

infectious chronic disorders, and so also is thrush of the tongue of infants; ringworm and certain other diseases of the hair and skin are known to be due to microbes allied to the higher fungi.

The microbes causing disease which have been studied best, are those belonging to the groups of Bacteria or Schizomycetes or fission fungi (they multiply by simple division or fission); most species of these have been cultivated in pure cultures, and the new crops have been utilized for further experiments on animals under conditions variable at the will of the experimenter.

[3. Demonstration: cultures of Bacteria in plates and in tubes.]

(To be continued.)

#### RECENT PHOTOGRAPHS OF THE ANNULAR NEBULA IN LYRA.

ANNULAR nebulae can no longer be regarded as a class completely apart. They should rather be described as planetaries in which one special feature predominates over the rest. The progressive improvement of telescopes has tended to assimilate the two varieties by bringing into view peculiarities common to both. It is only when they are ill seen that planetary nebulae appear really such. The uniformity of aspect at first supposed to characterize them disappears before the searching scrutiny of a powerful and perfect instrument. The usually oval surfaces which they present are then perceived to be full of suggestive detail. They are broken up by irregular condensations, or furrowed by the operation of antagonistic forces; betray here the action of repulsive, there of attractive, influences; and bear as yet undeciphered inscriptions of prophetic no less than of commemorative import. Among the various modes of diversification visible in them, however, two are especially conspicuous—first, the presence of a nucleus; next, the emergence of a ring, or even of a system of rings.

Now the nebula in Lyra, when distinguished by Sir William Herschel in the annular form, of which it is the most perfect exemplar, seemed completely perforated by a dark opening; but interior nebulosity, constituting the object essentially a disk with annular condensation, was noticed by Schröter in 1797, and is depicted as strongly luminous in the drawings of Lassell (reproduced in *Knowledge*, November 1890), Trouvelot (*Harvard Annals*, vol. viii., Plate 34, 1876), and Holden.<sup>1</sup> Moreover, a minute central star, visually discerned at intervals, has lately been photographed in unmistakably nuclear shape. The entire formation, then, consists of a disk, nucleus, and ring, and differs from many planetaries only in the proportionate lustre of its parts.

The records concerning the central star include some curious anomalies. They go back to the year 1800, when Von Hahn was struck with its disappearance. The change was in his opinion due, not to loss of light in the star, but to the veiling with delicate nebulous clouds of the dark background upon which, in former years, it had been seen projected (*Astr. Jahrbuch*, 1803, p. 106). His observations were made at Remplin, in Mecklenburg, with a 12-inch Herschelian speculum, somewhat impaired in brilliancy (Lisch, "Gesch. des Geschlechts Hahn," Bd. iv. p. 282). "Hahn's star" was next seen by Lord Rosse 1848 to 1851 (*Trans. R. Dublin Society*, vol. ii. p. 152), and drew the notice of Father Secchi in 1855 (*Astr. Nach.*, No. 1018). Twice observed by M. Hermann Schultz at Upsala in 1865 and 1867 ("Observations of 500 Nebulae," p. 99), it unaccountably, ten years later, evaded the deliberate scrutiny with the Washington 26-inch of Prof. Asaph Hall, who nevertheless perceived the nebula as exteriorly surrounded by a "ring" of nine faint stars (*Astr. Nach.*, No. 2186). The same great instrument, however, displayed the missing star to Mr. A. C. Ran-

<sup>1</sup> Executed in 1875, with a power of 400 on the 26-inch Washington refractor (*Wash. Observations for 1874*, Pl. vi.).

yard, August 23, 1878 (*Astr. Journal*, No. 200), while to Dr. Vogel, equally in 1875 with the Newall refractor, and on several nights in 1883 with the Vienna 27-inch, it remained imperceptible (*Potsdam Publicationen*, No. 14, p. 35). Very remarkable, too, is its non-appearance to Dr. Spitaler at Vienna in 1885, when he carefully delineated the nebula, as well as in 1886, during repeated verifying observations. The interior seemed then to contain only dimly luminous floccules; yet the star thus persistently invisible caught his eye at the first glance, July 25, 1887 (*Astr. Nach.*, No. 2800). It had in the meantime, September 1, 1886, been photographed by Von Gothard; and having committed itself to this *adsum qui fecit* avowal, has, now for four years past, abstained from capricious disappearances.

Its variability, then, is still unproved; since observational anomalies, even of a very striking kind, may be explained in more ways than one; and it is very easy *not* to see a fifteenth-magnitude star. More especially when the sky behind it is—perhaps intermittently—nebulous. Luminous fluctuations in the diffused contents of the ring certainly suggest themselves to the student of its history. At times a bare trace of nebulosity is recorded; at others, the whole interior is represented as filled to the brim with light—mist, coagulated, as it were, into a cirrous or striated arrangement. Under such conditions, the effacement of quasi-stellar rays, feebly seen at the best, is not surprising.

The "gauzy" stuff within the ring possesses very slight actinic power. The best drawings of the nebula represent what might be described as an oval disk with a brighter border, while in all photographs hitherto taken it comes out strongly annular. The interior does not fill up even with such abnormally long exposures as might be expected to abolish gradations by giving faint beams time to *overtake* the chemical effect more promptly produced by brighter rays.

The photographic record of the Lyra nebula goes back a very few years. It opens in 1886, with some Paris impressions showing a small, nearly circular ring, starless, and perfectly black within. A decided advance was marked by Von Gothard's picture of a pair of nebular parentheses—thus,  $\odot$ —inclosing a very definite, though probably non-stellar, nucleus. The failure of light at each extremity of the major axis, which makes one of the most significant features of this object, was already in 1785 noticed by the elder Herschel (*Astr. Jahrbuch*, 1788, p. 242; *Phil. Trans.*, 1785, p. 263); and Lord Rosse in 1863, and Schultz in 1865, were struck with its accompaniment, *on the north-eastern side*, by "nebulous radiations in the direction of the longer axis, which seemed momentarily almost to destroy the annular form." This appearance of an equatorial outflow, however, had shifted to the opposite or *south-westerly side* of the nebula when Holden observed it at Washington in 1875;<sup>1</sup> while a photograph taken by Mr. Roberts, with twenty minutes' exposure in July 1887, showed a very decided protrusion in the place indicated by Schultz, but only an abortive attempt at Holden's appendage. The suggestion of real changes of an alternating character, affecting luminosity perhaps, rather than figure, meets some confirmation in Prof. Holden's remark upon a further incompatibility between his own and Lord Rosse's observations on a different part of the same object. "It is a little curious," he wrote in 1876, "that that end of the minor axis which Lord Rosse has represented as the best terminated, viz. the *south*, is precisely that one which to-day, and with the Washington telescope, is least so" (*Monthly Notices*, vol. xxxvi. p. 63). And the Lick 36-inch similarly disclosed the whole of the bright southern edge as filamentous (*Monthly Notices*, vol. xlviii. p. 387) in opposite correspondence with the views obtained at Parsonstown of the northern edge.

<sup>1</sup> *Monthly Notices*, vol. xxxvi. p. 66: and pastel drawing in *Wash. Obs.*, 1874.

The central star was recorded in fifteen minutes on Mr. Roberts's plates (*Monthly Notices*, p. 29); it waited 1h. 50m. to appear at Bordeaux. A picture, however, taken there in three hours by M. Courty in July 1890 included all Lord Rosse's seven exterior stars (Rayet, *Comptes rendus*, 7 juillet, 1890); and Admiral Mouchez's suspicion that the nuclear one was inclosed in a quadrilateral of much fainter objects was verified, as regards three of the four, by a subsequent photograph obtained at Algiers by MM. Trépiéd and Rabourdin, with two exposures of three hours each, for which the international charting instrument of 13 inches was successfully employed.<sup>1</sup> In the resulting impression, Hahn's "star" is distended into a nucleus far more luminous than the fainter parts of the ring, and contrasting powerfully with a black intermediate space, usually grey and glimmering to telescopic vision. The ring itself comes out broad, hazy, and far from uniformly illuminated. Two somewhat unequal maxima and two conspicuous minima of brilliancy mark the extremities respectively of its minor and major axes. Its outline, though blurred, is tolerably symmetrical. No effusions interrupt, no "fringes" obliterate it.

The method of multiple exposures (introduced by Mr. Roberts) enabled, in November last, the Toulouse astronomers, MM. Andoyer and Montangerand, to get sittings from the Lyra nebula for a single portrait, summing up to nine hours, with the result of bringing out, over an area of three square degrees, about 4800 stars, including, of course, the nuclear *punctum saliens*. And the registration of this stellar multitude is the more valuable from the probability that some of them may belong to the same system with the strange object round which they swarm. Its inclosure by a "ring of stars" was remarked by Prof. Hall in 1887; Prof. Holden in 1888 perceived indications of a second similar but interior ring, evidently forming part of a complex nebular structure. The places of twelve of its minute components were measured by him; and it will be interesting to learn whether they can be identified in the Toulouse photograph.

An irresistible inference from the data collected, both visually and photographically, concerning the Lyra nebula, is that its ellipticity is genuine, and not merely an effect of foreshortening. For it would be absurd to suppose the plan of construction of a sidereal body related in any way to its situation as regards the line of sight from the earth; hence, geometrical shape that is emphasized by inequalities of light must correspond to a physical reality. It is certainly by no accident that the transverse axis of the object in question terminates in maxima, its longitudinal axis in minima of brightness; and this alone conveys a positive assurance that it is, and does not simply appear oval.

More especially when we find that this very peculiarity is shared by several other nebulae of the same class (Secchi, "Les Étoiles," t. ii. p. 13), and forms a link of a profoundly suggestive kind between them all and the great Dumb-bell Nebula. For this remarkable object, too, shows minima of illumination evidently homologous with those of the pattern ring-nebula; they affect corresponding parts of the structure, and depend, there can be little doubt, in a similar manner, upon internal organization. They are besides in each case attended by a symptom which may prove instructive as to their mode of origin. Mr. Roberts's photographs of the Dumb-bell, no less than of the annular nebula, bring into view dim effusions of nebulosity in the directions of its greatest extent. The elliptical outline is transcended at the two opposite points where it is partially interrupted by gaps of comparative obscurity. Now, the late Mr. Roche, of Montpellier, demonstrated that the "limiting surface" of a cometary mass falling towards the sun must assume

the shape of an oval pointed along the line of junction with the sun (*Mémoires de l'Acad. de Montpellier*, t. ii. p. 426). This surface, representing the boundary of the atmosphere controllable by the comet, necessarily contracts in proportion as the solar attraction gains predominance; while the matter thus progressively abandoned, instead of escaping indifferently in all directions, flows away solely along recurving lines from the nodal points (as they might be termed) of the cometary envelope. The question then presents itself whether both the oval figure, and the apparent effluences along the major axes of the nebulae we have been considering, may not be due to attractive influences in their neighbourhood. A gradual abandonment of nebulous material, at some previous time fully incorporated with the central mass, seems at any rate indicated, and cannot otherwise be easily accounted for.

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#### ZITTEL'S "PALÆONTOLOGY"—REPTILES.

IN the annual address to the Geological Society delivered last year by the retiring President, the work of which a portion is now before us was referred to as "the superb palæontological compendium now being published by our distinguished Foreign Member, Prof. K. v. Zittel, a book that, I fear, no English publisher at present would feel justified in undertaking." It is with a feeling of admiration mingled with regret—of admiration for this splendid work, and of regret that its like cannot be produced in this country—that we quote these words; for it is unfortunately but too true that palæontological science, or, in other words, the zoology of past epochs of the earth's history, is not cultivated among us with anything like that zeal which its importance and interest merit. Indeed (although there are signs that this spirit is now passing away), we too often hear palæontology and palæontologists mentioned by those who ought to know better with a covert, if not with an open sneer. Palæontology, however, if studied in a proper philosophic spirit, must be the very groundwork of all our systems of zoological classification; and therefore all students of zoology—both recent and past—owe a deep debt of gratitude to the author of this "Palæontologie," which may be said to be the only work which is so comprehensive as to deal, not only with the general outlines, but also with the details of the science of which it treats.

The two parts forming the subject of the present notice deal with that division of Vertebrates for which Prof. Huxley proposed the name Sauropsida, or, in other words, Reptiles and Birds. No less than 427 pages of letter-press, illustrated by 298 woodcuts, are devoted to this portion of the work, which is alone sufficient to give some idea of the fulness with which the subject is treated. Since, however, there are some repetitions of the figures, the total number is somewhat less than that given above. A considerable proportion of these woodcuts are original, but others have been copied from the memoirs of Owen, Cope, Marsh, and others, as well as from the British Museum Catalogues.

In dealing with the difficult question of the arrangement of the orders of Reptiles, and the number of such orders which it is advisable to adopt, we think that in the former respect the author has not been altogether well advised. The orders adopted are nine in number, and are arranged in the following sequence, viz.: (1) Ichthyosauria; (2) Sauropterygia; (3) Testudinata; (4) Theromorpha; (5) Rhynchocephalia; (6) Lepidosauria; (7) Crocodilia; (8) Dinosauria; and (9) Pterosauria.

Now the first point that strikes us as incongruous in this arrangement is the position assigned to the Theromorpha (otherwise known as Theromora or Anomo-

<sup>1</sup> *L'Astronomie*, t. ix. p. 441; Ranyard, *Knowledge*, November 1890; *C. rendus*, t. cxi. No. 15.

<sup>1</sup> K. v. Zittel, "Handbuch der Palæontologie," Vol. III. Vertebrata, Parts 3 and 4 (Munich and Leipzig, 1889-90).