Brewster, they may be recommended to study his original paper (*Phil. Trans.*, 1814, p. 397), when they will see that such a reading of it is both incorrect and incomplete.

F. A. BATHER.

Natural History Museum, October 28.

THE STAR SHOWERS OF NOVEMBER.

WELL may Mr. Greg, in his catalogue of meteoric radiants, published in 1876, affix a remark indicating the all-surpassing character of the mid-November meteors. For if there is one star shower more striking than all the rest, it is assuredly the Leonids. Every one who has seen the phenomenon at its best, is prepared to admit that it furnishes a grander spectacle than any other system, and will have realised that, once seen, it impresses itself indelibly upon the memory. There can be very few people living now who witnessed the great shower in America on the morning of November 14, 1833, but there are many Englishmen who vividly remember the fine but less splendid exhibition of 1866. With a swiftness unsurpassed among meteor streams, and with a brilliancy quite their own, the Leonids belong to the most striking class of these bodies, and offer a great distinction to the slow and gentle flights of the Andromedes, or meteors of Biela's comet which present themselves about a fortnight later. It is true the Leonids are only manifested, in vast abundance, once in a generation, and that, considered as an annual display, they usually fall below the strength of the August Perseids. But, considering all things, the November shower is undoubtedly entitled to precedence. The writer saw the Leonids in 1866, he also observed the rich displays of Andromedes in 1872 and 1885, and has been fortunate enough to witness many bright returns of the Perseids and of other prominent systems; but, of all such spectacles, one only, by its surpassing splendour, created an impression which still lives fresh in the memory, and that was the Leonids of November 1866.

The similar display which occurred in 1833, may be regarded as a very auspicious event, since it attracted attention to an important branch of astronomy which had been systematically neglected. Men began to seriously regard a phenomenon capable of giving such a remarkable sky picture, and the facts relating to it were collected and discussed. But the meteor showers of 1833 and 1799 were understood to be very exceptional events, and they had not been observed with that attentive regard to details which is so essential in this class of observation. Astronomers, however, were led to suppose that historical records might contain references to similar phenomena witnessed in ancient times, and Herrick, Quetelet, Arago and others, on consulting old works, found a number of descriptions of star-showers preceding that of 1799, and obviously of the same character. These occurred in 902, 931, 934, 1002, 1101, 1202, 1366, 1533, 1602, and 1698. A list of the dates was given by Prof. Newton in the *American Journal of Science* for May 1864, and he found, on comparing the intervals separating the various returns, that these brilliant meteoric apparitions visited us four times in every 133 years. The descriptions of them were quaint and imperfect, and of little scientific value apart from affording an important clue as to the period of the swarm; but it may be interesting to quote from a few of them. In October 902, a vast concourse of falling stars were scattered over the sky as thick as rain. On October 19, 1202, "stars shot hither and thither in the heavens eastward and westward, and flew against one another like a swarm of locusts; this phenomenon lasted until day-break; people were thrown into consternation and cried to God the Most High with confused clamour." A Portuguese chronicle thus refers to the shower of 1366: "Twenty-two days of the month of October being past, three months before the death of the king Don Pedro of Portugal, there was in the heavens a movement of the stars such as men never before saw or heard of. At midnight, and for some time after, all the stars moved from the east to the west, and after being collected together they began to move, some in one direction, and others in another. And afterwards they fell from the sky in such numbers and so thickly together that as they descended low in the air they seemed large and fiery, and the sky and air seemed to be in flames, and even the earth appeared as if ready to take fire." Coming down to modern displays, Humboldt saw thousands of bolides and falling stars succeed each other during four hours on the morning of November 13, 1799. The phenomenon returned in 1831 and following years, and the facts may be referred to seriatim:—

1831 November 13 a.m. An account of this shower was given to M. Arago by one of the officers of the French brig *Loiret*, as follows: "The sky being perfectly cloudless, and a copious dew falling, we have seen a number of shooting stars and luminous meteors of great dimensions. During upwards of three hours two per minute were seen. One of these meteors which appeared in the zenith left an immense train from east to west, like a luminous band, and the light it gave did not disappear for six minutes."

1832 November 13 a.m. Capt. Hammond, of the ship *Restitution*, then in the Red Sea, off Mocha, says: "From 1 a.m. until daylight there was a very unusual phenomenon in the heavens. It appeared like meteors bursting in every direction. On landing in the morning I inquired of the Arabs if they had noticed the above. They said they had been observing it most of the night, but had never seen the like before."

1833 November 13 a.m. The phenomenon continued during seven hours. At Boston the number of meteors was considered to equal one-half of the flakes which filled the air in an ordinary fall of snow. The number visible was estimated as upwards of 240,000. Another observer stated that between 4 and 6 a.m. about 1000 meteors per minute might have been counted.

1834 November 13 a.m. A large number of shooting stars seen in the United States.

1835 and 1836. Many meteors observed on same date. In the latter year, on November 13 a.m., an immense number of meteors made their appearance between midnight and daylight, but the display did not equal the shower of 1833.

1864 November 13 a.m. An observer on board the steamship *Ellora*, off Malta, wrote on November 14 as follows: "There was a grand display of meteors from midnight to 4h. a.m., all through the watch, the night before last. The watch, an old 'salt' and an intelligent man, said that it was the grandest shower he had ever seen." None were visible on the morning of November 14.

1865 November 13 a.m. Between 1h. and 5h. a.m. 279 meteors were seen by six observers at Greenwich, and it was computed that the total number visible during that period must have been fully 1000. Prof. Herschel noted 71 meteors between midnight and 3 a.m. At Cambridge University 98 meteors were observed between midnight and 2 a.m.

1866 November 14 a.m. 8485 meteors were counted by several observers at Greenwich. Mr. Wood, at Birmingham, estimated that between 1h. and 1h. 30m. a.m. meteors appeared at the rate of 3600 per hour. The maximum occurred at about 1h. 10m. a.m. when Dr. Burder, of Bristol, counted 80 per minute. From the combined observations of several persons looking in different directions, Mr. Lawton, of Hull, made the number of meteors to have been 144 per minute for nineteen minutes from 12h. 58m. to 1h. 17m. a.m.

1867 November 14 a.m. Weather generally unfavourable in England. At St. George, Grenada, there "was observed before day-break a shower of luminous meteors flying about in every direction and of every conceivable magnitude." At the University Observatory, Toronto, four observers counted 2287 meteors between midnight and 6 a.m. Of these 1345 were seen during the hour from 4 to 5 a.m.

1868 November 14 a.m. Many meteors seen in England, but the sky much overcast. At Rome, Secchi reported that 2204 meteors were counted between 2.30 a.m. and 5.45 a.m. At Toronto, Canada, 2886 meteors appeared between November 13 10h. 45m. p.m. and November 14 5h. a.m.

1869 November 14 a.m. Lieut.-Colonel Tupman, at Port Saïd, Lower Egypt, counted 136 meteors between 2.30 and 5h. 14m. a.m., and they were nearly all Leonids. At Santa Barbara, California, 556 meteors were noted by two observers in 2h. 25m. before 3h. 43m. a.m.

In 1870 moonlight partly interfered, but it was evident the meteor shower had lost its conspicuous character—a fact fully confirmed by observations in 1871. But it had not entirely disappeared, for in the years mentioned, and in those which succeeded, the middle of November always brought some of the swift streak-leaving meteors from the well-known radiant in the sickle of Leo.

In 1879 and 1888, on the morning of November 14, very distinct showers of Leonids were observed by the writer at Bristol, and in many other years they were also visible. Mr. Corder, at Bridgwater, saw a few Leonids in 1892, and, in 1893, Prof. Barnard, in California, described them as far more abundant than he had ever seen them before. Many very brilliant ones were seen, and they were especially plentiful on the mornings of November 13, 14 and 15. In 1894 moonlight interfered with observations.

This meteor system evidently forms a complete ellipse, for there seems no reason to doubt that it returns annually without a break. Even in parts of the orbit very far removed from the dense cluster, which seems identical with Tempel's comet (I. 1866), the meteoric particles appear to be pretty numerously distributed, for there were fairly active displays in 1879 and 1888. It is true the shower has not been observed every year, but there is good reason to assume its annual recurrence, and that it would be seen were the nocturnal sky free from clouds and moonlight just at the critical time.

One of the most important features of a meteor shower is that the flights are directed from a common centre, and no observation of such a shower can be regarded as complete unless the radiant point has been determined. The writer has generally found the radiant of the Leonids very sharply defined, and it admits of being accurately detected even by observers who are inexperienced, for the meteors leave luminous streaks, and these, lingering for one or two seconds, enable the directions to be correctly registered. The Leonid radiant has been frequently obtained, and the following are some of the values given by different observers in various years.

1833	November 13 a.m.	148°	+24°	Aiken.
,,	,, ,, ...	150	+20	Olmsted.
1836	,, ,, ...	150	+20	G.O.S. New York.
1865	,, ,, ...	148	+23	A. S. Herschel.
,,	,, ,, ...	148	+23	Newton.
,,	,, ,, ...	148	+24	Marsh.
1866	,, 14 ...	149	+23	Mean of nineteen positions by the best observers.
1867	,, ,, ...	147¾	+23	Bradley.
,,	,, ,, ...	150¾	+22	Watson.
,,	,, ,, ...	148	+23	Harkness.
,,	,, ,, ...	150¼	+22½	Sands.
1868	,, ,, ...	152	+18	Gilman.
1869	,, ,, ...	151	+22	Tupman.
1877	,, ,, ...	146	+26	Backhouse.
,,	,, 11–14 ...	148	+24	Denning.
1879	,, 14–16 ...	147	+23	Perry.
,,	,, 16 ...	151	+22	Sawyer.
,,	,, 12–14 ...	148	+25	Corder.
,,	,, 14 ...	148	+23	Denning.
1880	,, 12–13 ...	148	+22	Sawyer.
1885	,, 15–18 ...	150	+22	Denning.
1887	,, 15 ...	155	+25	Booth.
,,	,, 15 ...	150	+22	Denning.
1888	,, 14 ...	149	+22	Denning.
1890	,, 14–15 ...	151	+24	Backhouse.

In addition to these, some good positions are given in the catalogues of radiants by various authorities, thus :—

November 10–14 ...	148°	+22°	Schmidt.
,, 7–15 ...	153	+22	Greg and Herschel (1863.)
,, 12–13 ...	148	+24	Heis.
,, 11–15 ...	149	+23	Greg (1876).

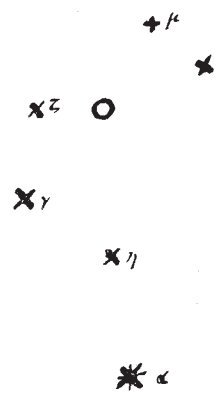
The mean place derived from a large number of positions, agreeing well amongst themselves and individually fixed by the most trustworthy observers, is at

$$149°{\cdot}15 + 22°{\cdot}9$$

This is almost identical with that of the naked eye star Piazzi IX. 230 (mag. 5·7). the place of which in 1880 was

$$149°{\cdot}1 + 22°{\cdot}5$$

Relatively to the bright stars forming the sickle of Leo the radiant is situated as in the following diagram :—



Place of the Leonid Radiant amongst the Stars in the Sickle of Leo.

It is of no utility beginning a watch for Leonids before 10.30 p.m., as the radiant does not rise until about that time. It is very rarely that a meteor is seen from a radiant on or a little below the horizon, but a remarkable Leonid was observed in 1879 November 13, as early as 10h. 20m. at three different places, viz. Writtle, Bedford and Bristol. As seen from the latter place, the meteor passed through an arc of 90°, the observed path being from 98° + 22° to 4° − 15°.

The interest in this meteor shower is now rapidly increasing, for we are drawing near the period when brilliant returns may be expected. Two years preceding the maximum, as in 1831 and 1864, we may certainly look for rich displays, so that November 1897 will form an important epoch. It is also in the highest degree probable that in 1895 and 1896 the shower will give decided indications of returning activity. This year the conditions will be very favourable, as the moon, being a slender crescent and within a few days of the new, will be unable to make her influence felt.

The shower of Leonids certainly endures from November 9 to 17, but the really brilliant displays only last a few hours, and these at the end of the present century will occur either on the mornings of the 14th or 15th. 1896 being leap year, the phenomenon may be expected earlier than usual. The year 1898 offers prospective events of extraordinary interest to the meteoric observer, for two brilliant displays may occur within ten days of each other. The Leonids will be due on November 14, and the Andromedes on November 23.

As to the nature of the observations necessary during the progress of a meteor shower, it may be suggested that two persons are required to fully note the features presented. One will record the number of meteors appearing during short intervals, say of five minutes, so

that the time of maximum may be ascertained as well as the aggregate number visible during the period covered by the watch. The other will register the individual paths of well-observed meteors on a star chart or celestial globe, determine the place of the radiant and its character, especially note large meteors and any other peculiarities that may offer themselves. One observer, working single-handed, may do a great deal by dividing his attention between the various points alluded to. It is always important to separate the number of meteors visible in a special shower from the total number seen, for the aggregate counted must exceed the actual strength of a particular stream, since it includes the sporadic meteors. When reckoning the visible meteors, therefore, the observer will do well to keep an account of the number unconformable with the radiant of the main display. The radiant of the Leonids can be readily assigned, not only because of the afterflows or phosphorescent streaks left by the meteors, which assist the eye in fixing their exact directions, but also on account of the well-known asterism involving it. The Leonids exhibit a more contracted area of radiation than the Andromedes, but it is a feature not yet thoroughly investigated. By selecting a number of well-observed tracks near the radiant, the extent of its diffusion may be readily determined. The writer has sometimes found the centre so definite that the conformable paths have intersected at a point.

W. F. DENNING.

THE OLD AND NEW NATURALISTS.

NATURALISTS, like the animals and plants of which they discourse, are subject to the process of evolution. The naturalist of the latter end of the nineteenth century is not quite the same species as that which bore the name at the end of the eighteenth. Differentiation has been at work. So markedly indeed is this the case, that one is tempted to ask whether the species, as such, is not well-nigh extinct. To-day there are biologists, comparative anatomists and physiologists, systematic botanists and systematic zoologists, palæontologists and embryologists. But where is the naturalist? Has he not been swallowed up by and distributed among his polyological progeny? And yet the word is still in use, and carries with it a more or less specialised implication. The other day a friend, who was discussing with me the work of an acquaintance, said: "He's a capital anatomist; it's a pity he's not more of a naturalist"; and I had no difficulty in catching his meaning. It may be worth while to consider the relative position and status of the old and of the new naturalist.

In one of his luminous essays—that on the study of biology—Prof. Huxley reminds us that Hobbes of Malmesbury (Leviathan Hobbes) said: "The register of knowledge of fact is called history. Whereof there be two sorts, one called natural history; which is the history of such facts or effects of nature as have no dependence on man's will; such as are the history of metals, plants, animals, regions, and the like. The other is civil history; which is the history of the voluntary actions of men in commonwealths." In Hobbes's terminology, then, naturalist was synonymous with man of science. Indeed, until quite a recent date, as I am told, the Professor of Zoology in one of our northern universities bore as his technical title the designation Professor of Natural and Civil History. Gradually the field of the naturalist was restricted. Those branches of science which seemed to be specially susceptible of mathematical treatment were allotted to the natural philosopher; the naturalist, as such, continued to deal with physical geography, geology, mineralogy, and the history of plants and animals. The names of Buffon and of Humboldt at once rise to our minds as those of naturalists of this encyclopædic type. But the progress of knowledge, and the vast accumulation of facts, necessitated further division of labour; and by this further differentiation the field of the naturalist was yet further limited to the natural history of animals and of plants. Nor did the process of differentiation stop here. To-day we have herpetologists and ichthyologists; we have zootomists and embryologists; we have systematic botanists and evolutionists; but where, one may again ask, is the naturalist?

I take it that the term "naturalist," as we now use it, implies the sympathetic study of animals and plants in their varied relations to each other under the natural conditions of their customary habitat. In short the naturalist is in great part what Prof. Ray Lankester would call a student of bionomics, or what Semper called an investigator of the higher physiology of organisms. His calling is a protest, first, against the wide-spread error that physiology ends with the individual; and secondly, against the no less erroneous view that science ends with analysis. The naturalist sees in the individual animal or plant merely a constituent unit in a connected whole; and welcomes the most minute analysis chiefly as a means to a more complete synthesis.

Looking back to naturalists of the past in the light of this conception, it is of Gilbert White of Selborne that we feel the term to be exactly descriptive; and in the old days it was the man of leisure like White, the sportsman like St. John, or the angler like Izaak Walton, that was the best and most characteristic naturalist. They started with no equipment of special training, indeed, but with a keen eye, an observant habit, and a generous love of all that ran wild and all that grew free in the face of heaven. They gave their hearts to nature for its own sake; their lavish interest therein had no ulterior motive; they accepted the plain unvarnished tale of creation, and were troubled by no problems of evolution, and in their writings their main object was close, accurate, and sympathetic description rather than reasoned and logical explanation.

Nor can we read the works of the older naturalists without feeling that they were humanists as well. It is true that the more typical humanists of their time regarded their naturalist proclivities in the light of amiable eccentricities, as hobbies with little or no intimate bearing on man, the central figure in all rational and serious study and investigation; little dreaming of the influence natural history was destined to exercise in their own proper sphere of work. But the naturalists were wiser than they knew; wiser perhaps than some modern humanists on the one hand, and some modern naturalists on the other. They included man in their field of view.

Is it too much to say that the connecting link between the old and the new naturalists is to be found in Charles Darwin? The author of the "Naturalist's Voyage" had received but little systematic training, as we now count systematic training; he had the keen eye and the observant habit; he had the generous love for, and sympathy with, nature in all her aspects; he was indeed an encyclopædist in his width of interests, which included physical geography and geology as well as the world of plants and animals; and man was assuredly not absent from his field of view. Is any one likely to question the assertion that Charles Darwin was a great naturalist of the old type? And after more than twenty years of experimenting, investigating, collecting an enormous mass of data, and thinking of the careful patient type which brilliant little bodies even now fail to appreciate, he gave to the world his "Origin of Species," by which the work of all future naturalists was set in a new light. And after that, did he not write his "Orchids," his "Insectivorous Plants," his "Climbing Plants," his "Earthworms," all of them full of the spirit of the new natural history? Had Darwin made another voyage, and had he given us another journal of a naturalist, what we should have