frontal convolution. A paper by Dr. John Punton follows, treating of mysophobia, with a report of a case, and emphasizing the close relation which exists between the so-called neurasthenias and insanity. Dr. Theodore A. Hoch's paper on acute anterior poliomyelitis, begun in the previous number, is concluded, with an exhaustive bibliography, and Dr. William W. Graves contributes a short paper on anesthesia associated with hyperalgesia sharply confined to the areola-nipple area of both breasts, which his experience leads him to consider as a pathognomic and practically constant stigma in hysteria.

We learn from the *British Medical Journal* that the publication of a quarterly periodical, to be called the *Journal of Tropical Veterinary Science*, has been undertaken by Messrs. H. T. Pease, principal of Lahore Veterinary College; F. S. H. Baldry, professor of sanitary science, Punjab Veterinary College, and R. E. Montgomery, assistant imperial bacteriologist, Imperial Bacteriological Laboratory, Muktesar, U. P. Each number will, as far as possible, consist of original articles of scientific interest, with reviews and extracts from current literature. Nothing of a personal or political nature will appear in the journal. Amongst the subjects to be dealt with in the forthcoming numbers, for which arrangements have already been made, will be a series of articles on the anatomy, physiology, and pathological conditions of the camel and the elephant; the intestinal and other parasites of animals; the biting flies and the ticks of India, together with their importance in the transmission of disease. The first number will appear on January 1, 1906. The publishers are Messrs. Thacker, Spink and Co., Calcutta.

DISCUSSION AND CORRESPONDENCE.

CYANIDE OF POTASSIUM.

To the Editor of Science: Recently when at Minas Prietas, Sonora, at the cyanide plant of Charles Butters, Limited, I observed in one of the settling tanks which was nearly full of pulverized ore, known metallurgically as 'slime,' that the surface of this material, which was saturated with and covered by a solution of cyanide of potassium, was pitted by holes and marked by trails, which I assumed to belong to some small invertebrate. That they were of organic origin seemed too obvious to be worthy of question.

There was no opportunity for me to wait until the solution was drawn down sufficiently to permit of a careful examination of the surface of the pulverized material, so it remains for some future observer to determine the identity of the form which produced the markings.

The observation is communicated to you in the hope that it may invoke a communication of similar observations on the part of others. What seemed remarkable to the writer was that any form of animal life could exist in a solution of cyanide of potassium.

F. J. H. Merrill.

SPECIAL ARTICLES.

THE PARACHUTE EFFECT OF THISTLE-DOWN.

The importance of the down of the Canada thistle (*Carduus arvensis*) for seed distribution is a matter of common knowledge, but it may not be quite so well known just how this is accomplished from a mechanical point of view.

When the head of the Canada thistle is mature and the day dry (moisture closes up the head even though mature), the scales of the involucre spread and expose the fluffy mass to the air. At this time the achenes may be detached from the receptacle by the slightest force, permitting them to float away attached to the down. This closing of the head is brought about by the unequal turgescence of the cells in the bracts of the involucre.

The down which grows on the receptacle—not on the achenes—serves the function of helping to keep water from entering the head, thus permitting the achenes to become thoroughly dry, though the weather may be damp at the time. Dampness tends to hold the achenes fast to the receptacle, and this tends, in some measure, to defeat the purpose of the down, because it may become detached from the achene and float away without its precious burden. Both the calyx-down and the receptacle-down are of such a nature that water will not adhere to them. This is because the surface has a stronger attraction for air than for water, owing to the fact that the surface is coated with a substance of an oily nature. Alcohol removes this substance.

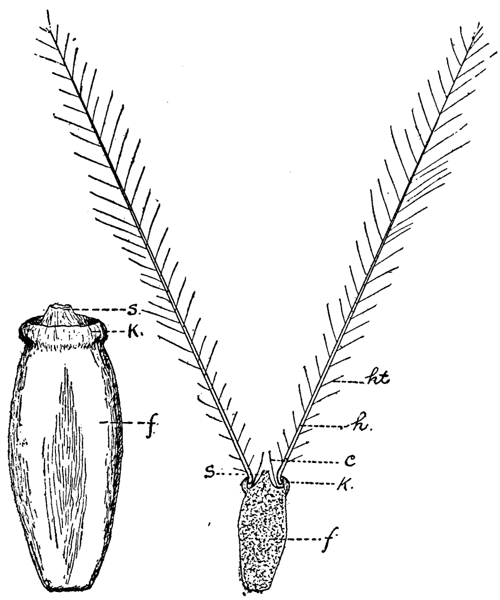

FIG. 1. *f*, the fruit (achene); *k*, collar round the summit of the achene, inside the edge of which the pappus hairs are supported, at the base for a distance of about .25 mm., forming a ring; *h*, the hair; *ht*, the hairlet; *c*, the base of the withered corolla; *s*, remains of the style broken away. (The style and corolla usually persist until the achene breaks from the pappus.) The diagram to the right is an imaginary vertical section. The drawing to the left is a view of an achene after the down has been detached. The hairs when dry are at an angle of about 45° to the vertical. The hairlets are at an angle of about 45° to the axis of the hair. Hence the hairlets make an angle of about 90° to each other, so that at whatever angle they be placed, the resultant effect can not be less than that of 45°. It will be noticed that the collar *k*, being slightly smaller at the extreme edge, clamps round the base of the ring of hairs. This is the more effective because the ring of pappus is slightly larger at its lower edge, making the collar act like a wedge. This is indicated in the diagram to the right.

From the nature and the position of the receptacle-down, it may once have served the function of moving the whole head by the aid of the wind; so that the suggestion is here offered that the achene-down is a later development from the point of view of evolution.

When the down, with its attached achene, is exposed to dry air for a few days, the contracting end of the achene causes it to rupture from the collar of the calyx-down, and thus a separation takes place eventually. This, of course, is an advantage, because the seed may thus reach a suitable place in the soil for germination. If the pappus remained attached, the chances for germination would be greatly diminished, because the down would then be but a hindrance by holding the achene above the soil. In many cases, therefore, the thistle-down seen floating in the air has no achene attached; and this separation would likely take place while floating in the air, because of the favorable conditions there for drying out.

A minute examination was made of several heads of thistle-down with a view to ascertain to what extent the down was adapted to the air conditions. In the heads there are from 95 to 120 achenes; or an average of about 108 per head; and there is an average of 80 hairs to one achene-cluster, and 110 hairlets on each hair. These hairlets are .005 mm. in diameter and 2 mm. long (approximately). The surface area of each hairlet would be $\pi \times .005 \times 2$; and of all the hairlets in each head: $\pi \times .005 \times 2 \times 80 \times 108$ sq. mm. The hairs being each .06 mm. in diameter, and 23 mm. long, the surface area for the whole head would be:

$$\pi \times .06 \times 23 \times 80 \times 108.$$

The cells composing the pappus are filled with air when the achenes are mature, and this adds to the buoyancy, but the inside surface is not here computed because it has nothing to do directly with the surface attraction of the pappus for the air of the atmosphere.

The total external surface area, therefore, would be:

$$\pi \times .005 \times 2 \times 110 \times 80 \times 108 + \pi \times .06 \times 23 \times 80 \times 108$$
$$= 67{,}342.6 \text{ square mm.}$$
$$= 673.426 \text{ square cm.}$$

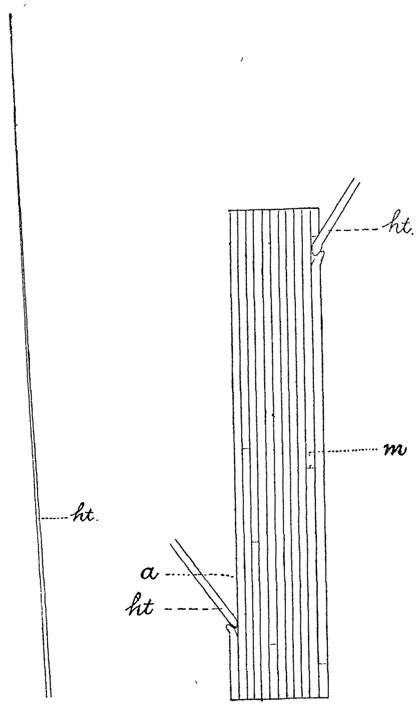

FIG. 2. The diagram to the left shows a hairlet, single cell, cavity filled with air. The other diagram is an optical longitudinal section through the diameter of a hair, showing the long, narrow, thin-walled cells. These are filled with air. *m*, cross wall; *ht*, hairlet; *a*, narrowing due to the extended cell *ht*. This illustrates the chief means of tapering of the hair, it being smaller at this point by the size of the hairlet.

Now, if this down-substance be considered as a flat lamina, it would have an area of one half of 673.426 sq. cm., because the lamina has two sides; and, as the lamina would be so exceedingly thin, the other surfaces may be neglected. Now, if t represent the thickness in centimeters, a the area in sq. cm., and s the specific gravity of cellulose,

$$\text{then } ats = \text{weight in grams,}$$

but, by actual experiment, the weight of all the downs (excluding achenes) in a head is .0561 grams,

$$\text{therefore } ats = .0561$$
$$= \frac{.0561}{as}$$
$$= \frac{.0561}{336\ 713 \times 1.13^{1}}$$
$$= .0000375$$

the thickness of the lamina in cm. It would, therefore, require over 26,000 of such laminæ to produce a thickness of one cm.

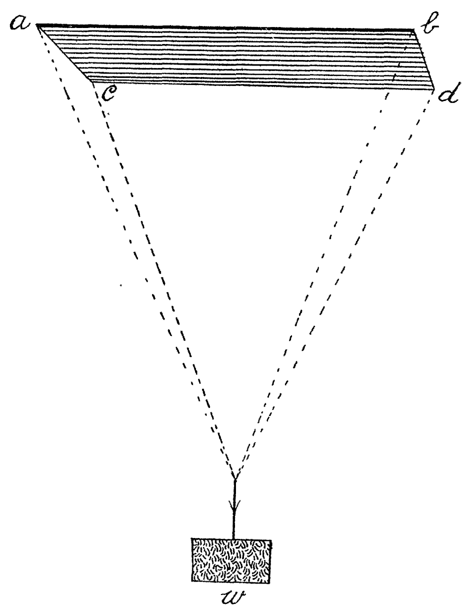

FIG. 3. Illustrates the parachute action of the lamina *abdc* when it is horizontal and, therefore, capable of producing its greatest effort. In the calculation, $w = 150$ lbs.

In the Standard Dictionary there are about 2,300 pages, having a total thickness of 11 cm., something over 200 pages to the centimeter. Therefore, to express in a striking manner, it may be said that it would take about 130 of such laminæ to make the thickness of one leaf of the paper just mentioned.

The weight of the achenes themselves—excluding the down—in a head, are approximately .108 gram; so that, for each gram weight of achenes, there is a surface area of 6,235.42 square centimeters.

[1] The specific gravity of cellulose in Swedish filter paper is 1.13 very approximately.

The adaption of thistle-down to floating in the air is seen at once to be quite remarkable.

The down acts as a parachute to carry the seed, and a calculation will set forth how great this force may be. It will be considered that the lamina referred to is placed horizontally and the achene attached. The rate at which the achene (with the down attached) will fall in still air is as explained in the solution given below:

In the formula $P = .004V^2S$,[2] P stands for the pressure in pounds per square foot, V the velocity in miles per hour, and S the number of square feet.

The downs and the achenes in a head weigh

$$.108 + .0561 = .1641 \text{ gram},$$

and the surface area of one side of the lamina is 326.713 square centimeters; but one gram $= .0022046$ pound, and one sq. cm. $= .155$ sq. in., therefore,

$$.0022046 \times .1641 = 004\, V^2 \times \frac{326.713 \times 155}{144}$$

$$\therefore\ V = .35 \text{ miles per hr. (approx.)}$$

From this it may be seen that a thistle-down starting from an elevation of 20 feet, would take 20/1848 hours to fall; and if we suppose the wind to be blowing at 20 miles per hour, the achene would be carried a distance of .21 mile, *i. e.*, about one fifth of a mile. In this calculation, all cross currents and changes of air are neglected.

In this parachute calculation, the lamina is supposed to be horizontal. This condition would necessarily give the maximum of the parachute effect. Now, if this be represented by E, the minimum effort could not be less than $1/\sqrt{2}\, E$, because of the configuration of the parts of the thistle-down.

Another illustration might possibly bring out more prominently the parachute effect: If a weight of 150 pounds be attached to the down in such a way that they will act with the maximum effect; and it be required to ascertain how many would be required to 'parachute' that weight so that it would fall at the rate of five miles per hour, the equation would be

$$150 = .004 \times 5 \times 5 \times S,$$

therefore,

$$S = 1{,}500 \text{ square feet};$$

but the down-lamina is, for a whole head of 108 achenes, 326.713 sq. cm., or .3624 sq. ft., therefore it would require

$$\frac{1{,}500 \times 108}{.36244} = 447{,}019 \text{ downs.}$$

In all these calculations, neither the viscosity of the air nor its capillary (surface) attraction is taken into account, though the latter is very considerable, as may be seen from the fact that small (microscopic) particles of sand, iron and the like, float, and

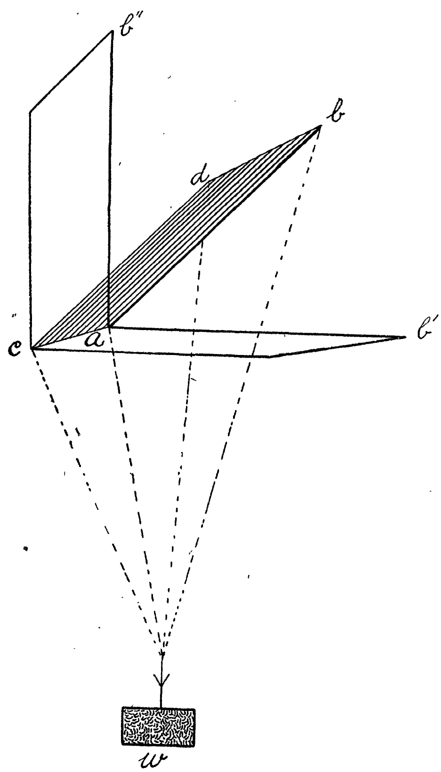

FIG. 4. The plane *abdc* is at an angle of 45°. The horizontal cross-section of the mass of air displaced in the descent of the plane, in this position, would be the area of *abdc* divided by the square root of 2. From the configuration of the parts of the down, this would give the minimum effect. (See Fig. 1.)

[2] Kent's 'Mechanical Engineering,' pocket edition, p. 492. This is the value given by Smeaton, 1759, but others have given it as low as $P = .0029V^2S$.

fall very slowly in the air. Theoretically, a small spherical body should fall at the same rate as a large spherical body of the same composition; but it does not, and this may easily be demonstrated by throwing a shovelful of coal composed of pellets of various sizes—some as fine as dust—into the air at a height of even six or eight feet. The very finest dust floats for some time in the air, and the largest pellets reach the ground first. It is indeed due to this surface attraction that small bodies like pollen grains, fungus spores and the like, are capable of being transported through the air over such great distances.

J. B. DANDENO.
AGRICULTURAL COLLEGE, MICHIGAN,
April 3, 1905.

THE WEIGHT OF THE BRONTOSAURUS.

AT the request of Professor H. F. Osborn the writer undertook to make an estimate of the probable weight in the flesh of a *Brontosaurus excelsus*. The mounted skeleton in the American Museum is 66 feet 7 inches long, and from this a very carefully studied model or restoration was made by Mr. Charles R. Knight, who also made use of Dr. W. D. Matthew's studies upon the probable size and arrangement of the muscles in this animal. The skeleton was mounted after the prolonged study and discussion of a number of specialists; its contours are strikingly lifelike, and Mr. Knight's long training well qualified him to infer the external contours of an animal from its internal framework. Hence the model should correspond fairly well with the animal itself.

From the model, a number of plaster casts were made, and one of these was used in the following determination. The model was constructed as nearly as possible to the exact scale of one sixteenth natural size, hence the cubic contents of the model multiplied by the cube of 16 (4096) should indicate the probable volume of water which would be displaced by the animal in the flesh. One of the casts was cut into six pieces of convenient size, which were then made water-tight by a double coating of shellac. Professor William Hallock very kindly consented to determine accurately the cubic contents of these pieces in one of the physical laboratories at Columbia University.

The weight of the cast in air minus its weight in water would equal the weight of an equal volume of water. This differential weight was determined in grams. As a gram is the weight of a cubic centimeter of water the weight of the water displaced gave directly the cubic contents of the model. Professor Hallock found the weight of the water displaced to be 7,595 grams (about .27 cubic feet), or say 7.6 kilograms. Hence the animal itself would displace $7{,}595 \times (16)^3 = 31{,}129{,}600$ c.c. or 31.13 metric tons. Converting this into tons, we have $31.13 \times 2{,}200 \div 2{,}000 = 32.24$, or say $34\frac{1}{4}$ tons, as the estimated weight of the water displaced by the animal. But as the animal was probably slightly heavier than the water displaced, in order to enable it to walk on the bottom along the shore of lakes and rivers, we may add about ten per cent. to $34\frac{1}{4}$ tons, securing as a final estimate 38 tons.

This result accords very well with Mr. F. A. Lucas's careful estimate of the weight of a 75-foot sulphur bottom whale, an animal of much greater bulk than the *Brontosaurus*. This weighed about 63 tons, and in conversation with the writer Mr. Lucas expressed the opinion that the *Brontosaurus* did not weigh 'much more than half as much.' This opinion seems justified by the estimate given above.

W. K. GREGORY.
AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK,
September 30, 1905.

QUOTATIONS.

COLLEGE ADMINISTRATION.

OF the several conferences of the installation week at Champaign-Urbana, the one announced as a conference of trustees to consider methods of administration builded larger and possibly better than it knew. It included not alone the problems of the conduct of the business machinery of these great corporations, but raised the fundamental issues in regard to *raison d'être* of boards and presidents, and administrative means and measures. And it raised the most pertinent query as to the