very irregular, light in texture; biliary matter freely scattered; blood discs distended and with ragged edges; red corpuscles congregated in masses; fibrine forming in heavy clots; blood rapidly coagulating; black spores are quickly fastening in the fibrine.

We have here, in the 14th day sick and the 16th day sick cases, black spores in active motion and biliary matter in both cases, and the corpuscles distended bladder-shaped, in ragged-edged condition; the fibrine quickly clotting. And in the captain's case, which was the worst of all, we have still black spores, biliary matter, and ragged-edged corpuscles.

In the 6th week case, a much milder case, moreover, than any of the others, it is reasonable to assume that in some way the patient has quickly eliminated the poison. There is no biliary matter in his blood, no black spores, no abnormal fibrine, no distension of red corpuscles; the latter are perfectly formed in rouleaux.

Examinatian of urine of Henry Oelrichs (second mate, bark "Pax"), July 17th, 1893 (14th day of beriberi):—

Odor, light, aromatic, and feverish.
Color, light (yellow) amber.
Reaction, excessively acid.
Appearance, transparent.
Specific gravity, 1.032 +.
Weight of a fluid ounce, 470.27 grains.
Solids in a " " 35.06 "
Nature of deposit, mucus.
Quantity of deposit, trace.
Bile, coloring matter not present.
Salts, " "
Sugar, Fehling's solution, trace.
  Chromate solution, "
  Nylander's solution, "
Sacchrimeter grammes in a litre, 0.00 +.
Albumen, nitric acid, 1 fl. ℥, not present.
  Picric solution, trace.
  Touret's solution, "
  Bichromate solution, not present.
  Bichloride solution, trace.
  Millard's solution, "
Polariscopic grammes in a litre, 0.00 +.
Microscopical appearances:—
Pus corpuscles, trace in quantity.
Epithelium, bladder, trace in quantity.

Quantitative examination:—

Urea, proportion per fluid ounce	6.605 grains.
Percentage of	1.404
Total, quantitative examination	66.050 grains.
Chlorine	.960 grains.
	204
	9.600 grains.
Sulphuric acid	.992 grains.
	210
	9.920 grains.
Phosphoric acid	1.024 grains.
	201
	10.240 grains.
Carbonic acid gas	1.120 grains.
	237
	11.200 grains.

Results on a net basis:—

Urea	1.40
Water	95.00
Sugar	0.00 +
Foreign	2.76
Albumen	0.00 +
Chlorine	.20 +
Sulphuric acid	.21
Phosphoric acid	.20
Carbonic acid gas	.23
	100.00

Traces of sugar and carbonic acid gas are commonly observed in the urine of beriberi patients.

Dr. Wallace Taylor, Osaka, Japan, sends me three interesting tables, which he made from examinations of 134 cases of beriberi. These examinations were made with Hayem's hæmatometer and Gower's hæmacytometer. The average corpuscular richness for the 134 cases is 94 per cent. This, he says, corresponds to the clinical experience in cases of beriberi. Most of the cases of beriberi seen by the general practitioners are well-fed, well-nourished, full-blooded appearing men. The ill-fed, poorly-nourished, weak constitution cases are the exception. During the past few years he has kept a record of the physical condition of the beriberi patients, and he gives this record, together with another record, of a beriberi hospital in Tokio:—

	Taylor.	Beriberi Hospital.	Sum.
Of strong constitution,	323	593	916
" average "	15	27	42
" weak "	9	6	15

Thus, in a total of 973 beriberi patients, there were 94 per cent of strong constitution (a result almost identical with that given in his tables), and only 6 per cent of average and weak constitutions.

"These numbers," says Taylor, "are large enough to be conclusive, and anæmia is not one of the pathological conditions of beriberi."

In his table No. 3 there is shown a general diminution of the hæmoglobine. The average hæmoglobine in 101 cases is 81 per cent. In some of these cases the amount is very low, being below 65 per cent, and with but few exceptions the per cent of hæmoglobine is below the per cent of corpuscles, showing a deficiency of the individual corpuscles in hæmoglobine.

The appearance of biliary matters, which I have shown in my analyses of the four cases of the bark "Pax," would show by itself a deficiency of hæmoglobine.

In the *Tribune Mèdicale*, Sept. 10, 1891, Messrs. Bertin-Sans and Moitessier show that it is the presence of hydrogen and carbonic acid in oxicarbonized blood that prevents the total destruction of hæmoglobine.

By sweeping their solution of oxicarbonized blood and water, with a current of hydrogen and carbonic acid gas, and an addition of sulphide of ammonia, they obtained the spectrum of reduced hæmoglobine. They thus show that oxicarbonized hæmoglobine can be readily transformed into a mixture of methæmoglobine and oxide of carbon. It is therefore reasonable to suppose that in an outbreak of beriberi where we have the presence of oxides of carbon and a deficiency of hæmoglobine (observable in all cases of beriberi) the latter is the effect of the former.

In Japan, the universal burning of charcoal produces the oxides, which held down in the low places by the moist atmosphere of the beriberi season, there is produced on a large scale and continually during the moist season what happens on board of each of those ships which come to us from the East with carbonized cargoes and beriberi-sick crews.

THE STRUCTURE AND AFFINITY OF THE PUERCO UNGULATES.

BY CHARLES EARLE, B. SC. (PRINCETON).

The discovery in 1880 by Baldwin of the presence of mammalian remains in the Puerco beds of New Mexico, was one of the most important in the history of vertebrate paleontology in this country. This rich mammalian fauna has been wholly described by that able investigator, Professor E. D. Cope, and to him we are indebted for having made known to the scientific world the interesting mammals which are imbedded in this formation.

As I have lately been studying a collection in the American Museum of Natural History from the Puerco, I propose in this paper to sum up some of the results of my investigations as relating in particular to the primitive ungulates of this formation, and especially to attempt to place some of these forms in or near their proper phylogenetic positions in the system.

As a word of introduction I would remark that most of the remains from the Puerco are in a poor state of preservation, and this applies particularly to the skeleton. The teeth are often well preserved, so that in working out the affinities of these mammals we are generally dependant upon the character of the teeth to discover their relationship to other forms. A very striking peculiarity in the dentition of the Puerco mammals, as pointed out by Professor Cope, is the fact that their superior molars are generally of the tritubercular pattern, and these upper teeth are associated with inferior molars, which are tubercular-sectorial, or a modification of the latter. In the tubercular-sectorial tooth the anterior portion is raised above the posterior or talon, and consists of three elevated cusps. By the modification of the latter pattern of molar, both the highly specialized sectorial teeth of the Carnivora and the quadritubercular teeth of the Ungulates have been derived.

In general we may say that, besides the characters of the teeth, the mammals of the Puerco epoch, in their skeletal structures, as far as known, are of a decidedly primitive type. The skull is short and heavy, with the orbit well forward over the teeth; the various processes of the skull for muscular attachment are prominent. Correlated with their low structure in general was the exceedingly small brain, as illustrated by the genus *Periptychus*. As the structure of the skeleton in the latter genus is the best known, I will enumerate some of its characters. The feet of Periptychus were plantigrade. The hind foot had five toes, the external one being not much shortened. The structure of the astragalus is well known in Periptychus and important, as teaching us one of the characters of the structure of the primitive foot in general. This bone is short and strongly depressed; the neck of the same is short and heavy. In all modern mammals which are digitigrade the trochlear surface of the astragalus, articulating with the tibia, is deeply grooved, whereas in Periptychus this surface is plane and flat. Another very important and primitive character of the astragalus in Periptychus is that it is perforated by a well-marked foramen. I am not aware that this perforation of the astragalus occurs in any recent Ungulate. The astragular foramen is of constant occurrence in Puerco mammals and also is present in some of their descendants in the Wasatch (*Coryphodon*).

In one respect the foot of Periptychus is more advanced than that of the genus *Phenacodus*, which is from a later formation (Wasatch); I refer to the articulation of the cuboid bone with the astragalus, but in general the foot structure of Phenacodus is far advanced in its evolution over that of Periptychus. Phenacodus was a digitigrade mammal, with the outer toes much shorter than the median. The long bones of the skeleton in Periptychus are short and heavy; this applies particularly to the humerus, which is an exceedingly heavy bone; its distal extremity is perforated by an entepicondylar foramen, another primitive character of this genus. The character of the humeral condyles in Periptychus is peculiar and different from all modern Ungulates. In the latter group the trochlear surface of the humerus is interrupted by a strong ridge separating the external from the internal articular surface. Now in Periptychus, as well as in Phenacodus, there is no such interruption of the condylar surface of the humerus, and it has the same character as in the modern Carnivora, thus showing how these two widely separated orders at the present time approach each other in their osteological characters in the Eocene. The ulna and fibula are large in Periptychus and more nearly approach the size of the bones of the preaxial side of the limbs than in modern forms.

Now the question arises, what great groups of mammals of later epochs than the Puerco are represented in this formation. I think that we may safely say that there were only a few main stems of Puerco mammals which persisted until later periods, and I shall endeavor to show that these stem forms were the direct ancestors of later types. As in so many cases, in seeking to determine phylogenetic relationships, we must turn to the investigations of Professor Cope to decide this question in part at least. He has described mammals from the Puerco which he considers to be Ungulates in their affinity, others to be related to the Carnivora, and still other types which resemble the Lemuroidea in the structure of their teeth. As I am only dealing with the Ungulates in this paper I shall speak of certain genera which Professor Cope and other paleontologists have determined to be closely related to this group.

The group of primitive Ungulates which Professor Cope has designated the Condylarthra is not a very homogeneous one, it appears to me, and perhaps with Schlosser we had better speak of a condylarthrous stage, through which all Ungulates are supposed to have passed rather than to attempt to confine these early forms all in the suborder Condylarthra. At least as shown by Professor Osborn, the characters laid down by Professor Cope as limiting the Condylarthra, would not include some of the forms (*Periptychus*) which Professor Cope has embraced in this suborder.

When we attempt to separate the Ungulates from the Unguiculates of the Puerco we are met with the obstacle that in most cases the distal phalanges of the feet have not been preserved. Accordingly we are dependant upon the character of the dentition to diagnose and separate these two groups. However, so low down geologically speaking as the Puerco, the different groups of Ungulates are not supposed to be distinctly differentiated, and then again in most cases the structure of the skeleton, and especially of the carpus and tarsus of these forms, is totally unknown. I believe, however, that the stems leading to the main types of the Ungulates which we meet with in the Wasatch, are fairly well separated in the Puerco, and more so than has been generally accepted. For example, when we consider another group other than the Ungulata, the Creodonta, we find a number of well-marked families of this order in the Puerco, which are distinct and lead up in some cases to types of later epochs. The Creodonta, with low-crowned, purely bunodont teeth, such as are included in the Triisodontidæ, the more specialized and trenchant dentition of the Provivirridæ (*Deltatherium*), and again the low-crowned and nearly quadritubercular lower molars of the Arctocyonidæ (*Claenodon*, Scott). The last-named genus is very likely the ancestor of the Wasatch (*Anacodon*).

Turning again to the Ungulates, what are the types of this order which we can distinguish in the Puerco? To attempt to decide this question we must rely on the characters of the teeth in nearly all cases. To ascend to the mammals of the Wasatch period for a moment we observe in that formation the Perissodactyles are distinct from the Artiodactyles. The former group has superior molars with six cusps, which may be either distinct or fused; the lower molars are quadritubercular. In the Artiodactyles of the Wasatch the superior molars are of the tritubercular pattern and the lower teeth are sexitubercular, or more nearly of the primitive tubercular-sectorial type already mentioned. Again, the premolars of the Perissodactyles are more complex than these of the Artiodactyles. Returning to the Puerco we find the same state of things well foreshadowed, although these two stems may have not passed the condylarthrous stage. In the genus *Euprotogonia* (= *Protogonia*), we have the supposed condylarthrous representative of the Perissodactyles, and in the genus *Protogonodon* of the Puerco I believe we are dealing with an ancestral Artiodactyle. I am aware of the fact that the skeletons of these two genera are totally unknown, so until they are discovered we will be unable to say whether these two forms were true Condylarthra or if they had assumed more of the characters which are typical of the two great divisions of the Diplarthra. I think that from a study of the teeth of the above genera that the two lines of the Diplarthra were fairly well separated even in the Puerco.

The upper true molars of Euprotogonia in the typical form, *E. puercensis*, consist of six tubercles. The superior premolars are simpler than in Phenacodus. A character of the upper molars of Euprotogonia, and separating it well from Phenacodus, is the absence of the parastyle and mesostyle. When we study the structure of the lower teeth in Euprotogonia, we are surprised to find them so highly developed for a Puerco form. The last lower premolar is nearly as complex as it is in the Wasatch Phenacodus, and in the typical species the crescents of the inferior true molars are as plainly marked as in the last-named genus. In the supposed ancestors of the Artiodactyles from the Puerco (*Protogonodon* and perhaps other genera, as suggested by Professor Scott) the characters of the dentition are well differentiated from those leading to the Perissodactyles. I have referred upper teeth in the American Museum collection to Protogonodon, which are of the tritubercular type, with exceedingly brachydont crowns. These upper teeth differ considerably from those of the bunodont Creodonta. The internal cones and intermediate tubercles in Protogonodon have coalesced and nearly form crescents. The external cusps of these superior molars are depressed and not as conical in section as in the Puerco Creodonta. The lower true molars of Protogonodon are sexitubercular, but differ in form from those of most of the Creodonta by the fact that the anterior portion of the tooth (trigonid) is not raised above the posterior (talon). The cusps of the lower true molars, as in the case with those of the upper molars, coalesce and form continuous tracts of worn enamel; this applies particularly to the posterior limb of each crescent. Lastly, the upper premolars in Protogonodon are not yet known, but the lower teeth of this series are well preserved and shows them to be absolutely simple in structure, consisting of a cone with slightly enlarged heels. In some specimens there is a trace of an internal cusp on the last lower premolar.

The characters above adduced as pertaining to the dentition of Protogonodon approach closely those of the earliest known American Artiodactyle, viz., *Pantolestes* from the Wasatch Eocene, I would suggest accordingly that *Protogonodon* may stand in ancestral relationship to this genus.

I do not agree with Dr. Schlosser in deriving the Artiodactyles from any of the known Periptychidæ, as the latter group has been defined by Professor Cope. In nearly all of the Periptychidæ the premolars are highly specialized and are not adapted for further evolution. Professor Scott, in his very valuable paper on the "Creodonta," only recently published, has subdivided the genus *Mioclaenus* Cope into several new genera, limiting the latter genus for a few species only; the type being the *Mioclaenus turgidus*. The structures of the premolars in Mioclaenus are more like those of some of the Periptychidæ than the Creodonta, and consequently Professor Scott believes that Mioclaenus is a condylarth. Other than the genera already mentioned as probably having been persistent types, I would intimate that *Mioclaenus turgidus* may stand in ancestral relationship to some of the White River bunodont Artiodactyles (*Leptochœrus*). The following phylogenetic scheme may illustrate the affinities proposed in this paper:

Perissodactyla.	Bunodont Artiodactyla.	Selenodont Artiodactyla.	Amblypoda.
|	|	|	|
Euprotogonia.	Mioclaenus.	Protogonodon.	Pantolambda.

DO THE LEAVES OF OUR ORDINARY LAND PLANTS ABSORB WATER?

BY EDWARD A. BURT, EAST GALWAY, N.Y.

CONFLICTING answers have been given to this question. Hales, Boussingault, and Henslow concluded from their experiments that leaves do absorb water; other investigators have failed to obtain such positive results, and have been inclined to doubt absorption. Furthermore, the theory that the transfer of liquids is largely accomplished through differences in density of the liquids in the plant caused and maintained by transpiration from the leaves — this, by giving a sufficient function to the leaves, has probably deterred investigators from entering upon an inquiry that promised only negative results, and that was beset with difficulties in carrying out. Yet a moment's reflection shows us that during the growing season of several months in each year, our vegetation is covered with dew night after night, and often when periods of drought prevent the plants from receiving an adequate supply of water through their roots. Does it not seem probable that plants are able to use the dew which covers their leaves?

Under the direction of Professor Goodale and Mr. W. F. Ganong, the writer has been recently carrying on a series of experiments in the botanical laboratories of Harvard University to determine —

(*a*) Whether it is probable that leaves do absorb water.

(*b*) Whether the conditions under which such absorption occurs, if it does occur, will not afford suitable ground for more special investigation later on.

Some of the results already reached seem to justify a preliminary publication.

Can Leaves Absorb Water?

To decide this, young branches of Diervilla grandiflora, common house geranium (Pelargonium), and Mesembryanthemum were cut from the parent plants while in full leaf. The clean-cut ends of these small branches were then dipped into a waterproof varnish — Brunswick black — so as to completely cover the cut ends and the sides for an eighth of an inch up the stem. The branches were then allowed to lie on a table in the laboratory — temperature, 70° F. — for a time until wilting occurred. They were then weighed, sprinkled with water, and shut in a botanist's tin collecting-box for from 16 to 46 hours. Having recovered their original fresh condition, the branches were then removed from the box and dried carefully from adhering water by exposure to the air of the room and by the use of blotting paper. They were then weighed. In each case there was an increase in weight indicative of absorption. The details are given in the following table: —

	Period of wilting	Weight of wilted branches.	Time shut in the box.	Weight of water absorbed.
	Hours.	Grammes.	Hours.	Grammes.
Diervilla grandiflora...............	3	12.12	16	0.36
Common geranium (Pelargonium).	49	26 79	46	5.76
Mesembryanthemum (a succulent-leaved plant)	49	40.55	46	0.77

Henslow obtained absorption with cut branches in a large number of cases and under a variety of conditions; but as he did not cover the cut ends of his branches, it has been objected that the absorption in his experiments occurred through the cut ends rather than through the leaves. My experiments show that the objection was not well taken. We must conclude that slightly wilted leaves may absorb water.

Do Leaves of Rooted Plants Absorb Water?

Small vigorous-growing plants of Ricinus and of a small-leaved Begonia were used. They were obtained from the greenhouse in 2- and 3-inch pots. The pot and the lower portion of the stem of each plant were then inclosed in a covering of sheet rubber in the following manner: A small circular opening of less than half an inch in diameter was cut in the centre of a piece of sheet rubber of suitable size. The rubber was then stretched in the region of the opening so as to make the aperture temporarily larger. The pot was then slipped down through this opening.

Upon lessening the tension, the rubber contracted clasping the stem just below the lowest leaves. With a stout thread the rubber was then wound firmly against the stem for a sufficient distance to make a close contact of the two. With its centre suspended from the place where tied about the stem, the rubber now hung down covering the pot loosely and completely concealing it. The lower portions of the rubber were now gathered together underneath the pot and firmly tied together with strong cord.

A thrifty young begonia plant with its pot so covered had its leaves thoroughly sprayed with water by means of an atomizer at 6 P.M. It was then placed under a large bell-jar in an atmosphere made and kept damp by wetting the inner surface of the jar with water and by suspending in the jar two large sponges dripping wet. With its leaves wet, the plant was kept in this damp atmosphere in the dark during the night. In the morning it was removed from under the bell-jar, dried carefully, and then weighed at 8.40 A.M. It had increased its weight 0.09 grams