or at most three half-prisms" more dispersion than was before obtained by "ten whole ones," does so at the cost of *all definition*, and will be certainly allowed at Greenwich, as well as everywhere else, to be a mistaken step in modern spectroscopy before another anniversary of the Royal Astronomical Society takes place.

PIAZZI SMYTH,
Edinburgh, March 17 Astronomer-Royal for Scotland

Greenwich as a Meteorological Observatory

IN NATURE (vol. xv. p. 421) there appeared a brief abstract of the presidential address of Mr. H. S. Eaton to the Meteorological Society of London on February 21. The increase of temperature at Greenwich in recent years is stated to be in reality due to local causes and not to secular variation, to which it has, as he thinks, been erroneously assigned. The effect of the growth of the population of London from 900,000 at the commencement of the century to 3,500,000 at the present time, and the still greater increase in the comparative consumption of coal, Mr. Eaton considers to be manifested by the rise in the average temperature of the air at the Royal Observatory, and for this reason it is concluded that Greenwich is not a suitable place for a meteorological observatory of the first order.

If the view enunciated by Mr. Eaton be correct, it is evident that the temperature of Greenwich during recent years has been in excess of that of surrounding districts. Is this view borne out by observation? Taking the figures for a number of places in the south-east of England whose mean temperatures have been calculated for the same thirteen years ending 1869, and adding the usual correction for height above the sea, we obtain the following results as their mean winter, mean summer, and mean annual temperatures; Greenwich, 40°·4, 63°·1, and 51°·1; Camden Town, London, 40°·4, 63°·3, and 51°·1; Royston, 40°·5, 62°·3, and 50°·8; Colchester, 39°·4, 62°·8, and 50°·6; Worthing, 41°·1, 61°·2, and 50°·7; Osborne, 42°·0, 62°·5, and 51°·8; Aldershot, 40°·9, 62°·6, and 51°·2; and Oxford, 40°·6, 61°·3, and 50°·4. A simple inspection of these figures is sufficient to show that the consumption of fuel and the vast population of London cannot be said to have had an appreciable influence on the temperature as recorded at the Royal Observatory, and that if the Greenwich observations show a rise of temperature during recent years, the whole of the south-east of England has shared in that rise. This result deduced from observations is such as might have been expected when the position of the thermometers at Greenwich and the mode of escape of the artificially heated air by chimneys into the free atmosphere is taken into consideration. It follows, therefore, that, so far at least as regards the temperature observations, the conclusion drawn as to the future of our great national Observatory as a contributor to the higher meteorological researches is not supported by the facts of observation.

ALEXANDER BUCHAN

Atmospheric Currents

I AM glad to have obtained from such exponents as Capt. Digby Murray and Mr. Murphy a clear statement of the old orthodox creed respecting the movements of the atmosphere.

The former, it is true, finds a difficulty in accepting Maury's belief that the currents cut one another in "curdles" in the equatorial calms, but none in adopting the same as regards the tropical calms, and his view may therefore, as I suppose, be taken as a modification of that which is graphically represented on Plate I. in the "Physical Geography of the Sea."

The question at issue between Capt. Digby Murray and myself amounts to this: Are rapid polar and equatorial upper currents observed over the region of tropical calms? Mr. Murphy's theoretical question appears to me to involve the inquiry—Is the force of the trades derived from the earth's rotation?

In tracing the course of the air particles along the route which he describes, the late Commodore Maury observes that this course is determined in certain particulars by "some reason which does not appear to have been very satisfactorily explained by philosophers." The latter do not as yet seem to have got rid of all the difficulties with which his theory is beset, which rather grow with its development.

I would beg the philosophers to look closely at the actual course of the atmospheric currents as shown by synoptic charts, not by charts of prevailing winds and mean pressures, which represent conditions never found at any one time in nature. The distinction between the "great currents" and the "temporary currents" is important enough, but it amounts to little more

than that between mean winds and actual winds; and to explain the mean winds on one principle and the actual winds on the opposite involves a fallacy.

Again and again we see a more or less irregular belt of high pressures, having central calms, extending across the North Atlantic. From the southern edge of this belt we may follow a particle of air in its course to and from the equatorial district of low pressure, also an irregular belt in the middle of which calms exist. The movement originates in the defect of pressure near the equator at the level occupied by the particle. Its velocity is governed by the steepness of the gradient; and its direction, in relation to the surfaces traversed, is affected by the increasing velocity of rotation of those surfaces. In the Doldrums it arrives at a district at which the gradient becomes zero and the horizontal movement has consequently disappeared; but a vertical movement has now been acquired from the difference in the tension of the particles above and beneath, a difference derived from solar heat. When the particle has arrived at a position in which this difference disappears the vertical movement vanishes, and a new horizontal movement commences owing to the defect of pressures on the polar side at the level then reached, and the direction of this movement is also affected in relation to the surfaces by their decreasing velocity of rotation. Where does the new movement terminate? Obviously in some district between the equator and the pole where horizontal pressures on all sides of the particle at its then level are equable, but where a vertical movement has been acquired, the particles near the earth's surface starting on their journey towards the equator. The *onus disputandi* lies with those who deny that such a district is presented by either of the belts of tropical calms.

We now look at the polar side of the calm belt of Cancer, and for this purpose we may take almost any, e.g., of Capt. Hoffmeyer's charts. We see in the majority of cases an aggregate of cyclonic circulations around local barometric minima, interfering and imperfect, and commonly becoming more so as they are propagated towards the pole. But we see no "polar depression" distinct from these, on which, as represented in the chart, we can lay the finger and say, "This is the result of centrifugal force; those are due to steam power." Within these systems an upward movement of the air occurs, owing to vapour condensation and the liberation of heat. Consequently towards these the particles of air near the earth's surface at the poleward edge of the tropical calms begin to travel, the earth's rotation deflecting their course in relation to the surfaces traversed. And from these, at a certain elevation, the particles return to the tropical calms for the same reason as that which determines the upper currents over the trades.

From the phenomena observed in the northern hemisphere I argue, *mutatis mutandis*, to those of the southern, and I expect the argument to be admitted by one who, like Mr. Murphy, attributes much less influence than I do to the work of water-vapour, and who even thinks that the mean movements of our atmosphere would be unaffected by the removal of all the water of our globe.

On some occasions pressure is high over all the North Atlantic on the polar side of the tropic, the anticyclones apparently extending nearly to the pole. In these cases we have no surface counter-trades over that district, yet the north-east trades continue to blow on the southward of the tropic as usual.

I repeat that all movements of the atmosphere originate in differences of pressure derived directly and indirectly from solar heat, and not in the force of the earth's rotation. And I must add that it seems to me very strange that any one while regarding the trades and their upper-currents as simply the effects of pressure differences in the lower latitudes, should maintain that the south-west and north-west winds of the temperate zones are simply the causes of the pressure differences in the higher latitudes. It would be just as logical to regard the south-west and north-west winds as due to pressure distribution, and the trades as the compensation for their eastward movement. W. CLEMENT LEY

March 10

Electrical Phenomenon

LAST night I noticed a powerful development of electricity in a curious manner. I had thrown a piece of common, thick, white, unglazed paper upon a low fire which was tolerably full of ashes. When it was charred so as to be black and brittle, I happened to take it up and break bits off. To my astonishment they stuck firmly to my fingers. I broke off two pieces each an inch long, and resting them on the tips of my two fore-fingers,

each was capable of rotating (though with very great friction). When brought near each other they repelled each other forcibly. I experimented with these pieces for several minutes without perceiving any diminution in their electrification. Both sides of the paper seemed to be in the same condition. I then laid them down, and left the room to fetch a piece of sealing-wax to test the nature of the electricity. But by the time I returned, all trace of electricity was gone, and by no means could I repeat the experiment so as to get the slightest charge of electricity.

It is more than probable that the electricity was developed by the chemical action of combustion of the coals, and that the hot air rising up and brushing past the paper acted as a carrier of electricity of one kind to the paper, and of the opposite kind from it, until it acquired a very high potential. But it would be interesting to learn exactly in what manner this action takes place, and whether the electrification was positive or negative.

Andersonian College, Glasgow

GEORGE FORBES

Strange Star.—Meteor

ON going out last Saturday evening about 8.55 P.M. my attention was arrested by a large deep red star in Serpens which I had never seen before. Its magnitude was greater than Arcturus, though its deep colour made it seem less bright. About ten minutes afterwards I saw it increase and diminish in magnitude two or three times producing the effect similar to a "flashing" light on the coast, after which it suddenly disappeared.

On the same evening, at 9.56, I saw a very fine meteor of a bright pale blue colour with coruscations of ruby colour at the nucleus. Its course was from Gemini over Aldebaran, disappearing below Pleiades. Of a long pine-cone shape, duration about three seconds.

W. M.

Gunnersbury, March 19

SCIENCE IN GERMANY¹

THIS book forms a continuation of the researches which in vol. i. treated of the season dimorphism as the result partly of exterior influences and partly of atavism. The present (second) volume comprises: (1) the origin of the markings upon caterpillars; (2) on the phyletic parallelism in metamorphous species; (3) on the transformation of the Mexican *Xolotl* into an *Amblystoma*; (4) on the mechanical conception of nature. The third treatise was published separately some time ago and was reviewed in NATURE; here we particularly wish to draw the attention of the lovers of natural science to the first paper. Weismann tries in the treatise in question to prove by his observations, and the deductions therefrom, that exterior influences and natural development or adaptation (*Naturzuechtung*) only can be the causes of the markings upon caterpillars. The observations referred to were made upon the caterpillars of several genera of *Sphingide*, and relate to the history of their development.

I. *Charocampa*.—The caterpillars of *Ch. elpenor*, which have just left the ova, show no markings of any kind in this first stage, being of a uniform greenish colour; after the first change of skin (second stage) they show a bright longitudinal streak on each side, between the dorsal line and the line of breathing apertures (stigmata). To this first streak Weismann gives the name of "subdorsal streak." In the third stage eye-shaped spots form in the fourth and fifth segments, inside of these streaks, and these are completely developed in the following stages, i.e., after the subsequent changes of skin, while at the same time the subdorsal streak decreases and leaves only imperfect traces. In the fifth stage the greenish colour changes to a brownish one, and the horn at the tail of the caterpillar becomes shorter. In the sixth and last stage the other segments begin to show eye-spots, but these are not developed to perfection. *Ch. porcellus* shows the same form and development of the larva, with the only difference that most of the phenomena occur one stage earlier than with *Ch. elpenor*. This conformity and accord of both genera in the order in which the markings upon the caterpillars appear and are developed, lead to the conclusion that the markings were acquired in the same order during the progress of development (phylogeny) of these caterpillars; the oldest form (*a*) therefore showed no markings at all even when perfectly developed; the following form (*b*) had only the subdorsal streaks; then in form (*c*) the eye-spots occurred in the fourth and fifth segments, and finally in all segments (form *d*). It is probable further, that of the two genera of caterpillars now living, *Ch. elpenor*

is the original, i.e., older form, on account of its still showing the different stages of development in their completeness; the younger or more advanced form, viz., *Ch. porcellus*, proves that each new marking, acquired during the progress of development, appears first in the later stages and then gradually extends to the earlier stages. The whole of this view is well supported by the markings upon the complete form of the other species belonging to the genus *Charocampa*, of which the development of the larva is still unknown in its different stages. These other species may be divided into three groups, corresponding to forms *b*, *c*, and *d* of the phylogeny in such a manner that wherever the subdorsal streak remains in perfection, the eye-spots are not developed, and wherever these show themselves the subdorsal streak is decreasing. Form *a* (first group) is known in the full-grown caterpillars of three species (*Ch. syriaca*, *Daraspia myron*, and *D. charilus*); to the second group (form *c*) belong the above described *Ch. elpenor* and *Ch. porcellus*, together with several others; the last group (form *d*), which shows completely developed eye-spots on all segments, is even more numerous represented by *Ch. bisecta*, *oldenlandia*, *alecto*, *acteus*, *tersa*, and *celerio*. The species of the genus *Charocampa* which Weismann examined, therefore represent three phylogenetic stages of development, and it is interesting that the tropical species are the most advanced ones. It is probable, indeed, of one species, viz., *Ch. celerio*, that in Europe it shows form *c* in the markings of its caterpillars, while in India the larvæ of the same species have already attained form *d*.

II. In a similar way the author shows that markings upon the larvæ of the genus *Deilephila*, to which the well-known *D. euphorbia* (commonly called Sphinx) belongs, have passed through seven phylogenetic stages of development, viz., (1) caterpillars without markings; (2) with a subdorsal streak; (3) with a ring-shaped spot upon the last segment but one; (4) with similar but not altogether perfect spots upon all segments; (5) with eleven perfect ring-spots upon the subdorsal streak; (6) with these ring-spots but without the streak; (7) with a double row of ring-spots. Nowhere in the development any deviation from this order is noticed, and the living species of this genus form five groups, the markings of their full-grown caterpillars corresponding to the phylogenetic forms Nos. 3 to 7.

III. A somewhat smaller number of stages of development is apparent in the genera *Smerinthus*, *Macroglossa*, *Pterogon*, *Sphinx*, *Anceryx*, which Weismann investigated less extensively than those mentioned before; however, he points out that upon their larvæ the simple subdorsal streak combines, in the course of development, with other longitudinal or oblique streaks, or becomes less distinct as the others increase in intensity.

Now Weismann considers that the remarkable conformities in the development of all the larva markings he investigated is the surest proof that we are dealing with a phenomenon of inheritance. Indeed three laws may be said to be established by these conformities, viz., (1) the development begins with the simple and progresses to the more complicated markings; (2) new markings first appear in the last stage of individual development; (3) these new markings then gradually pass backwards to the earlier stages and thus replace the older ones, causing them to disappear entirely. Weismann gives the following explanation of the phenomenon referred to in the second law:—Supposing that the respective markings are of use to the caterpillars, that therefore they are retained in subsequent generations by natural adaptation, this use can only be real if the caterpillars are big enough to resemble the different parts of the plants on which they feed, and thus escape being noticed by their enemies; and if a sufficient lapse of time is given for carrying this protection into effect. Both these conditions, however, are united in the last stage of development, where the caterpillars have attained the necessary size, and which is the longest of all stages. The use of the colour of caterpillars, and the markings upon them, is also perfectly evident. The younger ones are green as long as during the day they remain on the leaves of the plants they feed on; they do not then form a contrast with the colour of the leaves themselves. The older caterpillars remain green if the thick foliage of the plants protects them under all circumstances; if, however, the foliage is less dense, so that the caterpillars, as soon as they have grown bigger than the leaves, can be easily distinguished among them, they leave the green leaves in the day-time, and try to hide on the stems of the plants and among withered leaves; in that case, to complete the protection, their colour changes from green to brown. The biological value of the characteristic markings upon caterpillars, quite independently of their colour, may be recognised from the fact that

¹ Weismann, "Studien zur Descendenztheorie" ("Researches on the Descent Theory"). Vol. ii. On the last Causes of Transmutations.