February 13 has so generally been ascribed was really responsible for that outbreak, there should have been a series of displays, for this spot was very large and apparently active throughout its transit. As a matter of fact, whatever auroral effect the disturbed region in its vicinity was able to exercise fell about February 2-4 and February 29. Upon the latter date there was a fine display, but upon the former it was generally cloudy.

M. A. VEEDER.

Lyons, N.Y., March 23.

Pilchards.

I WAS very sorry to find from Mr. Dunn's letter (p. 511) that I had not reported his evidence on the occurrence of young pilchards with perfect accuracy. He admits that the misunderstanding was probably not altogether my fault. It seems that in the days before the railway existed in Cornwall, and when seines were largely used at Mevagissey for the capture of pilchards, small pilchards under 8 inches in length, of the same size as French sardines, were often taken in vast numbers, but were either allowed to escape, or used only as manure. The sentence in my article, therefore, which states that Mr. Dunn had never seen such pilchards must be corrected, and I make the correction most willingly, regretting that I should have unconsciously misrepresented Mr. Dunn's statement.

But I must warn your readers against the idea that my article on the growth of the pilchard contained nothing which Mr. Dunn had not discovered and made known years ago. The letter to which he refers in Buckland's "Familiar History of British Fishes" deals with the subject of curing pilchards in oil, and contains nothing whatever about the rate of growth of the fish. It merely mentions that if small fish were wanted they could be had in quantities: "Some seasons their smallness is a pest to the fisher men, and millions have been returned to the sea after being inclosed in the seines, because of being no money value." But Mr. Dunn acknowledges that I correctly reported him as saying that no such small sardines have been taken since the factory at Mevagissey was started, and that no pilchards of the same size as French sardines have ever been tinned in Cornwall. As for his exhibit of a series of pilchards from those an inch in length up to the two years old full-grown fish, I find that it is only catalogued in the Polytechnic Society's Report, and that no dimensions are mentioned, nor any description given. My published evidence on the rate of growth in this species was therefore by no means superfluous, and I am glad to find that my conclusions confirm those which he had already formed, but for which he had sought no satisfactory means of publication. I have often received and acknowledged with the greatest pleasure valuable information from Mr. Dunn: in this instance I was unaware that he had collected any evidence on the subject beyond that which I acknowledged in my article.

But while correcting misunderstandings on my part, Mr. Dunn misunderstands part of my article far more seriously. I stated that the adult sardine of the Atlantic coast of France was of the same size as the full-grown Cornish pilchard, while the sardine of the Mediterranean, taken at Marseilles, was considerably smaller. I did not say that the English pilchard was "larger than those of other countries," and I did not say that the Spanish pilchard was smaller than the Cornish. My "informants" were Prof. Pouchet for France, and Prof. Marion for Marseilles; and the accuracy of their published observations on the mere question of size is not in the least affected by any grave doubts, however much italicized, on Mr. Dunn's part.

Plymouth, April 5.

J. T. CUNNINGHAM.

Ornithology of the Sandwich Islands.

YOUR correspondents, Prof. Newton and J. E. Harting (p. 532), are a little hasty in their conclusions referring to the Banksian collection.

In order to make things clearer, I will go a little further back in the history of this matter.

When the Linnean Society removed from 32 Soho Square, Dr. Brown was left in possession of that portion which had been built upon and used by Sir Joseph Banks as his museum.

Mr. John Calvert, partly out of veneration for the old house where so many men of science had from time to time met together, and partly from want of additional space for his very extensive museum and library, secured a long lease of these premises, including the old museum; so by that arrangement Dr. Brown

became his tenant. Now, it is a well-known fact that a portion of the Banksian collection was never removed from these premises, and remained the property of Dr. Brown, at the death of whom, Mr. J. Calvert arranged with Dr. Bennet (one of his executors), who had been for months removing van-loads of books, herbariums, and other articles of scientific interest, to purchase and take over, with the premises, various cases of birds, sundry articles, and the remainder and refuse of this large collection.

In two cupboards on the south side of the gallery were the ethnological relics collected during the voyage of the *Endeavour*, as well as many manuscripts in the autograph of Sir Joseph Banks, together with some of the catalogues of his collection.

On November 10, 1863, there was a sale at the rooms of Mr. J. C. Stevens by order of the Council of the Linnean Society. We soon detected the case of birds, which marched in every particular the cases that we purchased of Dr. Brown's executor; it had the same handwriting at the back, undoubtedly in the autograph of Sir Joseph. We also detected, in a cabinet of fossils and minerals which had belonged to Dr. Pulteney, one of the volumes of Sir Joseph Banks's catalogue, which matches the other volumes we had previously obtained: that volume still contains the stamp of the Linnean Society.

Lot 174 of this sale was a very large lot in boxes and a cabinet; added to which was a good proportion of the dirt and dust of bygone times. This collection had been formed by Dr. Maton with great care and industry, and contained various figured and type specimens, being all named in the quaint nomenclature of that period. At the bottom of one of the drawers of the cabinet was a letter in the autograph of the great Linnaeus.

We purchased all these, together with others in that sale.

The Duchess of Portland, Sir Ashton Lever, and Sir Joseph Banks, were the great collectors of that period; and the Owhyhee case of birds might have been obtained by Sir Joseph either by purchase or otherwise at any date during his life. We have this case marked Owhyhee in the undoubted autograph of Sir Joseph Banks. The birds are all badly set up, and one has fallen from its perch, but underneath each one is a number which is referred to in one of Sir Joseph's catalogues.

In our Museum there are several thousand specimens which formed portions of the three collections just named, with regard to which we have absolute proof of identification, and in some cases the old lot tickets still remain.

As our museum is densely packed in several houses, and in some instances there are large cabinets four and five rows deep, it is not possible at a few hours' notice to dig out all and everything connected with this matter; but I will at the earliest opportunity bring the Banksian collection to the front, which I shall give a full description of in print, for the satisfaction of all those who are interested in the matter.

As to the collection of eggs of Mr. J. D. Salmon, we knew this collection well, but have never seen it since his death. There is not one single specimen in our museum that belonged to that collection, nor did we ever make a catalogue of the same, as the very exhaustive and elaborate catalogue made by the owner would be amply sufficient for all purposes.

ALBERT F. CALVERT.

63 Patshull Road, N.W.

First Visible Colour of Incandescent Iron.

HAVING read in your number for March 24 (p. 484) a letter on the above subject, I thought it might prove interesting to try a similar experiment with the carbon filament of an ordinary incandescent lamp. That used was an Edison Swan 16 candle-power 80 volt, and the method employed to heat it was to pass a gradually-increasing current (supplied from accumulators), using a water resistance gradually diminished by the addition of very dilute sulphuric acid in sensibly equal portions. The room in which the experiment was performed was very carefully darkened, and the observers were kept in darkness some minutes before the current was switched on, the dilute acid being added, so that, after visibility had been reached, five additions should bring the lamp to dull redness (by diffused daylight. The number of the experiment being called out, each observer wrote this down, together with his impression of the colour, *in the dark*, so that the retina was not affected by any extraneous light throughout. Each observer closely inspected the filament till he felt satisfied as to the colour, and then rested

his eyes in the dark till the next observation. There were twenty-five observers. The result seems worthy of notice.

(1) Of the twenty-five all agree that the colour of the filament is at first very pale. Thirteen call it very pale yellow, three call it white, seven a faint pink, two a bluish white.

(2) All agree that, as the temperature rises, the tint grows deeper and redder, passing through orange *before* reaching crimson. The words used to designate the final tint reached in the experiment vary from deep reddish orange to copper colour, dark red, blood red, crimson.

I may add that some of the observers had had considerable practice in observation, and their eyes were known to be normal so far as the perception of the tints of the visible spectrum is concerned. There is no reason to suppose that more than one, or two at most, possessed any abnormal sense of colour.

Assuming that in the cases of iron and carbon *light of greater frequency of vibration is emitted as the temperature rises, in addition to the light emitted at lower temperatures* (the vibrations causing which are merely increased in *amplitude*), is it not possible (1) that the *selective* power of the pigments of the retina at first scarcely comes into play, the slower vibrations acting on all to a certain extent, on the red more than the green, and the green more than the violet, in the normal eye? or (2) Does not the fact that all colours are more difficult to distinguish in a faint light, *e.g.* moonlight, make it likely that very weak irritation of *any part* of the retina (I mean a part which causes the sensation of light, and that coloured, when the irritation is stronger) is perceived as "light," the indication of specific absorption not being strong enough in comparison with the total amount of irritation to produce the sensation of any special colour in the light perceived? or lastly, if we do not make the above assumption, it would seem that iron and carbon at all events emit, when first visible, light of far wider limits of frequency of vibration than, so far as I know, is generally admitted.

Some photographic experiments which I hope may throw fresh light on the subject have been begun.

Eton College Laboratory, April 4.

T. C. PORTER.

Self-Registering Weather-cock.

I SHOULD be grateful if any of your readers would kindly recommend me a simple, inexpensive instrument, to automatically register the movements of a weather-cock above the roof.

Such an appliance must roughly indicate the direction of the wind at the time being.

Some years ago, a London builder put me up a very expensive instrument, which, beyond making considerable noise, was utterly useless.

J. LAWRENCE-HAMILTON.

30 Sussex Square, Brighton, April 11.

THE ROLLING OF SHIPS.

ONE fact that often strikes the thoughtful traveller by sea is that, notwithstanding the great and numerous improvements of recent years which have made life on shipboard pleasant and luxurious, little or nothing has been done to steady a vessel when she meets with waves that set her rolling heavily from side to side. The tendency seems to be rather in the direction of increased than of diminished rolling; for the steadying influence of sails, which makes the motion so easy and agreeable in a sailing ship, is fast disappearing in large steamers. Masts and sails add appreciably to the resistance of large fast steamers; so they have been cut down in size year by year till such fragments of sail as still remain are so small compared with the size of the ship as to retain little power to reduce rolling.

Shipowners and seamen do not show much sympathy with the discomfort and misery that rolling causes to most passengers. They perhaps get anxious about an occasional vessel that acquires the evil reputation of being a bad roller, because passengers may be frightened away and the receipts fall off in consequence; but beyond wishing, or attempting, to deal with abnormal cases, nothing seems to be thought of. Rolling is considered incurable, or as not of sufficient importance to trouble

about. Yet there is nothing which would contribute so directly to the comfort of landsmen at sea, or do so much to change what is for many misery and torture into comfort, as to check and reduce as far as possible the rolling proclivities of ships.

The laws which govern rolling are now well understood, and it is strange that this knowledge has not enabled an effective means of control to be devised. What is stranger still is that well-known means of mitigating rolling—such as the use of bilge keels—are employed in but very few cases. A ship rolls about a longitudinal axis which is approximately at her centre of gravity, and the rolling is practically isochronous at moderate angles in ordinary ships. The heaviest rolling occurs when the wave-period synchronizes with the natural period of oscillation of the ship. Many vessels are comparatively free from rolling till they meet waves of this period, and if such meeting could be avoided, excessive rolling could be prevented. Some vessels have periods as long as fifteen to eighteen seconds for the double oscillation, and as these would require to meet with waves 1300 to 1500 feet in length, in order to furnish the conditions of synchronism, it is seldom that they suffer from heavy or cumulative rolling. Such waves are, however, not rare in the Atlantic.

The limits of heavy rolling are fixed, of course, by the resistance offered by the water and air to the transverse rotation of the ship, which is very great because of the large areas that directly oppose motion in a transverse direction. But for this resistance, and the condition that rolling is only isochronous within moderate angles of inclination, a few waves of the same period as that of a ship would capsize her.

The two most obvious modes of preventing heavy rolling are, therefore, (1) to make the period of rolling of a ship as long as possible, so as to reduce the chances of meeting waves whose period will synchronize with it, and (2) to increase the resistance to rolling. The period of a ship varies directly as her radius of gyration, and inversely as the square root of her metacentric height. Hence the period may be increased by increasing the moment of inertia of the ship, or by decreasing the metacentric height. In armoured war-vessels the moment of inertia is large, on account of the heavy weights of armour on the sides, and the heavy guns that are either placed at the side or high up above the centre of gravity. Ordinary steamers have no such weights concentrated at great distances from the centre of gravity, and their moments of inertia are determined by the distribution of material in the hull that is fixed by structural conditions and by the stowage required for their voyages. Metacentric height cannot be reduced below a certain amount, which is necessary to prevent too easy inclination of the ship, or crankness, in still water. On the whole, we may regard the longest periods that the largest ships are likely to have with advantage to be about those named above, *i.e.* fifteen to eighteen seconds.

Length of period cannot give immunity against occasional heavy rolling; but increase of resistance reduces the angles of roll at all times, and especially when the angular velocity is greatest and the rolling is worst. Such resistance is furnished by the frictional resistance of the bottom of a ship and by the direct resistance of projecting parts of the bottom, such as the keel and the large flat surfaces below at the stem and stern. This resistance can be largely increased by means of bilge keels. The value of bilge keels is recognized in the Royal Navy, and the ships of the Navy have been fitted with them for many years with highly beneficial results. The advantage of bilge keels was proved beyond all doubt many years ago by careful experiments made in this country and in France; and the late Mr. Wm. Froude showed, by the trials he made of H.M.S. *Greyhound*