plaice should disappear. Of course it is theoretically possible that average length should decline without average weight, owing to the reduced competition for food attending a thinning of the population—though in that case the utility of a size-limit is not obvious—but in all probability the discrepancy is due to paucity of data in one or the other of the areas, and will disappear with the collection of more information. The point does, however, emphasise the importance of testing the adequacy of samples of fish used for statistical purposes, a matter which is dealt with in another paper of the volume on the Ymuiden plaice measurements.

The secretary concludes his official record of the conference with a reference to the reception of the council by the King, and with pleasant, if a little quaint, expressions of thanks to the institutions and gentlemen who constituted themselves hosts, and to the clubs which "opened their hospitable localities" to the members.

The second volume before us is devoted to the seals of northern Europe. The material used was collected by Hjort and Knipowitsch, and is of the most diverse character, ranging from zoological literature to the journals of sealing vessels. The intention in dealing with this data was to give accounts of the biology, economic value, and influence on fisheries of seals, and to arrive at conclusions on the question of their extermination. The first of these purposes is admirably carried out by Dr. Wollebæk in a paper well illustrated by charts and plates, the account of the distribution and migrations of the seals being especially interesting. The report is in two parts, a Norwegian and a Russian, and it is evident that the value attached to sealing by the Russians prevents their sympathising greatly with Norwegian projects for the extermination of these animals. The charges against the seals are that *Phoca vitulina* damages the salmon fisheries, which is generally admitted, and that *P. groenlandica*, *P. foetida*, and *P. vitulina* also damage the fishery for the cod which follow the "Lodde" (*Mallotus villosus*) to the coast of Finmark, in exceptional years causing its complete failure. The damage done by hordes of fish-eating seals in the exceptional "seal" years, such as 1902–3, must be very great; yet the report would undoubtedly have gained in value had more attention been paid to the admitted possibility that the exceptional conditions which brought the seals also drove off the fish. The hydrographic conditions of the years in question were so exceptional that they may well have determined the failure of the fisheries; yet they receive but brief recognition, and the resulting impression is somewhat that of a trial confined to speeches for the prosecution. One feels that, were the seals eliminated, the Lodde fishery would possibly still be liable to sudden failure.

The third publication under notice is one of a series issued at fairly regular intervals, and contains the detailed hydrographic and plankton observations made by the vessels employed in the international researches during the first quarter of 1907, together with illustrative charts and sections. The periodic preparation of these bulletins must be a severe tax on the time and energies of the workers, but the resulting records should be of great utility to those studying the North Sea and English Channel.

THE DAWN OF METEOROLOGY.[1]

METEOROLOGY as a science is young, but as a branch of knowledge very old, perhaps as old as mankind. Indeed, the beginnings of meteorology are to be found with the origin of human civilisation. In those remote times, man living as hunter or agriculturist mostly in the open air was more influenced by, and more depending on, the weather than we are ourselves at present, and he was therefore forced to watch atmospheric phenomena. He did so, of course, not in order to study the atmosphere and to discover its laws, but to derive immediate advantages for himself. He was anxious to learn how to protect his house against the inclemency of the weather, how to foresee the best atmospheric conditions for his undertakings, or how to find out the most favourable climatic situations for his fields.

[1] Abridged from a lecture delivered before the Royal Meteorological Society by Prof. G. Hellmann, and printed in the Quarterly Journal of the Society, October, 1908.

The experience of the more intelligent men in this respect was handed down, and at the same time augmented, from generation to generation, and formed very early an essential element in the knowledge of the people.

It was the popular weather-wisdom which is still living nowadays, and will never die. This weather knowledge soon assumed the form of short proverbs, or rather absolute rules, because thus they were easily committed to memory.

It would, therefore, be wrong to imagine that the rich store of weather-lore found in the Bible, especially in the Book of Job, in the poems of Homer and Hesiod, that is, in writings of the eighth century B.C., originated then in Palestine or Greece. On the contrary, the familiarity of the people with the sayings and rules concerning the weather, revealed to us by these writings, shows clearly that they must be considered even then as a primeval stock of culture. Indeed, there is every reason to believe that the origin of a great deal even of the modern weather-lore can be traced to its Indo-Germanic source.

People attribute a good deal of prognostic signification to the so-called "twelve nights" (or "twelve days"), which formerly were counted from the beginning of the year, but later, under the influence of the Christian Church, from Christmas. People believe that the weather of these twelve nights (or days) corresponds with that of the twelve months of the following year—indeed, a rather simple forecast of long range if it were true! This superstition is met in the whole of European literature back to the fifteenth century, and still earlier in many MSS. Also the Venerable Bede mentions it; and the Byzantine-Greek work on agriculture, called "Geoponica," which was collected in the sixth century A.D., tells us that even Democritus, in the fifth century B.C., was familiar with it in pretty much the same form. On the other hand, we learn from the Sanskritists that the old Indian or Vedic texts reveal the same belief in the twelve nights as a symbol of the following twelve months. But this superstition not only spread westwards with the Indo-Germanic race, it migrated also eastwards to China, where on New Year's Day a custom is still in use which is based on the same Indo-Germanic conception.

Another superstition concerning the weather leads us to old Babylonia. Many European chapbooks of past centuries, and a little Swedish book, "Sibyllæ Prophetia," which is sold to-day at fairs, contain forecasts of the weather and fertility of the whole year deduced from the thunder heard in each of the twelve months. These *signa tonitrui* can be followed up in MSS. until the Middle Ages, and go back apparently to the rich literature of thunder-almanacs or brontologies, in the composition of which in the fourth and fifth centuries even Byzantine emperors have taken part. In a similar chapter of the already cited Greek book "Geoponica" this doctrine is attributed to Zoroaster. Though this may not be the real author, yet his name indicates its Oriental origin; and, indeed, I found in the works of the Assyriologists—Sayce at Oxford and Lénormant in Paris—some translations of cuneiform tablets proving the Chaldaic origin of this superstition concerning thunder.

The state of meteorology in the old Babylonian culture, namely, three to one thousand years B.C., shows quite another character than it did in those primeval times in which the weather proverbs originated.

After having been formed into the beginnings of a learned profession by the priests, the atmospheric phenomena were brought by them into connection with the constellations of the heavenly bodies, and a complete system of consequences and combinations was established which gave rise to the astro-meteorology. It even formed an integral part of the Assyric-Babylonian religion.

The meteorological observations of the Chaldeans were apparently of a quite selective nature, referring above all to optical phenomena, especially to the halos. They distinguished clearly the small halo of 22° diameter, called "tarbasu," from the greater one of 45°, called "supuru." Besides, they paid much attention to clouds, winds, storms, and thunder; but a good many of these observations served more for a general prophecy of good and bad things, or omens, than for the forecast of the weather.

No meteorological theory has yet been discovered in the Babylonian tablets, of which, of course, only a small number has been preserved, and even a smaller number deciphered. But I was quite recently greatly surprised to find that the Babylonians had the windrose of eight rhumbs, and used already the names of the four cardinal points to denominate the intermediate directions; whereas it was until now generally supposed that we owe to Charles the Great, or perhaps to his learned monk Alcuin, who came from Yorkshire, this progress of the combination of the four principal winds to denote all others. That was indeed a great advance, for it is well known that in the Greek and Roman periods each wind had its peculiar name,

FIG. 1.—Fragment of Parapegma.

a practice still in use amongst the Italian mariners in the Mediterranean.

From the Babylonians to the Greeks is a far cry, but there is also great progress from a meteorological point of view. It seems that the Greeks were the first to make regular meteorological observations, some results of which are still preserved, and that their great capacity for pure science induced them to establish meteorological theories.

My first statement is not only proved by Theophrastus, who quotes several men in Asia Minor and Greece making meteorological observations, but also by the interesting fact that since the time of Meton, namely, since the fifth century B.C., in the so-called *parapegmata* (παραπήγματα), a kind of peg almanac fixed on public columns, the general data of the weather resulting from observations were exhibited. As these weather-almanacs differed from town to town, it clearly follows that they were based on individual observations made in each district.

Here is an example taken from the *parapegma* of Geminos, whose book, entitled "Introduction to the Phenomena," is of special value for this question:—

August 31.—The shoulders of Virgo are rising. The winds called ἐτησίαι cease to blow.

September 5.—Rising of Arcturus. South wind, rain, and thunder.

September 12.—The weather will likely change.

September 14.—Mostly fine weather for seven days, thereafter easterly winds.

Fig. 1 shows a fragment of such a *parapegma* found recently at Miletus, and now preserved in the museum at Berlin.

In the holes which can be seen in the marble stone little wooden pegs were put in order to fix the beginning of the year and the days, which gave rise to the name *parapegma*, derived from the Greek verb παραπηγνύναι = to fix into.

It is not surprising that in these *parapegmata* the observations of the wind prevail over all others, for they were of practical use to navigation and easily made. Also, the origin of the winds has always been a favourite subject of speculation among the Greek philosophers. In the epoch of Homer winds were still conceived as absolute beings like gods, whereas Anaximander of Ionia, who lived in the fifth century B.C., is the first to give a scientific definition of the wind, which is still valid. He says: ἄνεμον εἶναι ῥύσιν ἀέρος, the wind is a flowing of air.

It is therefore quite natural that the Greeks, even at this early period, used wind-vanes, which represent the older meteorological instrument, and a most interesting example of it is preserved in the "Tower of Winds" at Athens.

At the time of the construction of the tower, namely, in the first century B.C., a great many wind-vanes were already in use, for a contemporary Roman writer, Terentius Varro, tells us that in Roman villas they were constructed in such a manner as to show the direction of the vane on a windrose fixed to the ceiling of the room ("ut intus scire possis").

Soon after these earliest qualitative observations of the weather and direction of the wind we find the first quantitative ones, that is to say, the measurement of rain, in the first century A.D. It was made in Palestine, where the great influence of rainfall on the crops must have been fully appreciated at an early date, and the results of which observations are preserved in the Mishnah, a collection of Jewish religious books apart from the Bible. It seems to me most interesting to state that the amount of rainfall then considered as normal for a good crop corresponds pretty closely with that deduced from the modern observations made by Mr. Thomas Chaplin at Jerusalem, whence it can be inferred that the climate of Palestine has not changed.

Many of my audience will perhaps be astonished when I state that we are indebted also to antiquity for the first idea of a most important modern meteorological instrument. Most men of science are still of the opinion that antiquity achieved nothing concerning physical instruments and experiments; but the more we become acquainted with the scientific and technical literature of the Greeks and Romans, which at present is often the subject of study of philologists in preference to the classical authors, the more we learn their many positive results in this respect.

There are two physicists of special interest to us in this connection, namely, Philo of Byzantium, who lived in the third century B.C., and Hero of Alexandria, whose century is not yet settled, but who certainly lived after Philo and the great mathematician Archimedes, both being quoted

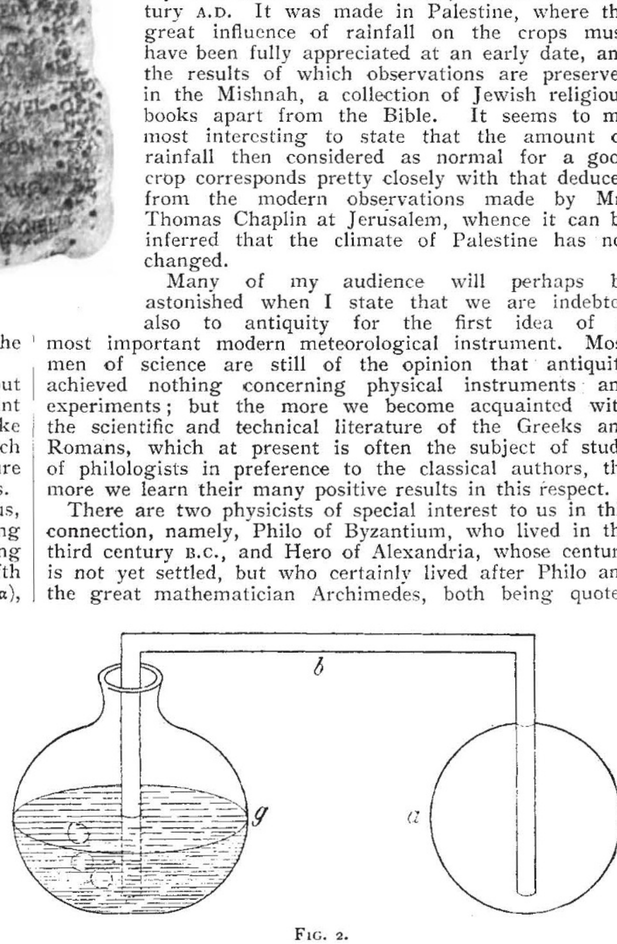

FIG. 2.

by him. In the writings of these two physicists we find the description of an apparatus which represents the primitive idea of the thermoscope.

Philo's description in his work "De ingeniis spiritualibus" (on pressure engines), the Greek original of which is lost, only an Arabian and a Latin translation being preserved, will be made intelligible by Fig. 2. He says:—

"One takes a leaden globe of moderate size, the inside of which is empty and roomy. It must neither be too thin that it cannot easily burst, nor too heavy, but quite dry so that the experiment may succeed. Through an aperture in the top is passed a bent siphon reaching nearly to the bottom. The other end of this siphon is passed into a vessel filled with water, also reaching nearly to the bottom, so that water may the more easily flow out. *a* is the globe, *b* the siphon, and *g* the vessel. I assert, when the globe is placed in the sun and becomes warm some of the air enclosed in the tube will pass out. This will be seen, since the air flows out of the tube into the water, setting it in motion and producing air-bubbles, one after the other. If the globe is placed in the shadow or any other place where the sun does not penetrate, then the water will rise through the tube flowing into the globe. If the globe is again placed in the sun the water will return to the vessel, and *vice versâ*. . . . . The same effect is produced if one heats the globe with fire or pours hot water over it. . . ."

Somewhat more complicated is the similar apparatus of Hero, to which he gives the name λιβάς, or drip (Fig. 3).

Now it happened that this book of Hero on pneumatics, which must have been widely distributed already in MS., was translated in the eighteen years between 1575 and 1592 no less than twice into Latin and three times into Italian. It was studied by Galileo, Porta, and Drebbel, and gave, about the year 1600, to all three men the idea of constructing a thermoscope, and to the last one also the impulse of making an experiment on the origin of the winds. From this it appears there is an interesting

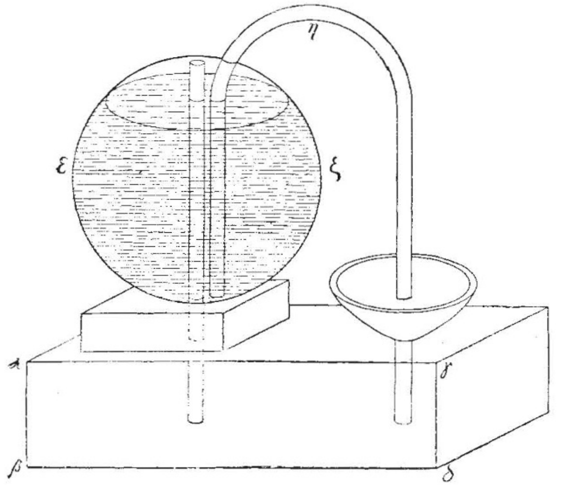

FIG. 3.

connection between the science of two remote periods with an interval of time of more than 1800 years.

As I said before, the Greeks were also the first to start theories of meteorological phenomena. Indeed, since the time of the oldest philosophical school, that of Ionia, there are few Greek philosophers who were not interested in some branch of meteorology. This covered a wider field of research then than at present, embracing, besides meteorology in the modern sense, also a good deal of physical geography and astronomy, especially shooting-stars, meteors, and comets. The favourite meteorological subjects of speculation and research seem to have been the origin of the winds, the theory of the rain, including the regular inundation of the Nile, and the rainbow. A good many cosmological speculations were also put forward by the meteorologists which often proved false, and, considered from a practical point of view, in all cases rather useless, whence in the period of Socrates meteorology itself came into disrepute.

But notwithstanding, meteorology made some real progress in time, and reached such perfection a century later that the system established by Aristotle remained for nearly two thousand years the standard text-book of our science. To be sure, considered from a modern point of view, Aristotle's meteorology was antiquated long ago, but if you imagine yourselves back in those old times you will agree with me that his treatise of meteorology—the earliest one existing—is an excellent piece of work, and well worthy of the greatest systematiser of all times.

I should go too far if I were to analyse here the merits and demerits of Aristotle's meteorology. It may be sufficient to say that his most distinguished successors, such as Theophrastus and Posidonius, have added but little to the perfection of his system, which, on the contrary, gave rise to innumerable commentaries and paraphrases. All text-books of meteorology issued on the Continent until the end of the seventeenth century are exclusively based on Aristotle, whereas, curiously enough, in England his influence was much less. If I except Duns Scotus, I do not know any British scholar who has written a commentary on the meteorology of Aristotle, and even this one has quite recently been disputed. It is true the number of treatises on meteorology published in Great Britain before 1700 is unusually small compared with that issued contemporaneously in Germany, Italy, and France, in Latin or the vernacular language. Englishmen seem always to have been more inclined to make actual observations of the weather than to theorise upon it and to write systematic treatises on meteorology.

Among the Romans meteorology made but little progress, like all other sciences of no immediate practical value. Pliny, Seneca, and Lucretius do not add any remarkable fact or theory to the knowledge of the Greeks, and probably the same can be said of the lost writings of Nigidius Figulus and Suetonius Tranquillus. From Virgil we learn some new weather-proverbs originating in Italy, and a writer on agriculture, Columella, who owned a large estate near Cadiz in Andalusia, has left behind a "Calendarium Rusticum," or rural calendar, with many interesting weather observations made in that district.

The extensive colonial possessions of the Romans were, of course, suitable for advancing the conceptions of climatological differences of the countries. As the great military expedition of Alexander the Great to inner Asia and India had brought to the Greeks the first knowledge of the monsoon winds, so the Romans were the first to point out the difference between the continental and maritime climate. Minucius Felix, a Christian writer from Africa, living in the second century A.D., says, concerning the climate of Great Britain, "Britannia sole deficitur, sed circumfluentis maris tepore recreatur," that is, freely translated, "Britain has little sunshine, but a mild climate on account of the warm sea-water flowing round it."

The barbarous state of Europe after the fall of the Western Empire was not adapted to the furthering of science, which was barely kept alive within the Christian Church. Yet the pursuit of meteorology never wholly ceased, for the Fathers of the Church, writing commentaries on the work of the seven days, the so-called Hexaëmeron, often took occasion, when dealing with the first day of the Mosaic Creation, to insert long elaborations on the atmosphere and its phenomena.

At the very beginning of the Middle Ages the great encyclopædists, such as Isidorus Hispalensis in Spain, the Venerable Bede in Great Britain, and Rabanus Maurus in Germany, were the first to devote more attention to meteorological questions, the interest in which must have been considerable in England, for in the tenth century an extract of Bede's writings, concerning astronomy and meteorology, was made for the uninitiated in the Anglo-Saxon language, which is perhaps the earliest treatise on science written in a popular form. It contains chapters on the winds, rain, hail, snow, and thunder.

A general revival of studies took place at the end of the twelfth century, when the writings of Aristotle, among which was his "Meteorology," came to the knowledge of the Western students by Latin translations made in Spain from the Arabian ones, not from the Greek originals. The imposing meteorological system of the great Stagirite again exercised a great influence on the writings of the scholars and on the teaching in the recently established universities, where, under the title "Meteora," regular courses and even exercises in meteorology were held. Albertus Magnus at Cologne wrote at this time his great meteorological works ("De Meteoris," libri iv., and "De Passionibus Aeris"), paraphrasing chiefly those of Aristotle, but adding also the opinions of other authorities and his own remarks; and at the same time, or somewhat later, Vincent de Beauvais in France, Thomas de Cantimpré in Belgium, Ristoro d'Arezzo in Italy, Bartholomew Anglicus (or de Glanvilla) in England, incorporated the Aristotelian ideas in their encyclopædic works all bearing the general title "On the Nature of Things" ("De Natura Rerum").

But the firm and absolute adherence to the doctrines of the master, Aristotle, the denying of all that could not be found in his writings, rendered the scholastic meteorology so noxious to any real progress that it came into conflict with all new ideas. Notwithstanding, these forced their way by and by, and the beginnings of the modern experimental science are to be found just at that epoch when scholasticism had reached its highest point, namely, in the thirteenth century.

It is not yet definitely settled where the new experimental science took its origin—most likely contemporaneously in France and in England, where the two friends Pierre de Maricourt (Petrus Peregrinus) and Roger Bacon can be considered as the first great representatives of the new aims.

The former, a French nobleman and military engineer, is the author of the famous treatise on the magnet, and made many optical experiments like his English friend; and although both have not dealt with meteorology properly speaking—except the rainbow—yet their general influence must have been great on our science also. Roger Bacon's energetic opposing of the experiment to the argument—"argumentum non sufficit, sed experientia," he says in his "Opus Majus"—conduced naturally to the observing of atmospheric phenomena instead of only interpreting the writings of the ancients.

Thus the new aims advanced meteorological observations also, for which the ground was well prepared. As I have just shown, such observations were made in antiquity and never had wholly ceased, despite frequent and long interruptions. For the custom of the Roman historians to note in their annals the more important atmospheric phenomena, especially those necessitating sacrifices, was handed down to the chroniclers of the Middle Ages, whose chronicles became richer and richer in entries of the weather, until at the end of the thirteenth century these records are so replete with remarks on the weather that the character of the seasons could be traced back.

Now the time is ripe for more systematic observations, and we find at Oxford William Merle, a fellow of Merton College, to whom remains the distinction of being the first man in the Occidental world to keep a regular journal of the weather day by day. It embraces the years 1337 until 1344. The journal is preserved at the Bodleian Library. It is the earliest known journal of the weather, kept at Oxford and later at Driby in Lincolnshire, where William Merle was rector.

A close examination of the circumstances forces me to the conclusion that William Merle was induced to make regular observations by the desire to ascertain the correctness of the prognostics made by himself and his colleagues at Oxford, where meteorology, or, more properly speaking, astro-meteorology, had been flourishing since the time of Robert Grosseteste, the famous Bishop of Lincoln. Merle himself has left behind two MSS. on the forecasting of the weather, and his contemporaneous fellow of Merton College, John Eschendon (or Ashendon), whose name has been corrupted into Eschuid, completed in 1348 a voluminous treatise of astro-meteorology bearing the title "Summa judicialis de accidentibus mundi." It was printed at Venice in 1489, and served in the sixteenth century as a text-book at the University of Vienna. The work is usually quoted in meteorological literature under the abbreviated title "Summa Anglicana," and is now extremely rare.

When, eighteen years ago, the journal of William Merle was re-discovered, it seemed to stand all alone, since we had no knowledge of other observations made in England or abroad but recently I have been able to find out a nearly continued sequence of series of such observations, and to prove that from the fourteenth to the middle of the seventeenth centuries, namely, until the invention of meteorological instruments the weather was regularly observed in many places in Central and Western Europe.

I had noticed that some copies of the large astronomical work, published in 1499 by Justus Stoeffler and Jacob Pflaum at Tübingen, "Almanach nova plurimis annis venturis inservientia," containing ephemerides for the years 1499 to 1531, were full of meteorological entries written on the broad margins. This induced me to make systematic inquiry into copies of the work named containing such entries preserved in the great libraries of Germany, Austria, and Switzerland. The result of this inquiry was rather astonishing. No fewer than 123 different series of meteorological observations belonging to the fifteenth, sixteenth, and seventeenth centuries were found. Considering that this number of necessity represents but a small proportion, and concerns only some parts of Central Europe, we may safely presume that in the whole of Europe their number must have been far greater. Some of these early series of weather observations are even corresponding ones, made by agreement.

A fresh stimulus for observing came at the end of the fifteenth century from quite another direction. The great discoveries of new lands and seas considerably enlarged and widened old ideas and conceptions. Atmospheric phenomena never seen before came to the knowledge of man, and climates very different from those at home became known. Intelligent men were struck by such varieties, and we can clearly observe their effect on them in the writings of that epoch. Luis de Camões, the famous Portuguese poet, described in his epos, "Os Lusiadas," for the first time minutely the water-spouts often observed by him off the coast of Guinea and the storms in the South Indian Ocean, while from the logbook kept by Christopher Columbus during his first voyage we learn the deep impression he got from the difference of climate and weather in the Atlantic beyond the Azores compared with that eastwards of the islands. Such new observations advanced mostly the doctrine of the winds, which was now more fully expounded in Spanish and Portuguese works, until in the year 1622 Francis Bacon was the first to publish a special treatise dealing entirely with the winds.

But meanwhile experimental science, the growing up of which I have just alluded to, was so much developed that in the first half of the seventeenth century the principal meteorological instruments were invented. To Italy belongs the glory of being the native country of instrumental meteorology, the cradle of which stood at Florence. These inventions proved the first step in making meteorology a science, and now the shadows of the dawn are fast disappearing before the full light of the rising sun.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Certain friends of the Chancellor desire the establishment of some award to be associated with Lord Rayleigh's name, in order to commemorate the unanimous election of a scientific investigator to the office of Chancellor of the University. With this object they have deposited a sum of money at the bank, the interest of which may be used for the purpose of awarding from time to time a prize to be called the Rayleigh prize. It is proposed to adjudicate these prizes at the same time and by the same adjudicators as the Smith's prize.

The Walsingham medal for 1908 has been awarded to C. C. Dobell for his essay entitled (1) "Protista Parasitic in Frogs and Toads," (2) "Chromidia and the Binuclearity Hypotheses"; and a second Walsingham medal to G. R. Mines and D. Thoday. Mr. Mines's essay was entitled "The Spontaneous Movements of Amphibian Muscles in Saline Solutions," and Mr. Thoday's essay was entitled "Increase of Dry Weight as a Measure of Assimilation." Lord Walsingham has expressed his willingness to give, this year, a bronze replica of the medal to each of the candidates awarded the second medal. The medal is awarded for a monograph or essay giving evidence of original research on any botanical, geological, or zoological subject, zoology being understood to include animal morphology and physiology. Essays for the ensuing year are to be sent to the chairman of the special board for biology and geology (Prof. Langley, The Museums) not later than October 10, 1909.