In addition to the necessary routine work, several researches were carried out, and the results of some of these investigations are embodied in the report. Mr. M. A. Brannon, who occupied the Garden's table at the Wood's Holl Marine Biological Laboratory, has his studies on *Grinnellia* nearly ready for publication. The Director, Mr. W. Trelease, has made a large collection of the flora of the Azores, and is now working at it. The collection fully represents the flora of those islands, and adds somewhat to what is known of the distribution of species through the group. The papers included in the present report are :—"Revision of the North American Species of Sagittaria and Lophotocarpus," by Mr. J. G. Smith, who also describes a few new or little known species ; "*Leitneria Floridana*," by Mr. Trelease. "Studies on the Dissemination and Leaf Reflection of *Yucca aloifolia* and other Species," by Mr. H. J. Webber ; and "Notes on the Mound Flora of Atchison County, Missouri," by Mr. B. F. Bush. The report is illustrated by sixty excellent plates.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Captain Fitzgerald ; a Common Marmoset (*Hapale jacchus*) from South-East Brazil, presented by Mrs. Florence Cowlard ; a Serval (*Felis serval*), a White-necked Stork (*Dissura episcopus*), a Vocifereous Sea Eagle (*Haliætus vocifer*), an Antarctic Skua (*Stercorarius antarcticus*) from Mozambique, presented by Mr. W. A. Churchill ; a Cardinal Grosbeak (*Cardinalis virginianus*) from North America, a Lazuline Finch (*Guiraca parellina*) from Mexico, presented by Miss E. A. Krumbholz ; an Orbicular Horned Lizard (*Phrynosoma orbiculare*) from California, presented by Miss Mabel Baker ; a Frilled Lizard (*Chlamydosaurus kingi*) from Roebuck Bay, West Australia, presented by Mr. Saville-Kent ; an Orang-outang (*Simia satyrus*, ♀) from Borneo, three Pratincoles (*Glareola pratincola*), European, an Eyed Lizard (*Lacerta ocellata*) from North Africa, a Brazilian Tortoise (*Testudo tabulata*), a Black Tortoise (*Testudo carbonaria*) from Brazil, deposited ; two Plumed Ground Doves (*Geophaps plumifera*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

TERRESTRIAL HELIUM.—The discovery by Messrs. Runge and Paschen of the duplicity of the bright yellow line seen in the spectrum of the gas obtained from cleveite, and of its apparent non-coincidence with the solar D_3 line, as announced in NATURE of June 6, has naturally led to the re-observation of the solar line.

Mr. Lockyer informs us that on June 14, observing in the fourth order spectrum of a grating having 14,438 lines to the inch, he found the D_3 line in the chromosphere to have a considerable breadth with rather uncertain indications of doubling, while in the spectrum of a prominence the line was much better defined, and was distinctly double, the less refrangible component being the fainter, as in the case of the gas from cleveite.

Writing under date June 25 (*Ast. Nach.* 3302), Prof. G. E. Hale gives a preliminary account of the observations he has made with the powerful spectroscope of the Kenwood Observatory. To eliminate the effect of the sun's rotation in displacing the lines, observations were made of the chromosphere at the sun's north and south poles.

On June 19 and 20 the chromospheric line was found to be 0·54 tenth metres broad, the wave-length of the middle being determined as 5875·924. In the spectrum of each of two prominences observed on June 20 and 21, an inconspicuous bright line was detected on the less refrangible side of D_3, both lines being narrow and sharp, and the distance between them being 0·357 tenth metres. The absence of metallic lines, other than H and K, indicated that the fainter line was probably not due to the accidental proximity to D_3 of a faint metallic line. Further observations on June 24 showed that the broad line in the chromosphere was also divisible into two parts, and it became evident that the wave-length of the D_3 line determined on June 19 and 20, as well as that determined by Rowland, must be affected by an error on account of the presence of the faint line on the less refrangible side. So far, Prof. Hale has not succeeded in obtaining a measure of the wave-length of the more refrangible and brighter of the solar D_3 lines, considered as a separate line.

The results so far obtained may be stated as follows :—

λ of solar D_3 line (Rowland)	5875·982
,, ,, (Hale)	5875·924
,, brightest component of terrestrial line (Runge and Paschen)	5875·883
Distance apart of components of terrestrial line (Runge and Paschen)	0·323
Distance apart of components of solar D_3 (Hale)	0·357

The wave-length of the brighter component of the solar D_3 line remains to be determined before the question of the identity of the solar and terrestrial gas can be regarded as completely set at rest.

The announcement that the yellow line of the gas from cleveite was double, also led Dr. Huggins to observe the chromospheric line. In his first attempts he failed to see the line double (*Chemical News*, No. 1855), but he now states that he clearly saw the line to be double on July 10, 11, and 13, the less refrangible line being the fainter, and the distance apart of the lines being about the same as that of the lines in the cleveite gas according to Runge and Paschen (*Ast. Nach.* 3302).

It is worth recalling that Belopolsky observed the solar D_3 line to be double in May 1894, and ascribed the appearance to the superposition of a telluric line upon the bright line. Prof. Hale's observations demonstrate very clearly that Belopolsky's explanation cannot possibly account for the doubling of the line as observed by him.

EPHEMERIS FOR BARNARD'S COMET, 1884 II.—The following search ephemeris for the return of this comet is due to Dr. Berberich (*Ast. Nach.* 3301) :—

	R.A. h.	m.	s.	Decl. °	′
Aug. 2	2	23	9	+ 12	29
6	2	29	7	13	19·5
10	2	34	30	14	6·8
14	2	39	16	14	50·9
18	2	43	23	15	31·9
22	2	46	48	16	9·7

The positions are for Berlin midnight, and are computed on the assumption that the comet will pass through perihelion on June 3. On June 30, Swift discovered a nebulous object in R.A. 20°, decl. + 2° 55′, which was missing on July 4, and was thought to be a possible return of the comet for which the ephemeris is given above. Dr. Berberich states that the observation by Swift does not fit closely into the orbit.

THE AUGUST METEORS.—Shooting stars from various radiants appear during the month of August ; but the most important shower is that of the Perseids. These are visible for a considerable period, with a maximum on August 10. According to Mr. Denning, the radiant point exhibits an easterly motion among the stars ; on the 10th it is situated in R.A. 45°, decl. 57° N. ; on August 2 it is in R.A. 36°, decl. 55°, and on August 16 in R.A. 53°, decl. + 58°. The density of the shower varies but little from year to year, the number of meteors seen by one observer on the morning of August 11 being from sixty to eighty. Unfortunately the moon rises about nine o'clock on the 10th, so that this year only the brighter meteors will be visible.

THE SUN'S PLACE IN NATURE.[1]

IX.

IN most of the earlier attempts which were made to explain the origin of new stars, the leading idea was that of a single body being suddenly disturbed in some way, with the possible result that the heat of its interior became manifested at the surface. Thus Zöllner, in 1865, suggested that the phenomena might be

[1] Revised from shorthand notes of a course of Lectures to Working Men at the Museum of Practical Geology during November and December, 1894. (Continued from page 255).

produced by the bursting of the crust which had just formed on the surface of a star approaching extinction. Again, in connection with the new star in Corona, I pointed out in 1866 that all that seemed necessary to get such an outburst in our own sun was to increase the power of his convection currents, which we know to be ever at work. Dr. Huggins at that time believed that the appearances were due to gaseous eruptions in a single body, and that "possibly chemical actions between the erupted gases and the outer atmosphere of the star may have contributed to its sudden and transient splendour."

Though Zöllner's theory was further advocated by Vogel and Löhse in 1877, the idea that such outbursts can be produced in a single body, without external influence, is now almost universally abandoned.

The alternative hypotheses mostly have to do with the possible action between two bodies—an idea first suggested by Newton—and, as I have already pointed out, the evidence that two bodies were engaged in the case of Nova Aurigæ, at least, is conclusive. Even Dr. Huggins has found it necessary to suppose the existence of two bodies, in order to explain the phenomena observed in this case; and Dr. Vogel, who made some most admirable observations during the appearance of this new star, states most distinctly that we can no longer regard the assumption of a single body as sufficient in any explanation of the occurrence.

Notwithstanding the general agreement as to the presence of at least two bodies in the outburst of Nova Aurigæ, there remain considerable differences of opinion as to the nature of the separate bodies, and of the kind of interaction between them.

One explanation which has been suggested ascribes the luminous effects to the development of heat due to the passage of a dark body through a gaseous mass, somewhat after the manner in which meteoric stones produce the appearances of shooting stars in passing through our atmosphere. This kind of action was first suggested by Mr. Monck in 1885, but the possibilities of such actions have been recently more fully discussed by Prof. Seeliger. He points out that the photographic investigations of Dr. Max Wolf and others leave but little doubt that space is filled with more or less extensive aggregations of thinly-scattered matter, which may be called cosmical clouds, thereby accepting my view of a "meteoritic plenum."

If a heavenly body in rapid motion becomes involved in one of these cosmical clouds, its surface will become heated, and the vapourised products will be partly detached and assume the velocity of the cloud; the fluctuations of brilliancy of a new star on this hypothesis are produced by the varying density of the cosmic cloud through which the body is passing.

This hypothesis of Prof. Seeliger's has been strongly combated by Dr. Vogel.

Another explanation depending upon the action of gases has been suggested by Dr. Huggins:

"The phenomena of the new star scarcely permit us to suppose even a partial collision; though if the bodies were very diffuse, or the approach close enough, there may have been possibly some mutual interpenetration and mingling of the rarer gases near their boundaries."

The idea that the phenomena might be produced by the close approach of two bodies, and the consequent disturbances due to tidal action, was first started by Klinkerfues; it has been recently strongly advocated by Dr. Huggins, though I fail to see how it fits in with his previous explanation.

The tidal theory differs from Zöllner's only in ascribing the eruptions to the disturbances produced by tidal action when two bodies approach each other. To employ the words used by Dr. Huggins, the tidal action gives rise to "enormous eruptions of the hotter matter from within, immensely greater, but similar in kind, to solar eruptions." This explanation, however, has met with much opposition on physical grounds.

Thus, Prof. Seeliger writes:

"The static theory of the tides, which is used throughout, is quite incapable of giving a correct representation of the deformations which are doubtless produced by the close passage of the two bodies; for with very eccentric orbits (which it is necessary to assume on other grounds), the continually varying action would last for so short a time that one could scarcely expect to derive a trustworthy conclusion in regard to the actual circumstances from a consideration based on the forms which the bodies could assume in equilibrium."

Again, Vogel objects that:

"Sensible tidal action cannot be assumed to last for any considerable time, as on account of the great relative velocity of the bodies, they would separate at the rate of forty-six millions of miles per day."

These, however, are not the only objections which may be raised to the idea that we have to do with phenomena of the nature of solar prominences, whether produced by tidal action in the case of two bodies, or by a bursting of the crust which is forming in the case of a star approaching the end of its career as a luminous body. In the first place, there is no reason to suppose that the prominences in our own sun are produced by tidal action. The fact that many of the lines seen in the spectrum of Nova Aurigæ during its first appearance were coincident with lines seen in the solar chromosphere, appears, at first sight, to support the idea, but, since the spectra of nebulæ also show chromospheric lines, the same argument might also be applied to prove that nebulæ are manifestations of prominences. I do not imagine that very many will be prepared to believe that nebulæ are prominences, for if they are, they must be prominences of an unseen sun!!

Mr. Maunder and others have pointed out that if the phenomena be due to the formation of solar prominences, the bright lines should be displaced to the more refrangible sides of their normal places, for the reason that only those prominences on the side of the star presented to us would be able to produce visible bright lines, and such prominences would necessarily have their chief movement in a direction towards the earth. We have seen, however, that in Nova Aurigæ, the actual displacement of the bright lines was just the reverse.

Again, the fact that Nova Aurigæ ended by becoming a nebula is difficult to reconcile with the idea that in its earliest stages its luminosity was produced by outbursts of the nature of solar prominences. Nothing seems more remote than the possibility of prominences cooling down and becoming nebulæ. To have so-called "solar prominences" there must be a sun to produce them, and that must remain when the outburst of prominences has ceased; in this case the last stage of the spectrum of the new star should have resembled that of the sun. The fact that it did not indicates how worthless is the prominence suggestion in the light of modern knowledge.

Another very important objection to the solar prominence theory is this: If new stars are real stars capable of exhibiting prominence phenomena, then we have real stars ending as nebulæ, and thus clashing with the idea now accepted even by Dr. Huggins, that nebulæ are "early evolutionary forms" of heavenly bodies. Further, if new stars be real stars, we should have to believe that the last expiring atmospheres of stars consist of hydrogen and unknown gases; but if we take the evidence afforded by the stars themselves, we find that instead of their last atmosphere consisting of hydrogen it indicates carbon or carbon compounds.

It is evident, therefore, that at present there is no agreement among authorities as to which of the special theories I have brought to your notice is to hold the field, each special hypothesis having got no further than a damaging criticism from the authors of the others.

The remaining general hypothesis we have to consider is that advanced by myself. We have everywhere in space, as is now being revealed to us, especially by the photographs of Barnard, Max Wolf, and others, meteoritic aggregations, swarms, and streams, the constituents of which are, comparatively speaking, at rest, or are all moving one way, if they are moving at all, and undisturbed, because they are not being intersected by other streams or swarms at any one time. But supposing any of these bodies cross each other, as unfortunately sometimes excursion trains cross each other, then there is a very considerable difference in the phenomena; there are collisions, and the collisions produce increased light, and we think that a new star is being born. Nothing of the kind. No new star is being born; there is simply a disturbance in a certain part of space, and when the disturbance cools down we shall find that that part of space is still absolutely in the same order. In the case of Nova Aurigæ, and in the case of Nova Cygni after the war was over, nebulæ have been found to lie in the precise positions occupied by the new stars, and the only thing that one has to say about it is that the nebulæ were there before, but that in consequence of our incomplete survey of the heavens they had not been observed.

After the new photographic chart of the heavens has been made, in future times, it will be found that all new stars are not really new, but the lighting up of something which existed there already. The argument for this theory, you will understand, is

simply this. Suppose I light a match, the smaller the match the sooner will it go out, and similarly the larger a fire the longer will it last. So if you are dealing in space with those illuminations which disappear in hours, days, or weeks, you cannot be dealing with any large mass; therefore the collisions in question cannot be between large masses of matter, but it must be a question of collisions amongst the smallest particles of matter we can conceive.

It is interesting to consider one of the possibilities which may explain why small nebulæ may be overlooked in telescopic observations. In the so-called achromatic telescope, all the rays of light are not brought to quite the same focus, so that when ordinary stellar observations are being made, the focus is adjusted for yellow rays which are most luminous to the eye. Now the greater part of the visual light of a planetary nebula is confined to a single line of the spectrum in the green, so that the focus which is best adapted for observations of stars is not suitable for the observation of a small nebula, the nebula being out of focus, and its feeble light thus reduced by the diffusion of the image. This difference is much more marked in large than small telescopes, and Prof. Campbell has pointed out that a small nebula like Nova Aurigæ will in general appear relatively brighter in a small telescope than a large one.

I will next go into some details touching the phenomena of the Novæ in relation to the hypothesis.

First let us see the crucial phenomena we have to explain. We have (1) the sudden bursting out of light and accompanying spectra; (2) the indication of the existence of two bodies revealed by the spectra; (3) the variations and dimming of the light and accompanying spectral changes; and (4) the final stage giving us the spectrum of a nebula.

Since the new era of spectroscopic work has begun, Nova Aurigæ and Nova Normæ have proved to us that the sudden illumination was, to say the least, associated with two bodies, and that these were in different stages of condensation. On the meteoritic hypothesis it was shown that the main differences between bodies giving bright and dark line spectra is one of condensation only: a sparse swarm gives us bright lines because the number of meteorites in unit volume is small and the interspaces are great; a more condensed swarm gives us dark lines because the number of meteorites in unit volume is greater, and the atmospheres of cooler vapour round each meteorite in collision begins to tell because the interspaces are reduced. I am the more justified in insisting upon the importance of this view that two bodies in different stages of condensation are involved, because years after it was formulated Dr. Huggins apparently arrived at it independently—at all events he makes no reference to my prior announcements when he brings it forward as an explanation of the phenomena.

The following quotations will show how this matter stands:—

"If we assume a brightening of the meteor-swarm due to collisions as the cause of the so-called new stars, we have good grounds for supposing that in these bodies the phenomena should be mixed, for the reason that we should have in one part of the swarm a number of collisions probably of close meteorites, while among the outliers the collisions would be few. We shall, in fact, have in one part the conditions represented in Class III*a*, and in the other such a condition as we get in γ Cassiopeiæ."[1]

"The discussion of the observations which have been made of the changes that take place in the spectra of new stars, has already shown that the sequence of phenomena is strikingly similar to that which occurs in cometary spectra after perihelion passage. In general, however, there will be a difference: namely, that in comets there is usually only one swarm to be considered, whereas in new stars, there are two, which may or may not be equally dense. In new stars, we have accordingly the ntegration of two spectra, and the spectrum we see will depend upon the densities and relative velocities of the two swarms."[2]

"The spectrum of Nova Aurigæ would suggest that a dense swarm is moving towards the earth with a great velocity, and passing through a sparser swarm, which is receding."[3]

"The circumstance that the receding body emitted bright lines, while the one approaching us gave a continuous spectrum with broad absorption lines similar to a white star, may, perhaps, be accounted for by the two bodies being in different evolutionary stages, and consequently differing in diffuseness and temperature."[4]

[1] November, 1887. Lockyer. *Proc.* R.S., vol. xliii. p. 147.
[2] November, 1890. Lockyer. *Phil. Trans.*, 182 A, p. 407.
[3] February 11, 1892. Lockyer. *Proc.* R.S., vol. l. p. 435.
[4] May 16, 1892. Dr. Huggins. *Proc.* R.S., vol. li. p. 494.

Now two sheets or streams of meteorites interpenetrating and thus causing collisions will produce luminosities which will indicate the condensation of each, and the spectra of the two Novæ we are considering thus indicate that the colliding swarms were of different degrees of condensation, and the variations of light observed indicate several such encounters between less dense swarms after the most dense one had somewhat cooled down. The final stage was arrived at and the pure nebula spectrum produced when the most condensed swarm had ceased to indicate any disturbance, after all the others had returned to their pristine quiet and invisibility.

It is important to insist upon the fact that the nebulæ are now almost generally conceded to represent "early evolutionary forms." We have then from the first appearance of a Nova to the last a "backwardation" in the phenomena ending in an "early evolutionary form." Increase of temperature is accompanied by spectral changes in a certain order; if the temperature is reduced the changes occur in reverse order, until finally we reach the "early evolutionary form," which cannot be a mass of gas because its temperature is lower than that of the sun, which it is potentially, and it must contain all the substances eventually to appear in the atmosphere of the sun.

On the hypothesis, then, we imagine a nebula in the position occupied by Nova Aurigæ not chronicled for the reason stated. This nebula is approaching us. It was disturbed by a much sparser stream leaving us, the relative velocity being over 500 miles a second. During the time of impact, the disturbances produced in the two swarms gave rise to bright-line spectra in the sparse swarm, and to dark-line spectra in the more condensed one. The spectrum of the sparse swarm disappears, the spectrum of the dense swarm changes gradually from dark to bright lines, and ultimately it puts on the original nebula spectrum. It is still there, and still approaching us.

We have next to consider the objections which have been urged against this hypothesis. They are of a most trivial nature. An objection made by Vogel is that it is improbable that the velocities could have been so great after collisions. The reply is easy. The light was produced by the disturbed members of the two swarms which escaped end-on collision. On the meteoritic hypothesis we can escape from the difficulties produced by the old idea of collisions *en bloc*. Such objectors would urge that the velocity of a comet as a whole would be retarded by passing through the sun's corona, but we have instances to the contrary.

Another objection has been raised by Dr. Vogel because in relation to the Nova I did not restate all I had previously written concerning the origin of the cause of bright and dark line spectra in stars. It has been difficult for him to understand how one (temporary) star should have bright lines in its spectrum, and another (temporary) star should have dark lines. All I can say is that upon such objectors lies the onus of producing a more simple (and yet sufficient) explanation than that I have suggested.[1]

J. NORMAN LOCKYER.

(*To be continued.*)

THE INTERNATIONAL GEOGRAPHICAL CONGRESS.

THE International Geographical Congress, now a recognised institution, has this year met for the first time on British ground. Originating in a festival organised to celebrate the inauguration of statues of Mercator and Ortelius at Antwerp and Rupelmond, the first Congress was held at Antwerp in August

[1] It has been stated that the meteoritic hypothesis has received a fatal blow from the observations of the Nova (*Astronomy and Astrophysics*, 1892, p. 509). Capable and unprejudiced persons I think will not be of this opinion. I append a quotation from an article by Prof. Campbell, which has appeared since the lectures were delivered.

"As bearing upon any possible theory of Nova Aurigæ, perhaps it will not be out of place to say here what I said last winter in another journal (Pub. A.S P. vi., 52, 133.) The Harvard College Observatory has shown that both Nova Aurigæ and Nova Normæ at discovery possessed substantially identical spectra of bright and dark lines, similarly and equally displaced. Both diminished in brightness, and both assumed the nebular type of spectrum. The new star of 1876 in Cygnus probably had nearly an identical history: passing from a bright star with a spectrum of bright and dark lines, to a faint object with a spectrum consisting of one bright line (undoubtedly the nebular line λ 5010, or the two nebular lines λ 5010 and λ 4960 combined). We may say that only five 'new stars' have been discovered since the application of the spectroscope to astronomical investigations, and that three of these have had substantially identical spectroscopic histories. This is a remarkable fact. We cannot say what the full significance of this fact is. One result, however, is very clear: the *special* theories propounded by various spectroscopists to account for the phenomena observed in Nova Aurigæ must unquestionably give way to the more *general* theories." (*Astrophysical Journal*, Jan. 1895, p. 51.)