marriage, and continuing to do so in successive generations. Now here we have in A and B not only the two moieties of the future tribe, but the tribe itself, in the making. The bisection *grew* out of a quasi-purposive exogamous instinct against marriage within the fire-circle.

There seems to be nothing against Aristotle's view that the tribe grew out of the family, except the curious but fashionable prejudice in favour of an organisation for primitive man of the baboon type. Mr. Atkinson in a remarkable paper has dealt the latest and one of the shrewdest blows at this prejudice, and doubtless anthropologists may in time revert to Darwin's suggestion that the earliest form of the human family resembled rather that of the unsocial anthropoids, such as the gorilla. It is noteworthy that Dr. Howitt modifies considerably the earlier conception of the Undivided Commune, and regards it as having been originally something like "what occurs when the modified Communes of the Lake Eyre tribes reunite." The battleground of the two schools is, of

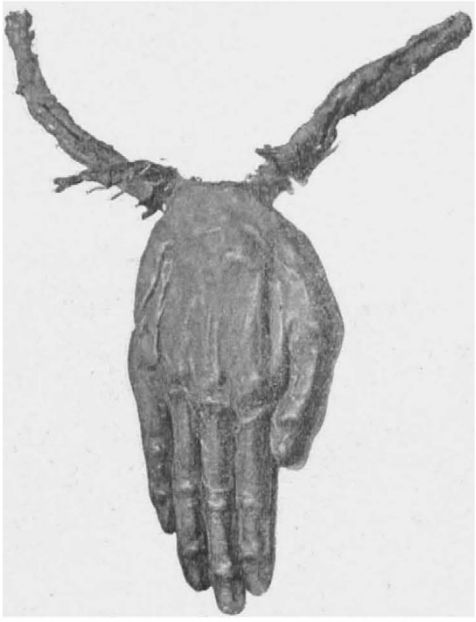

FIG. 2.—The *Bret* or Dead Hand. From Howitt's "The Native Tribes of South-East Australia."

course, the so-called group-marriage of the tribes last named. In this connection the author does good service by putting together a full and revised account of the Dieri marriage-system, with its *Tippa-malku* or individual marriage, and its *Pirrauru* or group-union. We are thus enabled with some certainty of data to compare the notorious Urabunna and Arunta systems. But when Dr. Howitt says, "the germ of individual marriage may be seen in the Dieri practice; for as I shall show later on, a woman becomes a *Tippa-malku* wife before she becomes a *Pirrauru* or group-wife" (p. 179), the logic strikes one as curious. The inference should surely be that the group-marriage has been evolved from the individual system, and not the other way about.

The author still regards the practice, as amongst the Wiimbaio, of exchanging wives on the approach of a pestilence, as a survival of group-marriage, and the right of access as a survival of the *jus primae noctis* and an "expiation" for individual marriage. One had thought that these two last categories had been relegated to the limbo of outworn fictions anthropological. Noticeable details are that the action of jealousy is very strong in the Dieri tribe; that, as the Rev. O. Siebert puts it, "the practice of *Pirrauru* is worthy of praise for its strength and earnestness in regard to morality, and in the ceremonial with which it is regulated, since no practice could be less in accord with the hetairism which Lord Avebury has imagined for the Australian aborigines" (p. 186).

It is disappointing to find that no mention is made of Cunow's theory of the four and eight subclasses; it would have been instructive to see what light an unrivalled personal knowledge of the system and an acquaintance, doubtless extensive, with the dialects might have thrown on the view that these classes are age-divisions, and have primarily nothing to do with marriage-restrictions. The Kurnai with their totems which do not affect marriage, and their local, not class-divisions, present a fascinating problem, and no one knows more about the Kurnai than does Dr. Howitt. Their marriage by elopement, and the systematic use therein of priestly assistance, are remarkable customs. "It was the business of the *Bunjil-yenjin* to aid the elopement of young couples. For instance, when a young man wanted a wife, and had fixed his mind on some girl, whom he could not obtain from her parents, he must either go without her, persuade her to run off with him, or call in the aid of the *Bunjil-yenjin*. In the latter case his services were retained by presents of weapons, skin-rugs, or other articles." The *Bunjil-yenjin* then sang a magic song until he thought his magic strong enough to secure the "covering up" of the parents in a state of coma.

The author in a very interesting essay applies the facts of "maternal descent" to the Teutonic Salic Laws. Among the more important features of the book is the masterly and final settlement of the vexed questions of the native headmen, and the belief in supreme beings, like *Daramulun*. The connection between the two questions is that the headman in the sky is the analogue of the headman of the tribe on the earth. Among the Kurnai—to note another difference between many of the south-eastern tribes and those studied by Spencer and Gillen—the knowledge of *Mungan-ngaua* is confined to the initiated men, who impart it in all sincerity to their novices; the Arunta, as Spencer and Gillen inform us, take this opportunity of explaining their deity away as a being only believed in by women and children. Among further details of interest are the Kurnai custom of the Dead Hand, the performance of the Indian Rope Trick by Kurnai medicine-men, the magical influence which exists between opposite sexes, and the belief that the initiated elders infuse their own magical power into boys at confirmation.

The book is a fitting crown to Dr. Howitt's labours, and is, in effect, the most considerable and important of all studies of the Australian race.

A. ERNEST CRAWLEY.

CHANGES UPON THE MOON'S SURFACE.

UNTIL within the last few years there has been a very general opinion that the moon was a cold, dead world, or, as it has been sometimes expressed, a burned out cinder, upon which nothing ever happened. This view was apparently due to the fact that the men who wrote the text-books on astronomy were not the men who studied the moon. Among the selenographers themselves, those astronomers who made a special study of the moon, there is not one, so far as the writer is aware, who has not expressed his belief that changes of some sort, volcanic or otherwise, occasionally occur upon our satellite. Reference

is made to such men as Mädler, Schmidt, Webb, Elger, and Nieson.

As the result of his lunar observations in Peru, Jamaica, and California, the writer has come to the conclusion that physical changes do occur upon the moon, and that they may be classified under three heads, those due to volcanic action, those due to the formation and melting of hoar frost, and those due to vegetation.

In the first class the classical example is that of Linné, which, according to the measurements of Lohrmann, Mädler, and Schmidt, prior to 1843, had a diameter of between four and seven miles. Its diameter at present is three-quarters of a mile. A few years ago a new crater was announced by Klein in the vicinity of Hyginus. The writer is not sufficiently familiar with this region to speak from personal experience, having but a few sketches of it, but he believes that a change there of some sort is generally admitted by selenographers.

Perhaps no area of its size upon the moon has been so thoroughly examined as the floor of Plato. It has been studied at intervals of about eleven years, first in 1870 by a committee of the British Association, next by A. S. Williams and others in 1881, and again a few years later, then by the writer at Arequipa in 1892, and again this past summer in California. In each survey about forty craterlets have been mapped, and each time some new ones have been discovered, while at the same time a few of those previously observed had ceased to be visible. The original trigonometrical survey of 1870 was based upon four craterlets located near the centre of the floor, and selected as primary stations. The easternmost of these was last seen as a crater in 1888. A trace of it was suspected in 1892, but a search for it this past summer with a 16-inch telescope working under most favourable climatic conditions failed to reveal any trace of it whatever. Even the large white area upon the floor which formerly marked its position has partially disappeared.

A map of the floor of Plato, based on a survey made in 1892, is given in the Harvard *Annals* (xxxii., plate x.). On this map the craterlet numbered 3 corresponds to craterlet number 22 of the older surveys. This craterlet was tenth in order of conspicuousness in 1870. In 1881 it had risen to the seventh place. In 1892, although carefully looked for, it could not be found, and it was entered on the map as a missing crater. A study of this region during the past summer revealed the presence of what appeared to be a large crescent-shaped bank of sand, six miles in length by from one to two miles in breadth. Its height was computed at not far from 1000 feet. It is the only object of the sort upon the floor, and the writer has so far found no previous record of its existence. When the sun is setting upon Plato it is by far the most conspicuous object within the crater walls, and was readily revealed by a 6-inch objective in Cambridge, Mass., working under very unfavourable atmospheric conditions. At sunrise it was also in part seen without difficulty under fair conditions. It seems incredible that so conspicuous an object as this should have been overlooked by all the earlier observers, had it then been visible.

I accordingly wrote to Mr. Williams, and he kindly sent me a list of forty-two observations made during the years 1879 to 1890, dealing with the particular portion of the crater floor where this formation was situated. Five of these observations were made during that portion of the lunar day when the object is now conspicuous, and when it is much more so than any of the craterlets upon the floor. Three of Mr. Williams's observations record that nothing was visible upon this portion of the floor. One observation records two small white spots, one of which he thinks may have been the original crater, and the other is possibly a neighbouring hill. Both of them as shown by this sketch were evidently very small objects as compared to the present formation. The fifth observation records a bright streak passing through the spot in question and extending for about thirty miles across the floor. Evidently if the present sandbank had been in existence at that time Mr. Williams could not have failed to have seen it and recorded it upon his sketches. Between this sand heap and the crater wall a large craterlet now exists. It is, in fact, the largest upon the floor, measuring about two miles in diameter, but owing to its peculiar position, and also to the fact that it is never bright like most of the others, it can only be seen at lunar sunset, and even then is not conspicuous.

Turning now to the second class of physical changes visible upon the moon, those due to the formation and disappearance of hoar frost, we find numberless examples scattered over the surface, but in most cases favourable atmospheric conditions and a large glass are necessary to render them clearly visible. Before dealing with any specific cases, however, it may be well to endeavour to answer some of the objections raised on theoretical grounds to the possibility of the existence of water vapour upon the moon.

The writer believes that he himself was one of the first to point out that if water vapour existed upon the lunar surface, it must sooner or later be dissipated into outer space (*Astronomy and Astrophysics*, 1892, xi., p. 781). That such a dissipation must have been going on in times past seems to be inevitable, but before reaching a conclusion as to the present existence of water vapour upon the moon, there are one or two important considerations that must be taken into account.

Vulcanologists are now generally agreed that the vast quantity of water, amounting to thousands, and sometimes to millions of tons, given off during volcanic eruptions is not rain water, nor yet water that has reached the interior from the ocean, but is water that either is being expelled for the first time from the earth's interior or is being expelled by heat from the rocky materials of the earth's crust with which it was previously united by the forces of crystallisation. If the earth is still discharging such large quantities of water from its interior there is no reason why the moon should not be doing the same thing. It is true the moon is smaller, but then also it began life later than the earth. The reason why the earth has oceans is that it is large enough and massive enough to retain the expelled water in that form. The moon, on the other hand, is too small to do so, and the water therefore appears scattered widely over its surface in the form of hoar frost before being dissipated into outer space.

Another objection to the theory of the existence of water vapour that has been raised is the statement that there is no evidence of erosion upon the moon. This statement is clearly a mistake, but the eroded valleys are small, and it requires good atmospheric conditions to detect them. Fairly conspicuous examples, however, exist upon the central peaks of Theophilus and Eratosthenes. Although the valleys are small, it is hard to understand how the comparatively minute amount of hoar frost at present found in these regions could have produced so great an effect, and we must conclude that formerly there must have been a great deal more of it. The only strong evidence that water in the liquid state ever existed upon the surface of the moon lies in the dry river-beds. The best example of these lies on the eastern slopes of Mt. Hadley, at the base of the Apennines. Another river-bed, partially fragmentary, discovered this past

summer lies sixty miles due south of Conon. Although difficult objects, the former has been seen in Cambridge, Mass. A sketch of it is given in the Harvard *Annals*, xxxii., plate vii.

Turning now from theory to fact, one of the clearest evidences of hoar frost upon the moon is found in connection with the pair of small craters known as Messier and Messier *A*. Sometimes one of these craters is the larger and sometimes the other. Sometimes they are triangular and sometimes elliptical in shape. When elliptical their major axes are sometimes parallel and sometimes nearly perpendicular to one another. When the sun first rises on them they are of about the same brilliancy as the *mare* upon which they are situated, but three days later they both suddenly turn white, and remain so until the end of the lunation. When first seen the white areas are comparatively large, especially that surrounding Messier itself, but it gradually diminishes in size under the sun's rays. By the eighth day little is left outside the crater itself, while at the end of the lunation only the bottoms and interior western walls remain brilliant. The general character of these changes can be followed even with a 4-inch telescope working under only moderate atmospheric conditions. Photographs of these craters showing their varying shapes and sizes will be found in the Harvard *Annals* (li., p. 28). Those to whom the *Annals* are not accessible will find these photographs and most of the other illustrations referred to in this article in my book "The Moon."

The white area surrounding Linné also shows evidence of change in size during the lunation. Soon after sunrise it measures 4″ in diameter, at noon 2″, and at sunset 3″·5. The change is evidently analogous to that shown by the polar caps of the earth and Mars, lunar noon in this case corresponding to midsummer for the planets, and sunrise and sunset to spring and autumn.

In the crater Eratosthenes there is a brilliant white area on the summit of the central mountain range. When the sun first rises on it it measures five miles in length by two in breadth. It soon, however, begins to dwindle, and two and a half days later all is gone save two little spots, each about a mile in diameter. They reach their minimum size five days after sunrise, when the smaller is about half a mile in diameter. They then begin to increase, the northern one attaining a length of five miles shortly before sunset. If these markings are due to white quartz, or some similar rock, it is difficult to account for their change in size.

The third class of physical changes with which we shall deal the writer believes to be due to the presence of vegetation. Changes of this class are more conspicuous than those of either of the other two, and if the explanation of vegetation is admitted, both the other explanations almost necessarily follow. It is therefore important to study these changes with the greatest care.

Before describing the facts, it may be well first to deal with the principal objection that has been made to the suggested explanation, namely, the lack of water on the moon in the liquid form. The reason that we believe liquid water to be lacking is that it is known that as we reduce the atmospheric pressure the boiling point of water is gradually lowered, until when we reach a pressure of 4·6 millimetres the boiling and freezing points coincide. Below this pressure ice changes at once into the gaseous form without passing through the liquid state. While, therefore, there can be no free water upon the surface of the moon, there is yet nothing to prevent it from occurring beneath the surface of the ground, retained by the capillary action of the soil. This action is so strong that, as has recently been shown by Cameron (*Science*, 1903, xviii., p. 758), it is capable of extracting water from a membrane against a calculated osmotic pressure of 36 atmospheres.

Since on the earth plants can live on moisture which they have in turn extracted from such a soil, there seems to be no difficulty in understanding how they could live on the moon, in a soil which could thus retain considerable moisture in spite of the low atmospheric pressure. Although in a state of nature, even in desert regions, all plants are occasionally exposed to water in the form of rain or dew, yet under artificial conditions we know that even such highly organised structures as house plants can flourish on water that

FIG. 1.—1901, July 26, 2·6 days, 43°

FIG. 2.—1901, March 31, 3·5 days, 54°.

in the liquid form reaches them only by capillary absorption from the soil.

Turning now to our observations, as early as 1837 it was pointed out by Mädler that there were two small spots in the crater Alphonsus which always became very dark at about the time of full moon, while earlier and later they were much lighter. A similar observation had been made by him regarding a region just to the south of the Mare Crisium. Little else was known regarding the matter until 1892. Since that date spots presenting these characteristics have been found all over the moon's surface, except in the vicinity of the poles. The most northern spot known is in latitude $+55°$, the most southern in latitude $-60°$. It is possible that some of the *maria*, notably Tranquillitatis, and part of the borders of Serenitatis and Vaporum, are covered with these spots, but in any case they do not cover more than 5 per cent. of the moon's visible surface, and possibly it is very much less.

It should be mentioned here that the western spot shown by Mädler in Alphonsus is now comparatively inconspicuous, but that north and south of it lie two others, which with Mädler's eastern spot form a very striking isosceles triangle at full moon.

We will now direct our attention to the crater Eratosthenes, which has been more carefully studied than any other region presenting these phenomena, and which exhibits the changes on a sufficiently large scale to enable us to make use of photography. The four photographs here shown were taken in the Island of Jamaica in 1901, and are enlargements from some of the negatives used in printing the Harvard "Atlas of the Moon." Beneath each figure is given the date on which it was taken, the number of terrestrial days that had elapsed since the sun rose upon it, and the colongitude of the sun, taken from Crommelin's ephemeris. The photographs are all on the same scale of 1/2,000,000, or about thirty-two miles to the inch. Upon this scale the moon would be 68·5 inches in diameter.

When the sun rises upon this formation the whole of the floor is at first of a light grey tint, whatever detail there is being but faintly marked. This tint is maintained by the south-western quadrant of the floor throughout the lunation. About three days after sunrise a dark spot appears on the north-western slopes of the central mountain range. The regions at its immediate base darken at about the same time, and an irregularly mottled dark sector appears as the result. On the fourth day the centre of the sector lightens, leaving two canal-like forms radiating from the central peaks. Although in a small telescope these canals appear straight, yet when well seen with a large glass they are found to present considerable irregularity of structure. On the eleventh day the southern one fades out, and just before sunset the northern one also disappears.

A faint X-shaped marking distinguishes the north-eastern quadrant of the floor at sunrise. The centre rapidly darkens as the sun rises upon it, and soon becomes intensely black. Three branches of the X successively fade away, leaving only the south-eastern one, which on the seventh day becomes very pronounced. A new branch or canal forms by gradual darkening on the east, while the canal on the north-east, which had disappeared, forms anew by a progressive growth downwards from the crater rim. This growth progresses for five days at a nearly uniform rate of 250 feet per hour, or about 4 feet a minute.

FIG. 3.—1901, April 2, 5·6 days, 79°

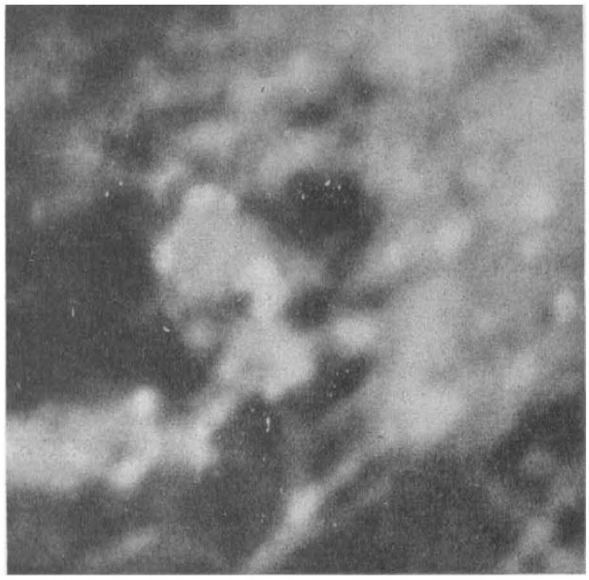

FIG. 4.—1901, March 5, 7·0 days, 97°.

The south-eastern quadrant, while very light at first, soon surpasses all the others in darkness. The dark area on the outer wall, which in the first figure is undoubtedly in part due to shadow, must very soon be partly due also to something else, for it still shows upon the third figure, which was taken but 0·8 day before full moon, when shadows are geometrically impossible. The last figure was taken 0·8 day after full moon, and the darker portion of the spot is seen to have rapidly increased in size and to have grown downwards with considerable velocity towards the central peaks.

Since this dark area cannot be shadow, our only alternative seems to be that we have here a real change in the character and brightness of the lunar surface. Since we do not know of any mineral which gradually darkens as the sun shines upon it, and later fades out again, our only alternative seems to be to call in the

aid of vegetation. At all events nobody has ever cared to propose any other explanation of the facts, so far as the writer is aware.

As the lunation progresses the western portion of this dark area slowly fades out, while the eastern is absorbed in the gathering shadows of the lunar night.

In various parts of the crater, but especially in the south-eastern and northern portions, numerous small canals and lakes present themselves. These markings are practically identical in appearance with those seen upon the planet Mars. They are too small to be well shown in the photographs, and seem to be of much more regular structure than the larger markings, which are here also called canals. It is possible that this difference is due merely to the fact that the larger markings are better seen. A more detailed account of the phenomena here described will be found in the Harvard *Annals* (liii.).

WILLIAM H. PICKERING.

SIR LOWTHIAN BELL, BART., F.R.S.

SIR Lowthian Bell, whose death at the age of eighty-eight has already been announced, studied physical science at the University of Edinburgh and the Sorbonne at Paris, and at the age of twenty-four entered the Walker ironworks, near Newcastle. There, we learn from the obituary notice in the *Times*, he remained until 1850, when he became connected with the chemical works at Washington, in North Durham. He greatly enlarged the works and laid down extensive plant for the manufacture of an oxychloride of lead introduced as a substitute for white lead by his father-in-law, Mr. H. L. Pattinson, F.R.S., with whom he was associated in the business at Washington. There, too, was introduced in 1860 almost the first plant in England for the manufacture of aluminium by the Deville sodium process.

Soon after the discovery of the main bed of Cleveland ironstone near Middlesbrough, Sir Lowthian Bell, in conjunction with his brothers, Thomas and John, started ironworks in 1852 at Port Clarence, on the north bank of the Tees. The Clarence works was one of the earliest and is now one of the largest iron-smelting works on the Tees. About half a century ago the Tees then flooded ground where iron furnaces now stand. Sir Lowthian Bell and his brothers acquired their own ironstone mines, collieries, and limestone quarries, while they were always prompt to adopt any improvement in process or apparatus that seemed likely to be advantageous.

In the development of the Cleveland iron industry the Bell firm played a very important part, and what has been the extent of that development may be judged from the fact that whereas the district in 1850 produced less than 25,000 tons of pig iron, at the present time Middlesbrough produces about one-quarter of the total output of this country. The firm was active in prosecuting those technical studies by which processes have been devised enabling Cleveland ores to compete as raw material for the production of iron and steel with others possessing greater natural advantages. In regard to steel, the great trouble with those ores is the high percentage of phosphorus (1.8 to 2.0 per cent.) contained in the cast iron which they yield; yet Middlesbrough, largely as a result of experiments carried on under Sir Lowthian Bell's direction, at a cost, it is said, of between 40,000*l.* and 50,000*l.*, produces steel rails in which this percentage is reduced to 0.07 or less

When the British Association met at Newcastle in 1863, Sir Lowthian Bell contributed a paper on the manufacture of iron in connection with the Northumberland and Durham coalfields. In 1870 he wrote a paper on the sanitary condition of Newcastle, and more recently he compiled an elaborate account of the iron trade of the United Kingdom, compared with that of the other chief iron-making countries. On the chemistry of iron he was a high authority. The establishment of a chemical laboratory in connection with the Clarence works shows how fully he realised the importance of the scientific study of industrial processes, and his own researches on the chemistry of iron and steel have become classic. Many of these appeared first in the form of papers read before the Iron and Steel Institute, and a number of them were subsequently collected and published in a volume entitled "The Chemical Phenomena of Iron Smelting." Sir Lowthian was also the author of a book on the "Principles of the Manufacture of Iron and Steel," as well as of many papers contributed to other scientific societies.

He was one of the original founders, in 1869, of the Iron and Steel Institute, and filled the office of president from 1873 to 1875, and in 1874 became the first recipient of the gold medal instituted by Sir Henry Bessemer the year before. He was a member of the Institution of Civil Engineers and of the Chemical Society, and a past president of the Institution of Mechanical Engineers. In 1874 he was elected a fellow of the Royal Society. In recognition of his services as juror of the international exhibitions at Philadelphia in 1876, and at Paris in 1878, he was elected an honorary member of the American Philosophical Institution, and an Officer of the Legion of Honour. He was elected on the council of the Society of Arts in 1876, and in 1895 was awarded the Albert medal of the society "in recognition of the services he has rendered to arts, manufactures, and commerce by his metallurgical researches, and the resulting development of the iron and steel industries." The honour of a baronetcy was conferred on him in 1885, and in 1893 he received the degree of LL.D. from Edinburgh University.

NOTES.

A SELECTION from the specimens recently presented to the British (Natural History) Museum by His Majesty the King of Portugal has recently been placed on public exhibition in the north hall.

THE annual meetings of the American Association for the Advancement of Science and of the American Physical Society were held in Philadelphia, Pa., in "Convocation Week," from December 26, 1904, to January 2.

THE International Botanical Congress will meet at Vienna in June next, when a discussion will take place on the important question of uniformity of nomenclature, regarded both from a scientific point of view and in connection with international reports.

UNDER the title "Lichtenstein Prize," the Montpellier Academy of Sciences offers a prize for the best essay dealing with any question of zoology not referring to man. The last day is November 1, 1905. Printed memoirs more than three years old, or papers which have gained previous prizes, are excluded.

THE third International Congress of Philosophy will be held at Heidelberg in 1908. Among the English speaking members of the organising commission the name has been added of Prof. Strong, of Columbia University. A detailed account of the congress held this year at Geneva is given in a special number of the *Revue de Métaphysique et de Morale* for November, 1904.