of physical education departments for publishable consecutive measurements of physique, and to encourage departments which do not repeat the measurements to do so in order that a sizable mass of consecutive measurements may be assembled. Probably the best sources of data by means of which the terminal phases of physical development may be studied at the present time are the college and university populations.

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KETENE ($CH_2=CO$): A NEW REAGENT FOR THE DETOXIFICATION OF VACCINE[1]

KETENE reacts with water, alcohols, primary and secondary amines and acids to form acetylated compounds, according to the investigations of Staudinger.[2] The rate of reaction of ketene for each of the above groups is different—primary amines react most rapidly. In general, the reactions of ketene are addition reactions and may be illustrated as follows:

$$CH_2=CO + H\text{–}NH\text{–}R \longrightarrow CH_3CONH\text{–}R.$$

Bergmann and Stern[3] have shown that ketene reacts with amino-acids to form acetylated amino-acids. Recently Herriott and Northrop[4] used ketene for acetylating the amino groups of pepsin. In our work *B. dysenterae* Shiga were treated with ketene.

Ketene was produced by the thermal decomposition of acetone vapors in a generator similar in design to Herriott's.[5] The gas was passed through a long water condenser and then through a spiral coil, which was cooled to 0° C. to condense any acetone vapors and polymers of ketene. After leaving the ice trap the ketene was passed through a 4 mm tube into a collodion dialyzing sack containing a twenty-hour culture of *B. dysenterae* Shiga suspended in 10 cc of saline solution and 190 cc of 2 M sodium acetate solution. The sack was immersed in a vessel containing 2 M sodium acetate solution in order to keep the pH nearly constant (a procedure adopted by Herriott and Northrop for maintaining a constant pH). Ketene was run into the bacterial suspension at the rate of one bubble per second for one half hour. A mechanical stirring device kept the suspension agitated.

One half hour exposure of the bacterial suspension to ketene was sufficient to kill the organisms. Such a treated suspension was washed with sterile distilled water once and with sterile saline solution three times before the desired density of the suspension was made. A control vaccine was prepared by heating a suspension of the bacilli at a temperature of 60° C. for 45 minutes.

Rabbits were inoculated intravenously at seven-day intervals with ketene-treated vaccine. The lethal dose of either heat-killed suspension or living bacilli suspension was given intravenously from one week to eleven days after the last injection of vaccine. All vaccines were of a density of 300 according to the Fuller's scale.

The results of intravenous inoculation into rabbits all weighing over 2,000 grams are shown in Table I.

TABLE I

Rabbit	Number of inoculations	Total cc of vaccine given	Days between first inoculation and lethal dose	Lethal dose cc	Results
			Immunized with ketene treated vaccine		
1	3	2	33	0.5 H	No toxic effects
2	3	2	33	0.5 H	" " "
3	3	2	27	0.5 H	" " "
4	3	2	27	0.5 H	" " "
5	4	2	28	0.5 H	" " "
6	4	2	28	0.5 H	" " "
7	4	2	28	0.5 H	" " "
8	4	2	28	0.5 L	" " "
9	4	2	28	0.5 L	" " "
10	4	2	28	0.5 L	" " "
			Non-immunized controls		
11	1	0	0	0.4 H	Complete paralysis. Died—36 hrs.
12	1	0	0	0.5 H	Complete paralysis. Died—40 hrs.
13	1	0	0	0.5 H	Complete paralysis. Died—34 hrs.
14	1	0	0	0.5 H	Complete paralysis. Died—36 hrs.
15	1	0	0	0.5 H	Complete paralysis in 60 hrs.*
16	1	0	0	0.5 H	Complete paralysis in 72 hrs.*
17	1	0	0	0.5 H	Paralysis in 52 hrs.*
18	1	0	0	0.5 L	Complete paralysis in 32 hrs.*

L—Living bacilli suspension.
H—Heat-killed vaccine.
*—Animal chloroformed.

Ten rabbits, each previously receiving a series of injections of ketene-treated vaccine over a period of 27 to 33 days, totaling 2 cc, manifested no toxic effects upon receiving the lethal dose of 0.5 cc of either heat-killed or living *B. dysenterae* Shiga. Eight control rabbits which had not received the ketene-treated vaccine showed complete paralysis with usual diarrhea and died within four days after each had been injected with 0.5 cc of either heat-killed or living *B. dysenterae* Shiga.

CONCLUSION

Acetylation of *B. dysenterae* Shiga with ketene for one half hour detoxifies the antigen. Such an antigen can be inoculated in large doses into rabbits without

[1] Preliminary report.
[2] H. Staudinger, "Die Ketene," Stuttgart, F. Enke, 1912.
[3] M. Bergmann and F. Stern, *Ber. Chem. Ges.*, 63: 437, 1930.
[4] R. M. Herriott and J. H. Northrop, *Jour. Gen. Physiol.*, 18: 35, 1934.
[5] R. M. Herriott, *Jour. Gen. Physiol.*, 18: 69, 1934.

producing toxic effects. Animals immunized with ketene-treated vaccine are highly resistant to doses of living or heat-killed bacilli which are lethal for non-immunized animals.

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THE OROGENIC HISTORY OF CENTRAL UTAH[1]

DURING the course of studies in 1929–1933 by the writer in the Wasatch Plateau, of central Utah, evidence accumulated to suggest that the rocks there classified as the lower part of the Wasatch formation were not really Wasatch (lower Eocene) in age, but older, perhaps still older Eocene. In the summer of 1934 the writer, searching for fossil evidence on the age of these beds, gathered a small collection of bone fragments which, although not exactly identifiable, were pronounced by C. W. Gilmore to be unmistakably dinosaurian. The presence of these fossils suggested a Cretaceous age for the beds containing them. In June, 1935, J. B. Reeside, Jr., and the writer made a somewhat more extended search, which resulted in a much larger volume of better material, from widely scattered localities. This material remains to be studied by Mr. Gilmore, and the limits of its significance can not yet be stated, but it serves clearly to verify the presence of a varied reptilian fauna, including dominantly several types of dinosaurs, at the time when the beds hitherto classified as the lower member of the Wasatch formation in central Utah[2] were deposited. Inasmuch as these strata were laid down considerably later than the major orogenic disturbance in which the rocks of the Wasatch Mountains were folded, the discovery in them of dinosaurian remains necessitates a notable revision of existing concept respecting the place in the geologic time scale of the known physical events, and this note is offered for the purpose of placing the essential facts on record pending the preparation of a fuller account, in which details of revision can be set forth.

In brief, the rocks of central Utah reveal the following sequence of events in late Cretaceous time:

(1) At some time following the deposition of the Price River formation[3] (coarse sandstones and conglomerates of upper Montana age) the rocks of the region were intensely folded and thrust as far east as the western border of the present Wasatch Plateau; this was the major folding of the mass now forming the Wasatch Mountains.

(2) After an epoch of profound and probably rapid erosion, a varied assortment of sediments, ranging from boulder conglomerate through sandstone to red shale and white to gray freshwater limestone, was deposited, attaining a maximum thickness of several thousand feet.

(3) The region was again disturbed, this time more gently, and the rocks of (2) were tilted up and planed off.

(4) Sedimentation again ensued, beginning with coarse boulder conglomerate and passing on to sandstone, shale and local limestone, including some varicolored sediments but in general not the deep reds of the foregoing strata; these are the dinosaur-bearing beds, formerly classified as the lower member of the Wasatch formation.

Other later epochs of disturbance are recognized in the region, but in confinement of this note to the essential facts concerning the older folding they need not be specifically mentioned.

The dinosaur bones are sparse at all known localities except the one discovered in 1934, and in general they are difficult to find; they occur as scattered individual bones and parts of skeletons, many broken before burial. In answer to the question whether they were possibly reworked from older beds it should be pointed out that the fragility of many of the specimens, the presence of large bones in very fine-grained sediments, the wide distribution of the remains in general and the abundance of the material at the best locality, which is many miles from the nearest possible source in older rocks, effectively demonstrate that the fossils are indigenous to the strata in which they are found.

The first disturbance above mentioned, the major compressive movement in the Wasatch Mountain belt, has generally been considered to mark the close of Cretaceous time, and the succeeding sediments have generally been classified as Eocene, although fossil evidence has been meager and difficult to interpret, in notable part suggestive of age older than Eocene but decidedly not conclusive, and in terms of pre-existing classification acceptable as Eocene. In all the rest of the known Rocky Mountain-Great Plains province the latest dinosaurs are found in the Lance and equivalent beds, now classified by many geologists as Cretaceous. There are of course involved here all the ramifications of the celebrated Laramie problem, and geologists familiar with the controversial terms

[1] Published by permission of the director of the U. S. Geological Survey.

[2] Edmund M. Spieker and John B. Reeside, Jr., *Geol. Soc. Am. Bull.*, 36: 448–449, 1925; Edmund M. Spieker, *U. S. Geol. Survey Bull.*, 819: 45–48, 1931.

[3] Spieker and Reeside, *op. cit.*, pp. 445–448; Spieker, *op. cit.*, pp. 39–45; Edmund M. Spieker and John B. Reeside, Jr., *Geol. Soc. Am. Bull.*, 37: 431–433, 1926.