is biconcave; the ninth being invariably biconvex." The same statement appears in the "Amphibia and Reptile" volume of the Cambridge Natural History, published some four years later (1901).

So far as I am aware, exception has never been taken to this statement. When, therefore, last year, I had occasion to examine the vertebral column of an Indian toad, *Bufo melanostictus*, I was surprised to find that the eighth and ninth vertebræ were not as described, but that, on the contrary, both were procœlous, resembling in this the seven preceding vertebræ.

At first I supposed that this was merely an abnormality resembling the condition found by Lloyd Morgan in *Rana temporaria* in 1886, and recorded by him in these columns (vol. xxxv., p. 53). I examined, however, five other specimens of *B. melanostictus* and also two of *B. andersonii*, and discovered that, in every case, all the vertebræ were procœlous, exactly as in my first specimen.

I could only come to the conclusion that, in these two species at least, we had exceptions to the rule laid down in the works quoted. On my return to England, therefore, I took an early opportunity of consulting Mr. Boulenger upon this point, who very kindly permitted me to examine a large collection of skeletons of *Bufo*.

Including my own specimens, more than fifty vertebral columns were examined, these belonging to some forty different species of *Bufo*, and it then became apparent that what I had been disposed to regard as an exceptional state of affairs, obtaining in a couple of Indian toads, *was actually an invariable condition, and, moreover, one apparently diagnostic of the genus Bufo*, for not a single specimen showed either an ampicœlous eighth or a biconvex ninth vertebra. In every case the centrum of the ninth vertebra, although hollow in front, has, of course, the usual double convexity behind.

GEO. E. NICHOLLS.

Zoological Department, King's College,
London, W.C.

A Lunar Halo.

A REMARKABLE coloured halo forming a complete circle about the moon was witnessed by me on Wednesday evening, December 2, at 7.15, my position being in North Shields. I am seventy-nine years of age, and never saw anything similar—that is, encircling the moon. It only lasted about seven or eight minutes. I am wondering if anyone else took much notice of it.

An entire ring and colours were distinctly visible. The inner part—that is, to the commencement of the halo or rain-circle—had a remarkably globular appearance, with the moon as an apex, and was the most prominent part of the phenomenon.

The moon at the time was very bright, but shining through light fleecy clouds at a great height; then the yellowy appearance commenced as shown, terminating with a dark orange rim.

The altitude of the moon would be about 60°, direction S.E., wind W.

THOS. TODD.

26 Percy Square, Tynemouth, December 5.

COLLOIDAL CHEMISTRY IN RELATION TO INDUSTRIES.

I.

WHEN the development of some branch of science reaches the stage at which a separate literature with its own terminology

begins to grow up, the question of its practical utility or its value to the arts begins to be asked. Whether research has to justify itself by such directly or indirectly useful results is at least arguable, but it must be admitted that the question is particularly natural when raised in connection with a discipline like colloidal chemistry which is concerned, *inter alia*, with substances such as form the raw materials or the products of important arts, many of which, like ceramics, dyeing, tanning, the making of bread and of fermented liquors, are as old as history.

Where industries have empirically reached a high degree of perfection, the chief function of science is to provide the explanation of processes which are the outcome of experience, generally with the result that improvements become possible which experience alone cannot suggest. In judging a new branch of chemistry it is too often overlooked that even inorganic chemistry has largely played this part and has not yet quite succeeded in it in some respects: thus the theory of a process as important and familiar as the lead chamber process of making sulphuric acid is still highly controversial. On the other hand, organic chemistry provides many instances of the opposite way in which science may assist industry: by producing new bodies the properties of which are anticipated on theoretical grounds.

While, therefore, too much must not be expected of a science as young as colloidal chemistry, there is no doubt that it is destined to be of considerable value to a great number of industries in both the directions indicated above. Probably the most convenient method of showing this will be to state, without undue technicalities, a number of fundamental propositions which have now been firmly established and to illustrate their bearing on industrial processes and problems.

There is an immense amount of material to prove that the physical properties of a body may be varied continuously between wide limits by simply altering the size of its particles present or—as it is technically called, "dispersed"—in another medium, below a certain maximum limit. This is strikingly the case with the most obvious property, colour: thus, colloidal gold can be obtained red, purple, blue, or green in solutions containing the same amount of metal, and silver solutions of the same concentration may range from colourless through yellow, red, and purple to blue. Colourless or slightly coloured substances, *e.g.* sulphur, may form brilliant blue solutions. Solid colloidal solutions are also known to exist, examples of which are ruby glass, coloured by gold or copper, and the blue rock salt occurring at Stassfurt, which is coloured by metallic sodium.

The possibility of obtaining colour by dispersing a colourless substance in a colourless medium has been suggested as an explanation of the striking tint of a very puzzling class of bodies, the artificial ultramarines. Their chemical composition is very uncertain, but none of the compounds of which they are a mixture are at all likely to be