptive of species, others treating of classification and similarly general problems.

The importance of this scientific work was widely recognised, and many marks of distinction were conferred upon him, both at home and abroad. He was an original member of the National Academy of Sciences of the United States, and in the year 1854 occupied the presidential chair of the American Association for the Advancement of Science. In 1851 he was elected a Foreign Member of the Geological Society of London, and in 1872 received from that Society the Wollaston Medal, the highest compliment the Geological Society can pay to the man of science; in the same year the University of Munich honoured him with the degree of Ph.D.; in 1877 he was the recipient of the Copley Medal of the Royal Society, and in 1884 was elected one of the foreign members; in 1886 Harvard conferred upon him the degree of LL.D.; he was also an honorary member of the Academies of Paris, Berlin, Vienna, St. Petersburg and Rome, and of the Mineralogical Societies of England and of France.

NOTES.

WITH the École Normale at Paris, which has just celebrated its centenary, the names of a number of distinguished men of science are associated. At the present time, no less than twelve of its old students are members of the Academy of Sciences. Pasteur left Lille to become the director of scientific studies at the school, and carried on, while in connection with it, the researches which have made his name known throughout