

prevent unnecessary light from entering the objective can be made of any material at hand, by taking a strip one inch long and three-fourths of an inch wide and turning up one end. A hole not more than three-sixteenths of an inch in diameter should be made at the angle. The shield should be placed on the upper surface of the slide, so that the hole will cover the point where the light from the mirror enters the glass. With this illuminator Möller's balsam test-plate is resolved with ease, with suitable objectives. Diatoms mounted dry are shown in a manner far surpassing that by the usual arrangement of mirror, particularly with large angle dry objectives.

Ottumwa, Ia.

WM. LIGHTON.

FOUCAULT'S PENDULUM EXPERIMENTS.

By RICHARD A. PROCTOR.

SCIENCE owes to M. Foucault the suggestion that the motions of a pendulum so suspended as to be free to swing in any vertical plane might be made to give ocular demonstration of the earth's rotation. The principle of proof may be easily exhibited, though, like nearly all of the evidences of the earth's rotation, the complete theory of the matter can only be mastered by the aid of mathematical researches of considerable complexity. Suppose A B (Fig. 1) to be a straight rod in a horizontal position bearing the

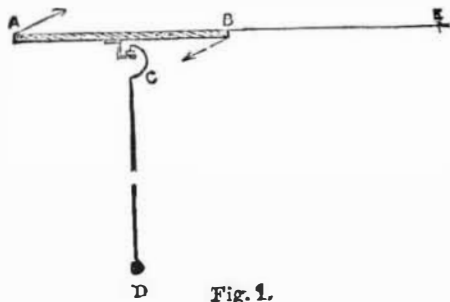


Fig. 1.

free pendulum C D suspended in some such manner as is indicated at C; and suppose the pendulum to be set swinging in the direction of the length of the rod A B, so that the bob D remains throughout the oscillations vertically under the rod A B. Now, if A B be shifted in the manner indicated by the arrows, its horizontality being preserved, it will be found that the pendulum does not partake in this motion. Thus, if the direction of A B was north and south at first, so that the pendulum was set swinging in a north and south direction, it will be found that the pendulum will still swing in that direction, even though the rod be made to take up an east and west position.

Nor will it matter if we suppose B (say) fixed and the rod shifted by moving the end A horizontally round B. Further, as this is true whatever the length of the rod, it is clear that the same fixity of the plane of swing will be observed if the rod be shifted horizontally as though forming part of a radial line from a point E in its length. In these cases the plane of the pendulum's swing will indeed be shifted *bodily*, but the direction of swing will still continue to be from north to south.

Now, let P O P' represent the polar axis of the earth; a b a horizontal rod at the pole bearing a pendulum, as in Fig. 1. It is clear that if the earth is rotating about P O P' in the direction shown by the arrow, the rod a b is being shifted round, precisely as in the case first considered. The swinging pendulum below it will not partake in its motion; and thus, through whatever arc the earth rotates from west to east, through the same arc will the plane of swing of the pendulum appear to travel from east to west under a b.

But we cannot set up a pendulum to swing at the pole of the earth. Let us inquire, then, whether the experiment ought to have similar results if carried out elsewhere.

Suppose A B to be our pendulum-bearing rod, placed (for convenience of description merely) in a north and south position. Then it is clear that A B produced meets the polar axis produced (in E, suppose), and when, owing to the earth's rotation, the rod has been carried to the position A' B', it still passes through the point E. Hence it has shifted through the angle A E A', a motion which corresponds to the case of the motion of A B (in Fig. 1) about the point E,* and the plane of the pendulum's swing will

*In reality A E moves to the position A' E over the surface of a cone

therefore show a displacement equal to the angle A E A'. It will be at once seen that for a given arc of rotation the displacement is smaller in this case than in the former, since the angle A E A' is obviously less than the angle A K A'.* In our latitude a free pendulum should seem to shift through one degree in about five minutes.

It is obvious that a great deal depends on the mode of suspension. What is needed is that the pendulum should be as little affected as possible by its connection with the rotating earth. It will surprise many, perhaps, to learn that in Foucault's original mode of suspension the upper end of the wire bearing the pendulum bob was fastened to a

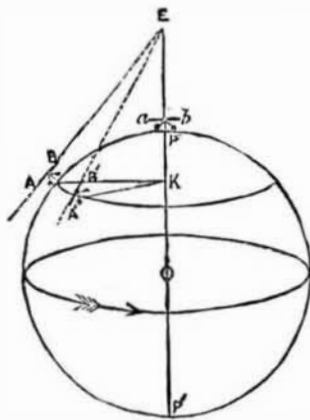


Fig. 2.

metal plate by means of a screw. It might be supposed that the torsion of the wire would appreciably affect the result. In reality, however, the torsion was very small.

Still, other modes of suspension are obviously suggested by the requirements of the problem. Hansen made use of the mode of suspension exhibited in Fig. 3. Mr. Worms, in a series of experiments carried out at King's College, London, adopted a somewhat similar arrangement, but in place of the hemispherical segment he employed a conoid, as shown in Fig. 4, and a socket was provided in which the conoid could work freely. From some experiments I made myself a score of years ago, I am inclined to prefer a plane surface for the conoid to work upon. Care must be taken that the first swing of the pendulum may take place truly in one plane. The mode of liberation is also a matter of importance.

Many interesting experiments have been made upon the motions of a free pendulum, regarded as a proof of the earth's rotation, and when carefully conducted, the experi-

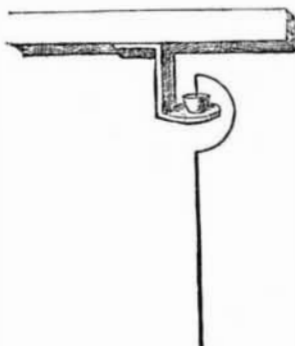


Fig. 3.



Fig. 4.

ments have never failed to afford the most satisfactory results. Space, however, will only permit me to dwell on a single series of experiments. I select those made by Mr. Worms in the Hall of King's College, London, in the year 1859:

"The bob was a truly turned ball of brass weighing 40

having E P' as axis, and E as vertex; but for any small part of its motion, the effect is the same as though it traveled in a plane through E, touching this cone; and the sum of the effects should clearly be proportional to the sum of the angular displacements.

*In fact, the former angle is less than the latter, in the same proportion that A K is less than A E, or in the proportion of the sine of the angle A E P, which is obviously the same as the sine of the latitude.

lb.; the suspending medium was a thick steel wire; the length of the pendulum was 17 feet 9 inches. The amplitude of the first oscillation was 6° 42', and during the time of the experiment—about half an hour—the arcs were not much diminished. As I had to demonstrate to a large number of spectators, I encountered considerable difficulty," says Mr. Worms, "in rendering the small deviations of the plane of oscillation visible to all. I accomplished it in three different ways." These he proceeds to describe. He had first a set of small cones set up, which were successively knocked down as the change in the plane of the pendulum slowly brought the pointer under the bob to bear on cone after cone. Secondly, a small cannon was so placed that the first touch of the pendulum pointer against a platinum wire across the touch-hole completed a galvanic circuit, and so fired the cannon. Lastly, a candle was placed so as to throw the shadow of the pendulum bob upon a ground-glass screen, and so to exhibit the gradual change of the plane of swing.

The results accorded most satisfactorily with the deductions from the theory of the earth's rotation.

A NEW LUNARIAN.

By Prof. C. W. MACCORD, Sc.D.

THE construction of apparatus for illustrating the motions of the heavenly bodies has often occupied the attention of both mathematicians and mechanicians, who have produced many very ingenious, and in some cases very complicated, combinations. These may be divided into two classes; the object of the first being to represent *exactly* what occurs—to reproduce the precise movements of the various bodies represented in their true proportions and relations to each other, in respect to distances, magnitudes, times, and phases. When the absolute complexity of the movements of the bodies composing the solar system is considered, it is not so much a matter of wonder that a planetarium which shall thus imitate them is a very delicate and complicated machine as that it should lie within the limits of human ingenuity.

In the second class, the object is to show the nature and the causes of specific phenomena, without regard to others perhaps, and without necessarily paying attention to exact proportions of distances and dimensions. Indeed, it is often the case that the illustration is made clearer by exaggerating some of these and reducing others; thus, for example, the causes of the variation in the lengths of the days and nights, and of the changes in the seasons, can be exhibited to much better advantage by an apparatus in which the diameter of the sun and its distance from the earth are enormously reduced than they possibly could be were they of their proper proportionate magnitudes; nor is the presence of any other planet, or the attendance of a satellite, at all necessary or even desirable for the purpose named.

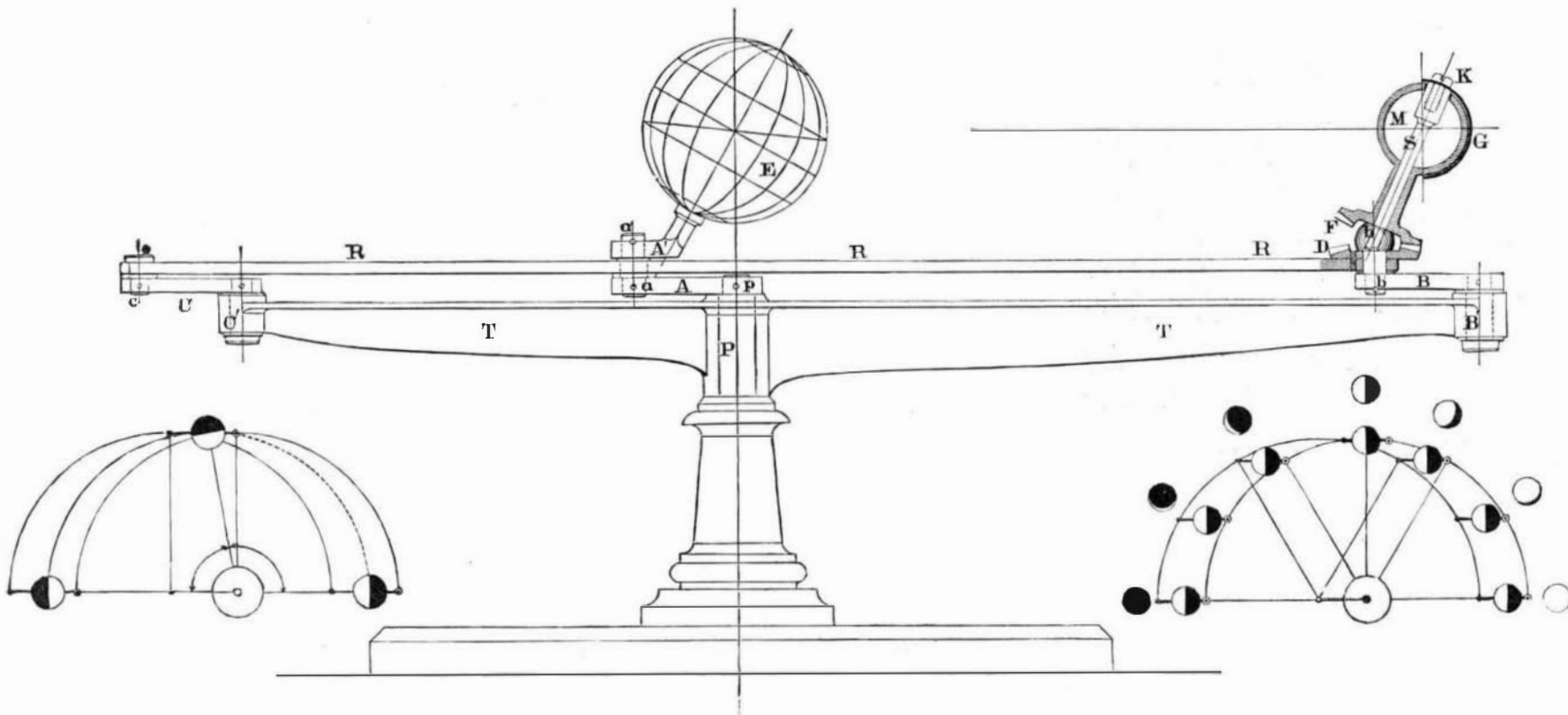
It is apparent that machines of this class can be made much more simple than those of the first, while at the same time it may safely be asserted that for educational purposes they are far more useful.

In both classes, the action involves the use of some sort of epicyclic train, since the motions to be explained are both orbital and axial. The planetary body is carried round by a train-arm, and its rotation about its axis is usually given it by a train of gearing, the inner or central wheel of which is stationary, being fastened to the fixed frame supporting the whole.

The lunarian which we herewith present belongs to the second of the classes above named; in its construction an attempt has been made to show by as simple means and in as clear a manner as possible the nature of the following phenomena, viz.:

1. Apogee and perigee.
2. The moon's phases.
3. The rotation on her axis, by reason of which she always presents nearly the same face to the earth.
4. The inclination of her axis to the plane of her orbit, and her consequent libration in latitude.
5. Her varying angular velocity, and consequent libration in longitude.

The mechanism consists of a train-arm, T, which turns upon the vertical pivot, P, fixed in the stand. In this arm, T, are the bearings of two cranks, B and C, equal in length to each other and to a third crank, A, which is stationary, being fixed to the pivot, P, by a pin, p. To the crank-pin of A is secured a reverted arm, A', which supports the earth, E, and keeps it also stationary. The three cranks are connected by the rod, R, like the parallel rod of a locomotive; to which is fastened by a steady-pin, o, the bevel wheel, D,



AN IMPROVED LUNARIAN.

concentric with the crank-pin, *b*. The head of this crank-pin is first made spherical, then faced off at an angle with the axis of *b*, and in the sloping face is firmly fixed the long screw, *S*, forming the support for the moon, *M*, which is caused to rotate about the axis of *S*, by means of the wheel, *F*, equal to and engaging with *D*. The upper end of *S* projects slightly through a perforation in the moon, and to it the hemispherical black shell or cap, *G*, is fixed by the screw, *K*; this cap represents the unilluminated part of the moon, and since *G*, *s*, *b*, and *B*, are in effect but one piece, the cap moves precisely as the crank does.

Now as the train-arm, *T*, is carried round, the cranks, *B* and *C*, will turn in their bearings; but by their connection with *A*, they are compelled to remain always parallel to themselves, and thus the axis of the moon receives a motion of translation. But since during this action the wheel *D* turns relatively to the pin *b*, the moon evidently rotates about its axis with an angular velocity precisely equal to that of its orbital motion.

The black shell however has the motion of translation only, and thus exhibits the phases of the moon, on the supposition that the source of light is infinitely remote and the rays come always in the same direction, which is not strictly true, of course; but the reasons of the varying appearance are as clearly shown as if it were absolutely exact. The same may be said in regard to the phenomena of libration; the inclination of the moon's axis to the plane of her orbit is really small, but is purposely exaggerated in this apparatus in order to make the results apparent; in the position represented, it is quite obvious that an observer upon the earth can see a little past one pole, and cannot quite see the other, as well as that this condition will be reversed after half a revolution.

The action in reference to the phases is clearly shown in the small diagram on the right. The one on the left illustrates the manner in which the libration in longitude is made apparent. It will be noted that the center of *M* is not directly over the axis of the bearing of the crank, *B*, so that after half a revolution the moon will be farther from the earth than she is here shown. Her orbit here is circular, whereas, in fact, it is an ellipse; but the earth not being in the center, her angular velocity in relation to the earth is variable, the result of which is that, when she is near her quadrature, the actual force presented to the earth is slightly different from that presented when in conjunction or opposition.

Thus these various peculiarities of the motion of our satellite are exhibited by comparatively simple means—the number of moving parts being, it is believed, as small as it can be made; and the substitution of a crank motion for the usual train of wheels, we think, is a new device.

THE UPRIGHT ATTITUDE OF MANKIND.

EVERY one must have heard or have read of the supposed perfect adaptation of the human frame to bipedal locomotion and to an upright attitude, as well as the advantages which we gain by this erect position. We are told, and with perfect truth, that in man the occipital foramen—the aperture through which the brain is connected with the spinal cord—is so placed that the head is nearly in equilibrium when he stands upright. In other mammalia this aperture lies further back, and takes a more oblique direction, so that the head is thrown forward, and requires to be upheld partly by muscular effort and partly by the ligamentum nuchæ, popularly known in cattle as the “pax-wax.”

Again, the relative lengths of the bones of the hinder extremities in man form an obstacle to his walking on all-fours. If we keep the legs straight we may touch the ground in front of our feet with the tips of the fingers, but we cannot place the palms of the hands upon the ground and use them to support any part of our weight in walking. Not a few other points of a similar tendency have been so often enlarged upon, in works of a teleological character, that there can be no need even to specify them at present.

But till lately it has never been asked, “Is man's adaptation to an upright posture perfect?” and “Is this posture attended with no drawbacks?” These questions have been raised by Dr. S. V. Clevenger in a lecture delivered before the Chicago University Club, on April 18, 1882, and recently published in the *American Naturalist*. This lecture, we may add, cost the speaker the chair of Comparative Anatomy and Physiology at the Chicago University!

Dr. Clevenger first discusses the position of the valves in the veins. The teleologists have long told us that the valves in the veins of the arms and legs assist in the return of blood to the heart against gravitation. But what earthly use has a man for valves in the intercostal veins which carry blood almost horizontally backward to the azygos veins? When recumbent, these valves are an actual obstacle to the free flow of the blood. The inferior thyroid veins which drop their blood into the innominate are obstructed by valves at their junction. Two pairs of valves are situated in the external jugular, and another pair in the internal jugular, but they do not prevent regurgitation of blood upward.

An anomaly exists in the absence of valves from parts where they are most needed, such as the venæ cavæ, the spinal, iliac, hæmorrhoidal, and portal veins.

But if we place man upon all-fours these anomalies disappear, and a law is found regulating the presence or absence of valves, and, according to Dr. Clevenger, it is applicable to all quadrupeds and to the so-called Quadrumana. Veins flowing toward the back, *i. e.*, against gravitation in the all-fours posture—are fitted with valves; those flowing in other directions are without. For the few exceptions a very feasible explanation is given.

Valves in the hæmorrhoidal veins would be useless to quadrupeds; but to man, in his upright position, they would be very valuable. “To their absence in man many a life has been and will be sacrificed, to say nothing of the discomfort and distress occasioned by the engorgement known as piles, which the presence of valves in their veins would obviate.”

A noticeable departure from the rule obtaining in the vascular system of mammalia also occurs to the exposed situation of the femoral artery in man. The arteries lie deeper than the veins, or are otherwise protected, for the purpose—as a teleologist would say—of preventing serious loss of blood from superficial cuts. Translating this view into evolutionary language, it appears that only animals with deeply placed arteries can survive and transmit their structural peculiarities to their offspring. The ordinary abrasions to which all animals are exposed, not to mention their onslaughts upon each other, would quickly kill off species with superficially placed arteries. But when man assumed the upright posture the femoral artery, which in the quadrupedal position is placed out of reach on the inner part of the thigh, became exposed. Were not this defect greatly com-

pensated by man's ability to protect this part in ways not open to brutes, he, too, might have become extinct. As it is, this exposure of so large an artery is a fruitful cause of trouble and death.

We may here mention some other disadvantages of the upright position which Dr. Clevenger has omitted. Foremost comes the liability to fall due to an erect posture supported upon two feet only. Four-footed animals in their natural haunts are little liable to fall; if one foot slips or fails to find hold, the other three are available. If a fall does occur on level ground, there is very little danger to any mammal nearly approaching man in bulk and weight. Their vital parts, especially the heart and the head, are ordinarily so near the ground that to them the shock is comparatively slight. To human beings the effects of a fall on smooth, level ground are often serious, or even deadly. We need merely call to mind the case of the illustrious physicist whom we have so recently and suddenly lost.

The upright attitude involves a further source of danger. In few parts (if any) of the body is a blow more fatal than over what is popularly called the “pit of the stomach.” In the quadruped this part is little exposed either to accidental or intentional injuries. In man it is quite open to both. A blow, a kick, a fall among stones, etc., may thus easily prove fatal.

Another point is the exposure and prominence of the generative organs, which in most other animals are well protected. Leaving danger out of the question, it may be asked whether we have not here the origin of clothing? The assumption of the upright posture may have made primitive man aware of his nakedness.

Returning to the illustrations furnished by Dr. Clevenger, we are reminded that another disadvantage which occurs from the upright position of man is his greater liability to inguinal hernia. In quadrupeds the main weight of the abdominal viscera is supported by the ribs and by strong pectoral and abdominal muscles. The weakest part of the latter group of muscles is in the region of Poupart's ligament, above the groin. Inguinal hernia is rare in other vertebrates because this weak part is relieved by the pressure of the viscera. In man the pelvis receives almost the entire load of the intestines, and hence Art is called in to compensate the deficiencies of nature, and an immense number of trusses have to be manufactured and used. It is calculated that 20 per cent. of the human family suffer in this way. Strangulated hernia frequently causes death. The liability to femoral hernia is in like manner increased by the upright position.

Now, if man has always been erect from his creation—or, if that term be disliked, from his origin—we have evidently nothing to hope from the future in the way of an amendment of this and other defects. But if we have sprung from a quadrupedal animal, and have by degrees adopted an upright position, to which we are as yet imperfectly adapted, the muscular tissues of the abdomen will doubtless in the lapse of ages become strengthened to meet the demand made upon them, so that the liability to rupture will decrease. In like manner the other defects above enumerated may gradually be rendered less serious.

A most important point remains: the peritoneal ligaments of the uterus fully subserve suspensory functions. The anterior, posterior, and lateral ligaments are mainly concerned in preventing the gravid uterus, in quadrupeds, from pitching too far forward toward the diaphragm. The round ligaments are utterly unmeaning in the human female, but in the lower animals they serve the same purpose as the other ligaments. Prolapsus uteri, from the erect position and the absence of supports adapted to the position, is thus rendered common, destroying the health and happiness of multitudes.

As a simple deduction from mechanical laws, it would readily follow that any animal or race of men which had for the longest time maintained an erect position would have straighter abdomens, wider pelvic brims with contracted pelvic outlets, and that the weight of the spinal column would force the sacrum lower down. This, generally speaking, we find to be the case. In quadrupeds the box-shaped pelvis, which admits of easy parturition, is prevalent. Where the position of the animal is such as to throw the weight of the viscera into the pelvis, the brim necessarily widens, these weighty organs sink lower, and the heads of the thigh-bones acting as fulcrum permit the crest of the ilium to be carried outward, while the lower part of the pelvis is at the same time contracted.

In the innominate bones of a young child the box-shape exists, while its prominent abdomen resembles that of the gorilla. The gibbon exhibits this iliac expansion through the sitting posture which developed his ischial callosities. Similarly iliac expansion occurs in the chimpanzee. The megatherium had wide iliac expansions due to its semierect habits; but as its weight was in great part supported by the huge tail, and as the femora rested in acetabula placed far forward, the leverage necessary to contract the lower portion of the pelvis was absent.

Prof. Weber, of Bonn, quoted in Karl Vogt's “Vorlesungen ueber den Menschen,” distinguishes four chief forms of the pelvis in mankind—the oval in Aryans, the round among the Red Indians, the square in the Mongols, and the wedge-shaped in the Negro. Examining this question mechanically it would seem that the longer a race had remained in an upright position the lower is the sacrum, and the greater is the tendency to approximate to the larger lateral diameter of the European female. The front to back diameter of the ape's pelvis is usually greater than the measurement from side to side. A similar condition affords the cuneiform, from which it may be inferred that the erect position in the Negro has not been maintained so long as in the Mongol, whose pelvis has assumed the quadrilateral shape owing to persistence of spinal axis weight for a greater time. This pressure has finally culminated in forcing the sacrum of the European nearer the pubes, with consequent lateral expansion and contraction of the diameter from front to back. From the marsupials to the lemurs the box-shaped pelvis remains. With the wedge-shape occasioned in the lowest human types there occurs a further remarkable phenomenon in the increased size of the fetal head accompanying the contraction of the pelvic outlet. While the marsupial head is about one-sixth the size of the narrowest part of the bony parturient canal, the moment we pass to erect animals the greater relative increase is there seen in cranial size, with a coexisting decrease in the area of the outlet. This altered condition of things has caused the death of millions of otherwise perfectly healthy and well-formed human mothers and children. The palæontologist might tell us if some such case of ischial approximation by natural mechanical causes has not caused the probable extinction of whole genera of vertebrates. “If we are to believe that for our original sin the pangs and labor of childbirth were increased, and if we also believe in the disproportionate contraction of the pelvic space being an efficient cause of the same difficulties

of parturition, the logical inference is that man's original sin consisted in his getting upon his hind legs.”

This subject is not without direct applications. Accoucheurs cause their patients to assume what is called the knee-chest position, a prone one, for the purpose of restoring the uterus to something near a natural position. Brown-Sequard recommends, in myelitis, or spinal congestion, drawing away the blood from the spine by placing the patient on his abdomen or side, with hands and feet somewhat hanging down. The liability to *spina bifida* is greatest in the human infant, through the stress thrown on the spine. The easy parturition in the lower human races is due to the discrepancy between cranial and pelvic sizes not having been as yet reached by those races. The Sandwich Island mother has a difficult delivery only when her child is half white, and has consequently a longer head than the unmixed native strain.

At present the world goes on in its blindness, apparently satisfied that everything is all right because it exists, ignorant of the evil consequences of apparently beneficial peculiarities, vaunting man's erectness and its advantages, while ignoring the disadvantages.

The observation that the lower the animal the more prolific (not universally true!) would warrant the belief that the higher the animal the more difficulties encompass its propagation and development. The cranio-pelvic difficulty may perhaps settle the Malthusian question as far as the higher races of men are concerned by their extinction.

[If the facts brought forward by Dr. Clevenger cannot be controverted, they seem to prove that man must have originated by gradual development from a four-footed being. Had he been created an erect, bipedal animal, as we find him, his structure would have been not in partial, but in perfect, adaptation to the conditions of that attitude. That some of the peculiarities of his structure are better in harmony with a horizontal than a vertical position of the spinal column, is perhaps the strongest argument against the theory of direct creation and the radical *totò calo* distinction between man and beast that has yet been advanced. We cannot at the moment lay our hands upon any thorough and trustworthy account of the valves in the veins of the sloth: as that animal spends its life hanging, back downward, the structure of the veins would be interesting in this connection. —Ed. J. S.]—*Journal of Science*.

OUR ENEMIES, THE MICROBES.

WE have seen the microbes, as our servants,* often performing, unbeknown to us, the work of purifying and regenerating the soil and atmosphere. Let us now examine our enemies, for they are numerous. Everywhere frequent—in the air, in the earth, in the water—they only await an occasion to introduce themselves into our body in order to engage in a contest for existence with the cells that make up our tissues; and, often victorious, they cause death with fearful rapidity. When we have named charbon, septicæmia, diphtheria, typhoid fever, pork measles, etc., we shall have indicated the serious affections that microbes are capable of engendering in the animal organism.

We call those diseases “parasitic” that are occasioned by the introduction of a living organism into the bodies of animals. Although a knowledge of such diseases is easy where it concerns parasites such as acari and worms, it becomes very difficult when it is a question of diseases that are caused by the Bacteriaceæ. In fact, the germs of these plants exist in the air in large quantities, as is shown by the analysis of pure air by a sunbeam, and we are obliged to take minute precautions to prevent them from invading organic substances. If, then, during an autopsy of an individual or animal, a microscopic examination reveals the presence of microbes, we cannot affirm that the latter were the cause of the affection that it is desired to study, since they might have introduced themselves during the manipulation, and by reason of their rapid vegetation have invaded the tissues of the dead animal in a very short time. The presumption exists, nevertheless, that when the same form of bacteria is present in the same tissue with the same affection, it is connected with the disease. This was what Davaine was the first to show with regard to *Bacillus anthracis*, which causes charbon. He, in 1850, having examined the blood of an animal that had died of this disease, found therein amid the globules (Fig. 1), small, immovable, very narrow rods of a length double that of the blood corpuscles. It was not till 1863 that he suspected the active role of these organisms in the charbon malady, and endeavored to demonstrate it by experiments in inoculation. Is the presence of these little rods in the blood of an animal that has died of charbon sufficient of itself to demonstrate the parasitic nature of the affection? No; in order that the demonstration shall be complete, the bacteria must be isolated, cultivated in a state of purity in proper liquids, and then be used to inoculate animals with. If the latter die with all the symptoms of charbon, the demonstration will be complete. Davaine did, indeed, perform some experiments in inoculation that were successful, but his results were contradicted by the experiments of Messrs. Jaillard and Leplat, and those of Mr. Bert concerning the toxic influence of oxygen at high tension upon microbes. As Davaine was unable to explain the contradiction between his results and those of Messrs. Jaillard, Leplat, and Bert, minds were not as yet convinced, notwithstanding the support that his ideas received from Mr. Koch's researches.

In 1877 Mr. Pasteur took up Davaine's experiments, and confirmed his affirmations step by step by employing the method of culture that he had used with such success in his studies upon fermentation. He isolated Davaine's bacterium by cultivating it in a decoction of beer yeast that had been previously sterilized (Fig. 2); and after from ten to twenty cultures, he found that a portion of the liquid containing a few bacteria, when used for inoculating a rabbit, quickly caused the latter to die of charbon, while the same liquid, when filtered through plaster or porcelain, became harmless.

Davaine's bacterium develops exclusively in the blood, and is never found at any depth in the tissues. This is due to the fact that the alga, having need of oxygen in order to live, borrows its flow from the blood, and thus extracts from the globules that which they should have carried to the tissue. The animal therefore dies asphyxiated. It is on account of the absence of oxygen in the blood that the latter assumes the blackish-brown color that characterizes the malady, and that has given its name of charbon (coal).

The parasitic nature of charbon was therefore absolutely demonstrated, first, by the constant presence of *Bacillus anthracis* in the blood of anthracoid animals, and second, by the pure culture of the parasite and the inoculation of animals with charbon by means of it.

Davaine began the demonstration in 1863, and Pasteur

*SUPPLEMENT, No. 446, page 7125.