A Unique Long-period Variable Star.

By MAJOR W. J. S. LOCKYER.

SINCE the year 1811 the star designated R. Aquarii (position for 1900 Right Ascension $23^h\ 38{\cdot}6^m$, Declination $-15°\ 50'$) has been known as a variable star. It goes through a complete cycle of variability in 385·5 days, attaining a maximum brightness of 6·2 and a minimum of 11·0.

This star, like about 85 per cent. of all long-period variables, has a spectrum of the class Md, *i.e.* a

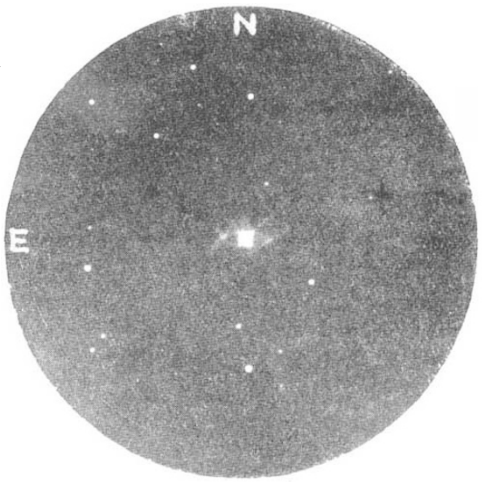

FIG. 1.—Nebulosity around R. Aquarii.

Photographed by C. O. Lampland, Lowell Observatory.

spectrum showing bright hydrogen lines and numerous absorption flutings of titanium-oxide on a continuous spectrum, and indicative of comparatively low temperature.

On October 16, 1919, Mr. Paul W. Merrill, using the 100-inch reflecting telescope of the Mount Wilson Observatory, discovered that several other bright lines, characteristic of gaseous nebulæ, were present. This made the spectrum unique, because while there is considerable evidence to connect hot stars, such as Class O or Wolf-Rayet Stars, with gaseous nebulæ, there was no instance, prior to this, in which a comparatively cool star is associated with the nebulæ.

A further interesting observation that has been made is that while the nebular lines remain almost constant in intensity throughout the light changes of the star, the other lines representing the Md spectrum vary through a large range. This suggests that the star and nebula are independent of one another: other observations on the other hand tend to show a close connection between the two.

The most recent discovery relating to this star is of extreme importance, for it is now known that the star is in the centre of a mass of nebulous matter.

The photograph showing this was taken by Mr. C. O. Lampland with the 40-inch reflecting telescope of the Lowell Observatory. This nebular image he describes as an oval-shaped, elongated configuration composed of arcs of well-defined nebular filaments and the star is centrally and symmetrically placed. The position-angle of the longer axis of the formation is about 90° and the greatest extent of the faint structure in this direction is a little more than two minutes of arc. Mr. Lampland has forwarded a positive photograph on film from which the accompanying illustration (enlarged twice) has been made. On his photograph 1 mm. represented 24·5 seconds of arc (approx.).

The general form of the nebulosity here displayed is very similar to that of the nebula N.G.C. 5921. This latter is reproduced on Plate I. in vol. xiii. of the "Publications of the Lick Observatory," and is given there as an example of what Mr. H. D. Curtis calls a ϕ-Type Spiral Nebula.

The actual presence of this nebulosity is of great value in accounting for the unique character of the star's spectrum. Attention must also be directed to the importance of long-exposed photographs with powerful reflectors for the purpose of searching for nebulosities whenever nebular lines appear in a spectrum. It will be remembered how such lines, appearing in the spectra of novæ in the later stages of their career, led to the discovery of the presence of nebular matter surrounding the star.

Marine Invertebrates.

FURTHER reports on material collected by the British and Australian Antarctic Expeditions have been received. The Chætognatha of the Australian Expedition have been described by Prof. T. H. Johnston and Mr. B. B. Taylor, systematic accounts of the Crustacea of the British (*Terra Nova*) Expedition are given by Mr. R. W. Barney on the Ostracoda, and on the Tanaidacea and Isopoda by Dr. W. M. Tattersall. Dr. H. M. Woodcock and Miss Olive Lodge describe the collection of parasitic protozoa, which consists of only three species—a new species of the flagellate genus Cryptobia, a new species of Gregarine (Selenidium), and a ciliate. This ciliate, for which a new genus (Hæmatophagus) is created in the family Stentoridæ, is parasitic on the baleen plates of the humpback whale, and feeds exclusively on the whale's red-blood corpuscles. It reaches a length of 1-1·5 mm., and secretes a delicate transparent tube, up and down which it moves; when feeding the oral end of the ciliate may project from the tube. The red-blood corpuscles are directed into the mouth by the adoral zone of strong cilia fused into membranellæ, pass into the protoplasm, and become enclosed in food-vacuoles. The larger vacuoles may contain numerous corpuscles which become compressed, and, owing to the dissolution of the envelope of the corpuscles, the hæmoglobin-containing substance of all the red cells in the vacuole merges into one homogeneous mass. As digestion proceeds the vacuoles pass gradually backwards, and pigment—agreeing in appearance with melanin—is formed on the outside of the vacuole. Hæmatophagus is unique among ciliates in producing melanin as a result of the digestion of hæmoglobin. This pigment tends to accumulate in the hinder half of the body, and the authors find evidence that when the organism is full-grown the pigment is got rid of by casting off that portion of the body prior to the commencement of the resting, multiplicative phase. How the blood of the whale becomes available to the ciliate has not been established.

Mr. C. H. Edmondson gives (Occasional Papers, Museum of Polynesian Ethnology and Natural History, Honolulu, 1920) a short account of the edible mollusca of the Oregon coast. These are all bivalves; some, belonging to the genera Siliqua and Mya, are

known locally as "clams" of various kinds, and there also occur two species of Mytilus, a pecten, a cockle, and an oyster. The Indians made extensive use of these molluscs before the advent of the white man on this coast, as is shown by the great heaps of shells still remaining. *Mya arenaria*, which was transported from the Atlantic coast many years ago, probably with oyster-spat, has become well-established in many localities on the Pacific coast, where it inhabits the mudflats of bays and has advanced up some estuaries, always remaining, however, within the influence of salt water. The author records that in January, 1918, excessive rainfall caused exceedingly high water in one of these estuaries, the Mya being washed with comparatively fresh water for four weeks, and at the end of the period a dense layer of fine sand, up to 2 in. in depth, covered the clam bed. A high percentage of the younger and weaker individuals was found to be dead, probably smothered by the fine silt. Mya is found to withstand transportation to inland markets if kept at a low temperature, and will remain in good condition for a week after having been taken out of the water, but the other clams cannot be sent successfully any distance in marketable condition. Certain of them are canned at the coast. Observations are given on the spawning periods and growth of the bivalves.

The attention of students of recent Crinoids may be directed to a paper by Dr. Austin H. Clark on "Sea-lilies and Feather-stars" (Smithsonian Misc. Coll., vol. 72, No. 7, 1921). The account, while devoted chiefly to external and skeletal features, includes short notes on regeneration, asymmetry, distribution, food, locomotion, etc.

Water-power Resources of India.[1]

THE Triennial Report (1919–1921) of the Hydro-Electrical Survey of India, which has just been received, is of the character of a comprehensive volume, embodying all the essential information contained in the preliminary and second Reports, which have already been noticed in NATURE. In addition, it contains later information derived from the investigation of certain sites selected for their potential value as sources of water-power supply. In the result, the opinion is formed "as a rough preliminary forecast" that the probable water of India for maximum development is some 12,680,000 kilowatts, equivalent to 21½ million water horse power, of which only 1¼ per cent. so far is developed or in course of development. The estimate is, of course, to be received with caution, as it is largely "speculative and based on the minimum of reliable information." The water power actually developed at the present time amounts to 138,780 kw., (continuous), capable of being expanded to 213,150 kw., in accordance with the ultimate capacity of the sites exploited. The following is a detailed summary of the probable *minimum* continuous water power :—

	Kw.
Assam	414,000
Baroda	4,000
Bengal	669,850
Bihar and Orissa	62,550
Bombay	644,310
Burma	951,570
Central India	680
Central Provinces and Berar	137,560
Cochin	4,000
Coorg	1,500
Gwalior	43,300
Carry forward	2,933,320
Brought forward	2,933,320
Jammu and Kashmir	305,330
Madras	92,310
Mysore	48,500
North-West Frontier	1,000,000
Patiala	290
Punjab and Canals	793,150
Rajputana	160
Sikkim	5,000
Travancore	450
United Provinces and Canals	403,370
	5,581,880

[1] Hydro-Electric Survey of India. Volume III. Triennial Report with a Preliminary Forecast of the Water Power Resources of India, 1919 to 1921. By J. W. Meares. Pp. ix+199. (Calcutta: Government Printing Office, 1921). 4 rupees.

The Survey is being made under the supervision of Mr. J. W. Meares, who was appointed Chief Engineer in succession to Mr. F. E. Bull. It is noteworthy that the same reluctance to finance hydrographical surveys exists in India as in other parts of the Empire. Mr. Meares is much concerned as to the outlook. As a consequence of the "Reforms" made by the Government of India, it was decided in October, 1920, that all outlay on water storage and water power would be a Provincial charge and that the necessary provision for hydro-electric surveys should therefore be made in the Provisional Estimates from and after the year 1921–22. When the Estimates came up for approval before the various legislative councils, in many instances reductions were moved, and as the matter now stands "the Survey is in danger of falling between the upper and the nether millstone, as the Government of India is no longer able to provide funds for a continuance of the work."

A considerable quantity of useful data is incorporated in the volume, including seven plates and maps, 23 diagrams, and 51 tables. Much detailed information is set out for the guidance and direction of those engaged in the Survey, of whose cordial co-operation Mr. Meares speaks very highly.

University Pensions.

THE Sixteenth Annual Report of the Carnegie Foundation for the Advancement of Teaching provides some interesting reading, especially regarding pension systems. The claim is made that in the Reports of the Foundation will be found "the most complete information concerning pensions and pension systems in existence." The remarks on the University Teachers' pensions in England and Wales deserve notice. Reference is made to the movement of the Association of University Teachers to secure the extension of the School Teachers (Superannuation) Act of 1918 to University teachers, or failing this to obtain benefits at least equivalent to those offered by the Act. As in previous years, the Report shows a strong bias against any non-contributory scheme. It is very easy to understand why this should be so. The Teachers' Insurance and Annuity Association of America could not have come into existence on any other than a contributory basis. On its own showing the Foundation was unable to finance a scheme such as is growing up in America. But no attempt is made to demonstrate how such a contributory scheme can be "sounder" than a non-contributory scheme backed by the government of the country. It would