Dictionary," and is assigned to the year 1660:—"To take the opposite course and to provide our remedy *antiparallel* to their disease." Here it seems intended to convey the idea of "parallel and in the opposite sense."

In Barlow's "Mathematical Dictionary" (1814), the modern meaning is given, and the old error as to the ratios of the segments of the sides of the triangle is pointed out.

In Rees's "Cyclopædia" (1819) the modern meaning is given, but a remark is added that Leibnitz used the word in the sense explained above; as no reference is given, we cannot tell whether the writer meant that he habitually used it or only in the article on the catenary.

E. M. LANGLEY.

Bedford.

A Surviving Tasmanian Aborigine.

IN your issue of November 14 (p. 43), you refer to the paper read by Mr. James Barnard before the Royal Society of Tasmania on a Mrs. Fanny Cochrane Smith, who lays claim to be the last surviving aboriginal Tasmanian. Since your note appeared, I have read a report of the paper published in the *Hobart Mercury* of September 10 last, and think my view on the claim may be of some interest to your readers.

Mr. Barnard states that he knew Mrs. Smith forty years ago when she was seventeen years of age, and that during the period which elapsed since then until she called upon him shortly before he wrote his paper, he had not known of her whereabouts. In favour of the claim I can only find that she has, with apparently one exception, always been referred to officially as a pure-bred aborigine, and that Parliament appears to have voted her grants on two occasions (in 1882 and in 1884) on account of her unique position.

The objections to the claim may be briefly summarized as follows:—

(1) From the meagre account given, it appears her hair and complexion are both that of half-castes, and we are not supplied with any other description of her features or stature or peculiarities so as to be able to judge on the question.

(2) Beyond the mere statement as to mutual recognition no evidence is given that the claimant is the same girl Mr. Barnard knew forty years ago at Oyster Cove, nor, indeed, is there anything to show that this woman is the child, or one of the children, referred to by Lieut. Friend in controverting Count Strzelecki's well-known views, which *quasi* fact forms the foundation for the claim.

(3) The woman herself is reported to have no recollection of witnessing, at the age of thirteen, a document sufficiently important to have impressed itself on her memory, and it is somewhat strange that this very document is said to describe her as a half-caste.

It would, no doubt, be interesting were it to be eventually proved that this woman Fanny is a pure-bred aborigine, but for the present Truganina must be considered the last survivor of her race.

HY. LING ROTH.

Lightcliffe, November 23.

Brilliant Meteors.

THE brilliant meteor seen at Warwick School and in Cumberland I saw at Folkestone on November 4 a little before 8. It was travelling slowly from north-west to north, about 30° above, and parallel with, the horizon. After travelling some distance it appeared to partly explode, and then went a little farther and burst. At first it was a beautiful green colour, but after it had partly burst it was nearly white. I imagined its colour was through the haze there was in the sky. From what I saw I am certain it would have been a splendid sight had the atmosphere been clear.

P. A. HARRIS.

Inchulva, Maidstone, November 27.

LAST night, in clouded moonlight, whilst walking here from Newton by the road over Little Dunnow, my attention was arrested by the glare of what must have been a very bright meteor, seen through clouds which formed a general covering. The quarter in which the light appeared was east by north, at an elevation of about 25°, and it lasted a second and a half. There appeared to be three centres of illumination, but these may have been only thinner portions of the clouds. The time, as nearly as I could get it by comparing my watch by telegraph at the village post office this morning, was 22h. 48m. 45s.

Slaidburn, Clitheroe, December 2. R. H. TIDDEMAN.

REPORT ON THE MAGNETICAL RESULTS OF THE VOYAGE OF H.M.S. "CHALLENGER."

IT will be remembered by readers of the "Narrative of the Voyage of H.M.S. *Challenger*," that Vol. II., published in 1882, contained a report of the magnetic observations made in that vessel in considerable detail. It has, however, been reserved to the present year for a full discussion of the *Challenger* observations and their bearing on our existing knowledge of terrestrial magnetism to be made, and the following is an abstract of the final Report about to be published in Vol. II., "Physics and Chemistry of the Voyage of H.M.S. *Challenger*."

The method of representing the values of the magnetic elements by curves of equal value has, since 1700, when Halley published his map of the declination, found general favour; for in succeeding years we find Mountain and Dodson, Churchman, Yeates, and Barlow, also published maps of the same magnetic element.

In 1819, Hansteen added maps of inclination to the declination for certain epochs, and in 1826 produced a chart of isodynamic lines, revised in 1832.

Following Hansteen, there appeared, in 1840, Gauss and Weber's atlas, the result of calculations from about eighty-four observations distributed over the world, presenting a remarkable approach to the truth, even when viewed in the light of our comparatively extended knowledge of the earth's magnetism in the present day. It may be observed that, if only a fresh magnetic survey of the regions south of 40° S. latitude were now made, a recalculation of the Gaussian constants might be undertaken promising important results.

Between 1868 and 1876 Sir E. Sabine's "Contributions to Magnetism" were read before the Royal Society, forming a series of papers on the magnetic survey of the globe for the epoch 1842.5. Although the maps accompanying these contributions serve as a point of departure for comparison with subsequent maps, an examination of them shows that in Africa and the North and South Pacific Oceans there were large blanks from want of observations.

There remained, therefore, a large field for observation, and it will now be shown how largely the *Challenger* Expedition contributed to the filling up of these blanks, and added to our knowledge of the changes going on in the magnetic elements in places visited by previous observers.

The whole of the magnetical results have been embodied with others from every available source in four charts¹ of the magnetic elements, for the epoch 1880, which may prove acceptable to magneticians desirous of noting the changes in the magnetic elements since 1842.5.

The *Challenger* was not an ideal ship in which to conduct magnetic observations at sea, for she was seldom at rest from pitching and rolling, and although the errors in the observations caused by the horizontal component of the ship's magnetism were moderate, and could be eliminated by "swinging" the ship, those proceeding from the vertical component were large, and necessitated a frequent comparison with normal values on land. But by discussing fully a series of observations made in numerous places in both hemispheres where no trace of local magnetic disturbance could be found, the magnetic condition of the ship was readily determined for any period of the voyage. As a consequence of this, normal values of the magnetic elements could be obtained in the neighbourhood of places known or suspected of being affected by local magnetic disturbance, and the amount of such disturbance measured with considerable accuracy.

This method of detecting local magnetic disturbance,

¹ Note published with the "Report of the Scientific Results of the Voyage of H.M.S. *Challenger*," Physics and Chemistry, Vol. II., Part VI.

was applied to the solitary islands of the ocean visited by the *Challenger*, and the following are some of the principal results.

At Madeira there was a difference of $7\frac{1}{2}^\circ$ in the observed inclination between observations made at 1 foot and $3\frac{1}{2}$ above the ground; and at Santa Cruz, Tenerife, the inclination was $2\frac{1}{2}^\circ$ in excess of the normal observed in the ship.

It was at Bermuda, however, that the most remarkable results were obtained. For some years previously, observers in different parts of the group had obtained very different values of the declination, and our men-of-war when swinging for deviations of the compass had found constant errors for every direction of the ship's head which were peculiar to Bermuda. It could only, therefore, be by a properly equipped expedition like that of the *Challenger*, and systematic observation, that the immediate cause of all this local magnetic disturbance could be traced.

For this purpose the declination was observed at seventeen stations, the inclination at ten, and the intensity at seven. Combining these observations with others made by previous observers, it was found that between the Governor's house at Mount Langton and the lighthouse on Gibb's Hill, there is a disturbing magnetic focus attracting the north-seeking end of the needle with a force considerably in excess of that due to the position of Bermuda on the earth considered as a magnet. The normal values of the magnetic elements were obtained by swinging the ship at sea $15'$ south of the green outside the dockyard. The difference between the observed declination at Clarence Cove and Barge Island was $5^\circ 44'$. The greatest difference in the inclination was $1^\circ 47'$, and in the vertical force $+0.314$ (Brit. units).

Local magnetic disturbances were also noted at St. Vincent, Cape de Verde Islands, Tristan d'Acunha, Kerguelen Island, Sandwich Islands, Juan Fernandez, and Ascension, but not at St. Paul Rocks.

By applying the same method of obtaining normal values at sea, and observing on other adjacent solitary islands such as St. Helena, similar effects result, and the following general conclusions seem to be supported by fact with regard to local magnetic disturbance:—

(1) That in islands north of the magnetic equator, the north-seeking end of the needle is generally attracted vertically downwards, and horizontally towards the higher parts of the land; (2) south of the magnetic equator the opposite effects are observed, the north-seeking end of the needle being repelled: in both cases by an amount above that due to the position of the island on the earth considered as a magnet.

Interesting as these conclusions may possibly be from a scientific point of view, they are of real importance in practical navigation. Navigators have asserted that their compasses were disturbed when passing the land in certain parts of the world. We learn from the *Challenger* observations that within 5 feet from the soil the greatest magnetic disturbance did not exceed 3° in the declination and $2\frac{1}{2}^\circ$ in the inclination. Remembering the law of magnetic attraction and repulsion, it is impossible that a compass in such case could be disturbed in a vessel passing the land at the ordinary distance. In point of fact, it has been shown that it is to submerged magnetic land comparatively near the ship's bottom that the disturbance of the compass is due. The remarkable instance at Cossack in North-West Australia may be cited in support of this conclusion. Thus in H.M.S. *Meda*, sailing on a line of transit of two objects on land for a quarter of an hour in 8 fathoms of water, it was found that the compass was steadily deflected 30° , no visible land being nearer than 3 miles.

Great as the gain must be to the navigator to be thus warned of a formidable danger in certain places, it also lays upon him the important duty of being on his guard

against similar disturbances elsewhere, reporting any new discoveries as he would a rock or shoal.

Large as was the *Challenger's* contribution to the magnetic charts for 1880, it will be readily understood that it required considerable reinforcement from other sources, as their construction was dependent on observation alone. Every available observation between the years 1865–87 was utilized. Beyond the published sources of information on this subject may be mentioned the observations made on the east coast of Africa by the officers of H.M.S. *Nassau* in 1874–76, and on the west coast of Australia in 1885–86 by H.M.S. *Meda*. Also the sea observations between Australia and Cape Horn of the declination in H.M.S.S. *Esk*, *Pearl*, and *Thalia*, between 1867–87, not forgetting those of the New Zealand Shipping Company's vessels in 1885–86.

To combine this twenty years' observation usefully, a somewhat extended knowledge of the distribution and amount of secular change became a necessity. Generally speaking, it is only at fixed observatories that this element of terrestrial magnetism is known with precision, for, as already shown, observations a few feet apart often give very different results. In the more frequented parts of the earth this secular change is approximately known, especially in the United States, where valuable work has been accomplished.

One great object of the voyage of the *Challenger* was to visit certain unfrequented positions where previous observers had been, rather than the beaten tracks. Thus Ross's position of 1840 on St. Paul Rocks was visited, and the secular change during thirty-three years obtained. Then Tristan d'Acunha, an important station situated in mid-ocean, rarely visited for magnetic purposes. At Kerguelen Island, another of Ross's positions, observations of all three principal magnetic elements were made, and the secular change found approximately.

In the Indian Ocean generally, north of 30° S., the secular change of the declination rarely exceeds $1'$ annually, but at Kerguelen Island the westerly declination is increasing at least $5'$ annually.

It was, however, from two positions on the homeward voyage that the most novel and remarkable values of the secular change were obtained—Sandy Point, Magellan Straits, and the Island of Ascension, with its adjacent waters.

At Sandy Point, with the horizontal force nearly stationary, and the declination decreasing $3'$ annually, it was hardly suspected until 1876, when the *Challenger* visited the place, that the inclination was apparently changing $11'$ annually. Comparing the *Challenger's* results by swinging near the Island of Ascension with Sabine of 1842.5, the following values of the secular change are obtained: declination increasing $8'$ annually; south inclination increasing $14'$.

From these results the notable fact is made evident, that the north-seeking end of the needle is found to be moving in opposite directions, downwards at Sandy Point, and more strongly upwards at Ascension. Extending the inquiry into the surrounding seas and countries, it was found that these opposite movements of the needle were not confined to the spots where they were discovered.

The author of this Report, after having discussed his collection of a large number of observations of the magnetic elements for all parts of the world—in many cases extending over several years—obtained approximate values of their secular change for the epoch 1840–80.

These several values were weighted according to their relative accuracy, and entered on maps against the places of observation. Lines of equal value were then drawn for each element, and the following general results obtained with regard to the movements of the north-seeking end of the needle.

1. *Declination*.—The principal lines of little or no change were found to take the course from St. John's,

Newfoundland, to the West Coast of Africa, near Cape de Verde, emerging near Cape Palmas, and then to Cape Town; thence curving upwards near Mauritius, downwards south of Cape Leeuwin, again upwards through Adelaide and Cape York to the vicinity of Hong Kong. A second line passed from Sitka through the western portion of the continent of North America, striking South America near Callao, then following the trend of the coast to a point near the western entrance to Magellan Strait.

The foci of maximum value of change were found: (1) between Scotland and Norway, change about 9' annually, needle moving eastward; (2) on the east coast of Brazil, needle moving westward about 8'. Minor foci were also found: one near Kerguelen Island, the other in the South Pacific. Another focus apparently exists in Alaska. The general tendency was for the values of the change to decrease gradually from the foci to lines of no change.

2. *Inclination*.—Similarly to that of the declination, there are lines of no change, two principal foci of maximum secular change, but only one minor focus. The lines of no change are not so clearly defined as those for the declination, data being still wanting. The principal foci of maximum change in the inclination were found: (1) near the Gulf of Guinea, between Ascension and St. Thomé, which may be called the Guinea focus. Here the north-seeking end of the needle was moving *upwards* about 15' annually. (2) in the latitude of Cape Horn, and about 80° W. long. This may be called the Cape Horn focus, and the annual change was 11', needle being drawn *downwards*. It must be distinctly understood that both the positions and values of the change are only approximate, and only the general features in the angular movement of the freely suspended needle are to be accepted, as clearly shown by this investigation.

3. *Magnetic Intensity*.—In the horizontal force, the annual change (B.U.) was about -0.002 near Cape Horn, whilst between Valparaiso and Monte Video the focus of greatest change was about -0.017. Again, on the west coast of Portugal a focus of +0.009 (B.U.) occurred.

Turning to the vertical component of the earth's intensity, some remarkable results were observed. At the Cape Horn focus an annual change of 0.055 (B.U.) was found in the vertical force, the north-seeking end of the needle being drawn *downwards*, the change diminishing in value until the zero line extending from Callao across the American continent to the west coast between Bahia and Rio de Janeiro, and then taking a southeasterly course north of Tristan d'Acunha, was reached. Northward and eastward of this zero line there were found increasing values in the annual change in the *upward* vertical force acting on the north-seeking end of the needle until the Guinea focus was reached, where its full value was increasing 0.025 annually. From the Guinea focus to Northern Europe, Asia, and the Atlantic seaboard the change gradually decreased in amount. There were signs of minor movements in the north-seeking end of the needle in China, Mexico, and the United States.

One of the chief factors in the compilation of the previously mentioned maps of the three elements for the epoch 1880 were the observations taken in the *Challenger*, and these were reduced to the common epoch by means of the investigation of annual change to which reference has just been made.

It may be truly said that the *Challenger's* track was studded with magnetic observations. After successfully traversing the Atlantic Oceans in varying directions, the three magnetic elements were obtained by swinging, in probably the most southerly position since the days of Ross in the *Erebus* and *Terror*, in lat. 63° 30' S., and long. 90° 47' E. But the most valuable part of the contributions to terrestrial magnetism obtained in the *Challenger* were the observations made in the North and

South Pacific. The route lay from Wellington, N.Z., to Tongatabu, and Fiji, from the Admiralty Islands to Japan, and thence in mid-ocean from nearly 40° N., through the Sandwich Islands and Tahiti to 40° S., nearly at right angles to the curves of equal magnetic inclination.

During the voyage much experience was gained as to the usefulness of the Fox circle as an instrument for use on board ship at sea, the general result being that valuable work may be done with it if frequently compared with the absolute instruments on land, and the instrument mounted on a gimbal stand prepared to withstand the vibrations caused by the engines of the vessel.

Although on the general question of the secular change of the magnetic elements much has been already written in this Report, there yet remain some important points which demand further discussion.

As to the causes of the secular change various hypotheses have been advanced. Thus in the early part of the last century, Halley considered the change was chiefly caused by a terella with two poles or foci of intensity rotating within and independently of the outer shell of the earth, which also possessed two foci of intensity, the axes of the two globes being inclined one to the other but having a common centre.

Again, Hansteen at the beginning of the present century concluded that there are four poles of attraction, and computed both the geographical positions and the probable period of the revolution of this dual system of poles or points of attraction round the terrestrial pole.

In later years Sabine considered the secular change to be caused by the progressive translation of the point of attraction at present in Northern Siberia, this point of attraction resulting from cosmical action. Walker also agreed with Sabine as to the cosmical origin of the change.

Later still, Balfour Stewart gave reasons for attributing the secular variation to the result of solar influence of a cumulative nature.

Keeping in view these hypotheses, and recalling the chief results of observation during recent years, how do they accord?

Observation generally points to the fixity of the magnetic poles—or two limited areas where the needle is vertical—in respect to the geographical poles. Again, in Siberia there is little or no apparent translation of the greatest point of attraction in that region, and the North American focus of intensity is probably at rest.

Thus the results of observation in recent years are not favourable to hypotheses founded on the translation of the poles or foci of magnetic intensity.

Let the terms blue and red magnetism be adopted, and the movements of the red, or north-seeking, end of the needle alone be considered.

The question arises, What have recent observations offered us instead? They tell us that near a line drawn from the North Cape of Norway across the Atlantic to Cape Horn lie some of the foci of greatest known secular change. It was also found that at the Cape Horn focus of vertical force the needle was moving downwards, or there was the equivalent to a blue pole of increasing power of attraction, the freely suspended needle being attracted towards it over an extended region around. At the Guinea focus there was the equivalent to a red pole of increasing power of repulsion, the freely suspended needle being repelled over an extended region of undefined limits. The action of these two poles apparently combine to produce a focus of considerable angular movement in the horizontal needle near Brazil.

In China there is a minor blue pole of increasing power attracting the needle over a large area.

With apparently small secular changes in Siberia, and the horizontal needle moving somewhat rapidly to the eastward at the focus of change in the declination in the German Ocean, and similarly to the westward in Alaska,

analogy points to the probability of there being a decrease in the vertical force in the high latitudes of North America, or the equivalent to a red pole of increasing power repelling the needle for a large area around it.

The variations in the vertical force at and about these poles or foci of attraction and repulsion at different epochs are not yet sufficiently determined, but if the hypothesis of translation be given up, it is not unreasonable to suppose that the secular changes in the declination and inclination are chiefly dependent upon changes in the relative power of these poles.

No satisfactory explanation has yet been given of the remarkable changes in the earth's magnetic force as measured on its surface, and suggestions are only possible in the present instance.

The voyage of the *Challenger* has shown that local magnetic disturbance is found in the solitary islands of the sea, although surrounded by apparently normal conditions, similar to that on the great continents. It has also been suggested that the magnetic portions of these islands causing the disturbance may possibly "have been raised to the earth's surface from the magnetized portion of the earth forming the source of magnetism," and tending to prove Airy's conclusion "that the source of magnetism lies deep."

In view, therefore, of past geological changes and those now in progress, it may fairly be conceived, not only that large changes have likewise occurred in the distribution of the magnetic portions of the earth appearing here and there on the surface and producing local magnetic disturbance, but that there are others of a more progressive character below the earth's surface which are only made manifest by the secular change observed in the magnetic elements. This conception with regard to secular change is not intended to exclude the view that solar influences may have a small share in producing the observed phenomena.

In conclusion, it may be remarked that they who would fully see the substantial gains to terrestrial magnetism which have been obtained by the voyage of the *Challenger* must refer to the original of this abstract Report, with its plates and charts of the magnetic elements. Subsequent research may add to, qualify, or reverse the conclusions drawn from the observations, but the observations will probably retain a long-abiding value to magneticians.

E. W. CREAK.

ON THE SUPPOSED ENORMOUS SHOWERS OF METEORITES IN THE DESERT OF ATACAMA.

IT is now universally acknowledged both that meteorites come from outer space and that shooting-stars, whatever they are, have an extra-terrestrial origin. It is further asserted that a meteoritic fireball and a shooting-star are only varieties of one phenomenon. Indeed, after it is once granted that a meteoritic fireball is produced by the passage through the terrestrial atmosphere of a dense body entering it with planetary velocity from without, and that shooting-stars have an extra-terrestrial origin, it is a very fair assumption that a shooting-star is likewise a dense body rendered luminous during its atmospheric flight.

One great objection to this assertion is that, again and again, showers of hundreds of thousands of shooting-stars have taken place, during which no heavy body has been observed to reach the earth's surface. The only known case of the arrival of a meteorite during a shooting-star shower has been that of Mazapil, on November 27, 1885, and that single coincidence may possibly be the result of accident. A sufficient explanation of this difficulty, however, is to be found in the small size of the individuals which produce the appearance of a shooting-

star shower. That the individuals are really minute is proved by the fact that, while the total mass of a large swarm, like that producing the November meteors, is so small that there is no perceptible influence on the motion of the planets, the number of separate individuals is almost infinite. It is established that the Leonid swarm must be hundreds of millions of miles in length, and some hundreds of thousands of miles in thickness; and in the densest part of the Bielid swarm, passed through in 1885, the average distance of the individuals from each other was about twenty miles.

Further, it is now acknowledged that comets are themselves meteoritic swarms, and Mr. Lockyer has lately brought forward spectroscopic evidence that the fixed stars and the nebulae are similar to comets in their constitution.

The question therefore immediately presents itself, Is the size of a meteoritic shower, on reaching the earth's surface, ever comparable with that of a meteoritic swarm, as manifested by a shower of shooting-stars?

During the present century nearly 300 meteoritic falls on the earth's surface have been observed, and on only a single date, namely August 25, 1865, has there been observed a fall on two distant parts of the earth on the same day. On that date stones fell at Aumale in Algeria, and at Sherghotty in India; but as the times of fall differed by about eight hours, and the stones arrived from different directions, it is more than probable that the coincidence of date was accidental. Hence we must infer that a swarm of meteorites, as far as actual observation of tangible objects goes, far from being hundreds of millions of miles long, with individuals a few miles apart, is a comparatively small group, separated from its neighbours, if it has any, by a distance comparable with the earth's diameter.

The extent of surface over which meteoric stones have been picked up after some of the best known and most widely spread falls is given in the following list:—

Limerick, 3 miles long.
Mocs, 3 miles by 0.6 mile.
Butsura, 3 miles by 2 miles.
Pultusk, 5 miles by 1 mile.
L'Aigle, 6 miles by 2.5 miles.
Barbotan, 6 miles long.
West Liberty, 7 miles by 4 miles.
Stannern, 8 miles by 3 miles.
Knyahinya, 9 miles by 3 miles.
Weston, 10 miles long.
Hessle, 10 miles by 3 miles.
New Concord, 10 miles by 3 miles.
Castalia, 10 miles by 3 miles.
Khairpur, 16 miles by 3 miles.

As far as I have yet been able to ascertain, the greatest observed separation has been sixteen miles. In the case of Macao, Cold Bokkeveldt, and Pillistfer, wider spreads have been chronicled, but later information has shown the inaccuracy of the earlier statements.

As regards the meteoric irons, there have only been nine observed falls since the year 1751: in seven of them only a single mass was found; in the remaining two there was in each case a couple of masses, not more than a mile apart. There is thus no recorded instance of an observed shower of meteoric iron. The most convincing proof of the actuality of such showers is furnished by the masses which have been found in the Valley of Toluca, in Mexico; their existence had been chronicled as early as the year 1784, yet in 1856 it was still possible to collect as many as sixty-nine. When etched, they show the Widmanstätten figures in the most excellent way, and in their characters they are typical meteorites. Belonging, as they do, to a single type, they lead to the conviction that they are the result of a single shower. But the region over which the fall took place is not large; the