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.

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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

the border of the continental United States could be utilized. It might be noted here that the quality of this new rubber is, according to rubber experts, somewhat better than the best grades of guayule, but not as good as Para.

The choice of *Chrysothamnus* and related genera as the plants first to be investigated was the result of a preliminary examination made in 1904. In September of that year the late Judge A. V. Davidson, of Independence, Inyo County, California, sent some twigs to the Department of Botany for identification, with the information that the Indians prepared from the plant a sort of "gum" which they chewed. The plant was a species of *Chrysothamnus* of the *graveolens* group. Further samples were submitted at our request, and in October, 1905, a preliminary chemical examination of them was made by Professor G. E. Colby, of the California Experiment Station. This examination indicated the presence of rubber, but not in sufficient amount to warrant further investigation. A report to this effect was made public in the press and as a result some further examinations were made by at least one commercial rubber company. The matter was soon dropped, however. It is probable that the plants used in this commercial examination were of an entirely different species from those now being examined.

During the past year some 200 different plants have been studied in detail, both in the field and in the laboratory. As a result it can now be definitely stated that many species of *Chrysothamnus* (formerly known as *Bigelovia* and commonly called rabbit-brush, or golden-bush) carry rubber in at least small quantities and that it occurs also in three species of *Ericameria* and in one species of *Stenotus*.

One species of *Ericameria* carries 9.5 to 10 per cent. of pure rubber, in addition to about 9 per cent. of acetone-extractable resins, etc. Although this plant possesses agricultural possibilities, it is too small and occurs too sparingly to be considered as a source of wild rubber. In six species of *Chrysothamnus* the older parts carry from 3 to 5 per cent. of rubber. This percentage is for dry rubber and does not include the resins or other acetone-soluble impurities. The term "species" is here used in a narrow sense. The six species referred to are all allies of *C. nauseosus*, *C. graveolens*, or *C. teretifolius*. Further taxonomic studies will be necessary before final determinations can be made, since some of the forms do not correspond to any of the described species.

The most important of these species is a large shrub, the rubber-producing portions of which commonly weigh from two to ten pounds, with a maximum observed weight of about sixty pounds. It forms nearly pure stands of considerable extent in some parts of the Great Basin Area. Histological examinations indicate that the rubber content is fairly uniform throughout its distribution. Much care must, however, be exercised to avoid confusion with closely similar forms, some of which exhibit marked fluctuation in their rubber content, while others uniformly carry not even a trace of this substance. Professor P. L. Hibbard, of the California Experiment Station, who has made the chemical analyses, reports for the most important form as follows:

	Acetone Extract, Per Cent.	Benzol Extract. Per Cent.
Plant 1, base of stem	3.74	5.06
Plant 2, base of stem	3.90	4.40
Assorted plants, trunk and root bark	3.90	7.80

These figures are for fairly dry shrub. If based upon perfectly dry shrub the percentages would be somewhat higher.

Field experiments have been instituted to determine the possibility of inducing a greater growth of the rubber-bearing tissues and also to determine whether or not it is feasible to harvest the rubber without killing the plants. Some attention is also being paid to the possibility of bringing the plants under culture for commercial purposes.

It is now proposed greatly to extend the scope of the investigation and to include many more species. In addition to locating the principal supply of the more promising species and its extent, we hope to study more inten-

sively their ecologic behavior, seasonal variation, reproduction, and other points of scientific as well as economic interest. We shall, therefore, be extremely grateful for samples from any district in which the plants grow, and shall be pleased to send instructions for the taking of these. However, even a small portion of the basal part of the stem will be helpful, since this will enable us to make a preliminary examination to determine the desirability of securing more abundant material.

The above partial outline of the results thus far obtained will be followed in due time by a detailed report on our studies.

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SCIENTIFIC EVENTS

BRITISH CIVIL SERVICE ESTIMATES FOR SCIENCE AND EDUCATION

The Parliamentary Paper dealing with Class IV. of the Estimates for Civil Services for the year ending March 31, 1919, is summarized in *Nature*. A special grant of £30,000 is included in aid of certain universities, colleges, medical schools, etc., to meet loss of income arising from circumstances of war. It may be remembered that the Estimates for 1915–16 included a similar grant of £145,000 for the same purpose. The grant for the National Physical Laboratory has been transferred from the head of the Royal Society, under which it formerly appeared, to that of the Department of Scientific and Industrial Research. It amounts to £89,750, being an increase of £64,475 upon the grant for 1917–18. The state receives, however, for testing fees and other services rendered by the laboratory the sum of £11,250, and £3,000 as contributions from cooperating bodies. The new Fuel Research Station has a grant of £7,000, of which £4,000 is required for salaries and wages, and £3,000 for apparatus, materials, etc. The grants made by the Department of Scientific and Industrial Research amount to £56,500, in comparison with £30,000 in 1917–18. The salaries, wages and allowances of the department are estimated at £8,900.

The following gives the grants in summary:

UNITED KINGDOM AND ENGLAND

	£
Board of Education	19,206,705
British Museum	126,142
National Gallery	11,639
National Portrait Gallery	3,779
Wallace Collection	4,012
London Museum	2,300
Imperial War Museum	19,000
Scientific Investigation, etc.	54,241
Department of Scientific and Industrial Research	148,350
Universities and Colleges, Great Britain and Intermediate Education, Wales	321,700
Universities, etc., Special Grants	30,000
Scotland	
Public Education	3,041,545
National Galleries	4,283
Ireland	
Public Education	2,203,104
Intermediate Education (Ireland)	90,000
Endowed Schools Commissioners	855
National Gallery	1,830
Science and Art	163,393
Universities and Colleges	96,350
Total	25,529,228

The appropriations for scientific institutions are as follows:

	£
British Museum	90,022
Natural History Museum	44,045
Imperial War Museum	19,000
Royal Society	6,000
Meteorological Office	22,500
Royal Geographical Society	1,250
Marine Biological Association of the United Kingdom	500
Royal Society of Edinburgh	600
Scottish Meteorological Society	100
Royal Irish Academy	1,600
Royal Irish Academy of Music	300
Royal Zoological Society of Ireland	500
Royal Hibernian Academy	300
British School of Athens	—
British School at Rome	500
Royal Scottish Geographical Society	200
National Library of Wales	3,200
National Museum of Wales	7,500
Solar Physics Observatory	3,000