Synthesis	*H. A. Morton* (Ph.D., University of Pittsburgh), Senior Fellow. C. J. Herrly (B.S., Pennsylvania State College).	$5,000 a year. Bonus: $5,000. January 1, 1919.
No. 140. Silverware	H. E. Peck (B.S., Clarkson Memorial College of Technology).	$2,500 a year. December 11, 1918.
No. 141. Insecticides	O. F. Hedenburg (Ph.D., University of Chicago).	$3,000 a year. January 1, 1919.
No. 142. By-products Recovery	Walther Riddle (Ph.D., University of Heidelberg).	$3,000 a year. January 1, 1919.
No. 143. Coke	*F. W. Sperr, Jr.* (B.A., Ohio State University), Advisory Fellow. Marc Darrin (M.S., University of Washington). O. O. Malleis (M.S., University of Kansas). L. R. Office (B.S., Ohio State University).	$7,000 a year. January 1, 1919.
No. 144. Fertilizer	H. H. Meyers (B.S., University of Pennsylvania).	$3,000 a year. Bonus: $5,000. January 5, 1919.
No. 145. Soap	(Fellow to be appointed.)	$2,000 a year. January 5, 1919.
No. 146. Glue	R. H. Bogue (M.S., Massachusetts Agricultural College).	$2,500 a year. January 5, 1919.
No. 147. Distillation	David Drogin (B.A., College of the City of New York). H. F. Perkins.	$5,300 a year. January 18, 1919.
No. 148. Tobacco	W. B. Pattison (M.A., University of Nebraska).	$2,100 a year. Bonus: $2,000. February 1, 1919.
No. 149. Laundry	*H. G. Elledge* (M.S., University of Pittsburgh), Senior Fellow. K. R. Beach (A.B., Southwestern College).	$5,000 a year. February 15, 1919.

It required the cataclysm of the Great War to bring men to realize fully the part which applied science is playing and, more particularly, will play in the life of nations. As men have come to know that everything in modern warfare is controlled in a large measure by science—no gun of large caliber is located or fired without its aid—so they have come to know that in the making of things—in the economy and progress of manufacturing operations—science must have a place, an important place too. With this idea in mind, institutions of learning and industries in this country, but more especially abroad, are investigating and studying methods to bring about cooperation between science and industry. The Mellon Institute is proud that, while very young, it has been a pioneer in the field. Its principal claim to distinction, apart from its contributions to specific industries, is based on the service it has been able to render to other institutions in demonstrating the practicability of a system which brings together science and industry for the development of a future and more gracious civilization.

The administration of the Mellon Institute is now constituted as follows:

Raymond F. Bacon, Ph.D., Director (on leave of absence);

Edward R. Weidlein, M.A., Associate Director and Acting Director;

E. Ward Tillotson, Jr., Ph.D., Assistant Director;

John O'Connor, Jr., M.A., Assistant Director;

William A. Hamor, M.A., Assistant Director (on leave of absence);

David S. Pratt, Ph.D., Assistant Director;

Martin A. Rosanoff, Sc.D., Head of the Department of Research in Pure Chemistry.

E. R. Weidlein,
Acting Director
Mellon Institute of Industrial Research,
University of Pittsburgh,
March 1, 1918

THE EFFECT OF CATTLE ON THE EROSION OF CANON BOTTOMS

To every explorer in the arid cañon country of southern Colorado the steep-walled arroyo trenched in the center of the flat alluvium bottom is a familiar sight. Its vertical banks many times twenty or twenty-five feet high in the soft crumbling soil are no mean impediment to travel and its sandy or stony bottom is a source of constant anxiety to the freighter. Every storm fills this miniature

gorge with a rush of turgid mud-laden water and even when the rain has passed there is in the air the continual dull crash of the caving banks. At places the arroyo fills all the cañon bottoms, at others it is a mere crack in a wide expanse of alluvium, but it is continually encroaching on the bottom land. The depth of the erosion varies greatly and is controlled apparently by the distance of bed rock from the alluvium surface (which is governed by the amount of alluvial filling that had taken place) and by a fixed minimum grade which is determined by the amount of overloading of the stream and the grade of bed rock. This minimum will become smaller therefore as the alluvium is gradually removed from the cañon bottoms. The maximum depth of erosion observed by the writer is twenty-five feet, the average is probably about ten feet. The former is reached in exceedingly narrow cañons such as the upper Chaquaqua Cañon, and that of the Purgatoire in southeastern Colorado and Yellowjacket and Sandstone Cañons in southwestern Colorado. The arroyos are formed only along intermittent streams. The cañons of McElmo Creek and the Purgatoire River seem to have been dry at least part of the summer in the early days (although they now flow water all the year around) and for this reason they exhibit the arroyo at the cañon bottom.

The steepness of the alluvial banks testifies to the recent origin of these arroyos. What caused them to appear so suddenly? Rarely is it that the processes of erosion are disturbed yet it appears that the disturbance which caused these arroyos has taken place during the last sixty years. The settlers who first entered these cañons found the bottom lands low and rounded with no suggestion of an arroyo at the center. The writer has talked with pioneer ranchers both in southwestern and southeastern Colorado and on this point they are unanimous. The arroyos have developed since their advent. To this may be added this further physical evidence:

1. Along the bottoms of Yellowjacket, Sandstone and Hovenweep Cañons in southwestern Colorado the arroyos are cutting into the ruins of Indian houses (stone) which are extremely old as they represent a civilization much like that of the Zuni while the Utes have occupied this region since the time of historic record. The houses were built on alluvial flats and it is only recently that the streams have cut into them.

2. Old roads and trails frequently cut straight across gullies which it is now impossible to cross. (Southeastern and southwestern Colorado).

3. Along the sides of the cañon wall where the alluvium has been completely removed from the cliff sides the imprint of roots still remains (Chaquaqua Cañon—Southeastern Colorado.)

4. The fact that water is more abundant in the cañon bottoms now than previously seems to have a bearing on this subject In the early days (1860–1865 in eastern Colorado) (1870–1880 in western Colorado) water appears to have been very scarce in these cañons. This would seem to be due to the water flowing under a heavy alluvium cover as the precipitation records indicate no perceptible climatic variation. The formation of these arroyos seems to have uncovered a number of these hidden flows of water.

5. No alluvial terraces are found. The cañon floor is usually very nearly flat. If these arroyos were cyclic, we should expect to find a series of terraces representing a series of stages in the erosion of this alluvium. Such is not the case, even in comparatively wide cañons. The usual cañon rock terraces represent cycles exceedingly remote when compared with the one under discussion.

Comparisons of the drawings and photographs of government reports of 1860 to 1870 with recent photographs confirm this hypothesis, as the older reports do not seem to show any arroyos like those now developed.

The development of these arroyos seems to have been, therefore, contemporaneous with development of ranching. To what must we ascribe them then? The writer believes they are caused by cattle. Cattle influence erosion in two ways: first by the wearing of trails; second by the destruction of vegetation.

Cattle make trails along the line of easiest passage. usually the center of a cañon. They differ from the wild animals in that they are not hunted by man and must not shun narrow confined places, but actually converge toward them. Their trails grow rapidly and the writer can recall many which are five feet wide and a foot and a half deep. These trails effect erosion in two ways. First they form channels for the passage of water; second because of the absence of vegetation they form channels of easy erosion. Their compact surfaces are also hard places for the water to sink into the soil. During a heavy shower it is noticeable that water starts to form pools in these trails long before the surrounding surface shows the slightest sign of having reached its saturation point. When the storm becomes heavy each one becomes a miniature torrent and rapid erosion takes place in much the same manner as it does on a steep country road and finally small gullies are worn. Where rounded gullies are already present the walls are broken down and the vertical-walled arroyo finally results.

The influence of cattle on the vegetation of cañon bottoms as a whole is rather difficult to estimate, yet it must be considerable. The writer has seen in cañon pockets inaccessible to cattle deep grass so matted and tangled as to preclude any thought of erosion and cause maximum absorption, while in the same cañon where the cattle have ranged, the bottom is nothing but a tramped field of dust which offers maximum opportunity for erosion and minimum opportunities for absorption. This is particularly true in the mid summer and autumn months when cloud-bursts are frequent. We may, therefore, summarize the effect of cattle by saying that they increase the rapidity of the run-off and the rate of erosion by destroying vegetation, by compacting the soil and forming channels for the passage of water.

The introduction of this new element produced a disturbance in the nicely balanced forces of erosion so that the alluvial flats of the cañon bottoms were no longer planes of equilibrium. The increased volumes of water that swept down the cañons demanded larger channels. These the trails and the small gullies which grew from the trails, supplied, until finally the process formed the arroyos we meet to-day. The present cycle is one of readjustment. In wide cañons the alluvium will be cut away until the width of the stream course becomes so great that water will lack the force to erode and the final channel will be a rounded one of somewhat lower grade and much closer to bed rock than the present one. In narrow cañons the alluvium will be entirely removed (along Chaquaqua Creek this has already taken place) and the stream erosion grade will be formed. Of course this process is small by the side of the great base leveling which is taking place in these regions, but it is interesting in that it shows the extreme nicety with which the forces that erode are balanced. It also shows rather forcibly one of the effects of the influences of human industry on the topography. Its economic effect is not as great as that of deforestation, but it will result in the ultimate abandonment of many small farms along some of the streams. For these reasons it is deserving of further investigation.

James Terry Duce
University of Colorado

AN EMERGENCY SUPPLY OF RUBBER

The department of botany of the University of California has undertaken a study of certain West American shrubs belonging to *Chrysothamnus* and other genera of the Compositæ to determine whether or not an emergency or supplementary supply of rubber exists in such native plants. This investigation is one of the projects of the botanical subcommittee of the Pacific Coast Research Conference acting under the Council of Defense of the State of California. Results thus far obtained indicate that the total amount of rubber present in these native species is considerable, but that the percentage yield of individual plants is too small to render its extraction profitable at present prices. If, however, the importation of raw rubber should be curtailed through enemy action, this emergency supply existing within