1. Forty-five varieties of bacteria found in the water of the Schuylkill river were used in the first experiment. Cultures of each organism were made on agar-agar and after attaining a luxuriant growth were sterilized, the reaction was taken, and the medium was again slanted. A set of these tubes was inoculated with the *bacillus typhi abdominalis* and a second set with *bacillus coli communis*.

The object of this research was to ascertain whether the two organisms would grow on media containing the products of the activity of water bacteria. The reaction was alkaline in every tube. The *bacillus typhi abdominalis* and the *bacillus coli communis* lived in every instance, some showing fairly luxuriant growths, while others were only transparent films.

2. In the second experiment, thirty-nine varieties of the water bacteria used in the first experiment were inoculated into tubes each containing 10 cc. of sterilized tap-water and 5 drops of bouillon. Two sets of tubes were made as before, one being inoculated with the *bacillus typhi abdominalis* and the other with the *bacillus coli communis*. To ascertain whether the two organisms under consideration would multiply in the presence of water bacteria, gelatine plates were made for twelve or more days. Both bacilli gave characteristic colonies with each of the water organisms, except two which had apparently an antagonistic effect upon their development. They were both members of the *subtilis* group. In other members of this group this peculiarity was absent.

The typhoid bacillus in several instances outlived its associate organism. In one instance a gelatine plate made from a tube of sterilized water inoculated with the typhoid bacillus and a water bacterium 160 days previously gave characteristic colonies of the *bacillus typhi abdominalis*.

3. To meet the objection that might be raised to the use of heat for the sterilization of the medium in which the water organisms had grown, the opinion having been advanced that some products of growth are either volatile or rendered inert by high temperatures, flasks each containing 70 cc. of bouillon were inoculated with water bacteria and incubated for from 15 to 20 days. The cultures were then filtered through porcelain, the reaction was taken, and the filtrate was run into sterilized tubes which were inoculated with the *bacillus typhi abdominalis* and the *bacillus coli communis* and then incubated. In each of the thirteen filtrates inoculated the bacilli grew and multiplied for at least four days.

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CURRENT NOTES ON PHYSIOGRAPHY (I.).

INTRODUCTORY NOTE.

It is proposed to contribute to Science under the above title a series of notes and comments on recent investigations and current literature concerning physiography, or physical geography in its modern form. A brief statement of the field to be covered may be appropriate at the outset.

Following the plan introduced by Carl Ritter, and popularized in this country chiefly by Arnold Guyot, geography may be defined as the study of the earth in its relation to man. Some prefer to extend this relation to all forms of life. Physical geography may then be defined as the rational study of those features of the earth which must be understood in order to appreciate its relation to man. In deference to the opinions of the majority of the conference on geography, held in Chicago in Christmas week, 1892, physiography is taken as the name of this subject in its modern form, with particular reference to the rational study of the lands, where man dwells. Descriptive geography is an empirical study

that hardly deserves a place in modern teaching. Political geography is undifferentiated history. Commercial geography is the elementary phase of economics. The distribution of plants and animals leads the way to botany and zoölogy; the chief value of this subject coming from the emphasis that it gives to those physical features and conditions of the earth that determine the distribution of life; when it is made a basis for the introduction of classification and terminology, it is misused, for these matters need deliberate study with a method and discipline of their own. The subjects of oceanography and meteorology involve considerations and disciplines so different in many respects from those which characterize the study of the lands that they fully deserve separate names and treatment; but their teachings must be frequently drawn on for use in physiography.

Contributions from many subjects, astronomy, physiology, botany, zoölogy, history and economics, are merged into a single elementary study—geography—in the earlier school years; all are expanded and separately treated in later school years; all deserve to be treated over again afterwards in the broader way characteristic of college teaching; and all include broad fields for investigation in the university.

Physiography being particularly directed to the study of the lands, must of necessity in its higher researches give due consideration to the more minute features of land forms and their development—subjects which recent writers name geomorphology and geomorphogeny—for the sufficient reason that a close understanding of the development of land forms greatly aids the observation, description and recognition of the forms themselves; and that the knowledge thus only to be gained of the forms of the land is essential as a preparation for the careful study of their relations to man and other inhabitants of the earth.

As thus explained, physiography is an outgrowth of geology; and geology, especially field geology, is a necessary preliminary discipline both for those who would undertake the higher study of physiography and for those who would reduce it to the simplest form of expression for early school use.

MEANING OF THE TERM, BASELEVEL.

SINCE the introduction of the term baselevel by Powell twenty years ago, its use has become popular but unhappily its meanings have not been well defined. A subdivision of the work that the word has been made to do now seems desirable. It should be restricted rather closely to its original meanings, and newer terms should be employed for its secondary meanings. Powell originally wrote: "We may consider the level of the sea to be a grand base level, below which the dry lands cannot be eroded, but we may also have, for local and temporary purposes other base levels of erosion, which are the beds of the principal streams which carry away the products of erosion." (Colorado River of the West, 1875, 203.) By using a few qualifying adjectives, there need be no confusion between general, local and temporary baselevels. When unqualified, the general baselevel, or sea level, should be understood.

When a region has been baselevelled (the verb being here made from the noun, after the ordinary English fashion), the surface thus produced is often spoken of as a 'baselevel.' For example, J. S. Diller writes: "It is evident that a general baselevel of erosion must have originated approximately at sea level. This is the only position in which a very extensive baselevel can originate. If we now find such a baselevel at a considerable elevation above the sea, its position furnishes evidence that since the baselevel was formed the country has been uplifted." (Chicago Journal of

Geology, II., 1894, 33.) Further on in the same article, he writes of the 'deformation of the baselevel.' Although the writer has repeatedly made a similar use of the term, it now seems doubtful if it should be used so freely; and some such word as peneplain might serve to replace this extension of the original meaning of baselevel. This is the more advisable, when it is considered how very seldom a region is reduced sensibly to baselevel; how generally a long eroded surface still retains some faint inequality of form which should be expressed in its name.

GEOMORPHOLOGY OF THE SOUTHERN APPALACHIANS.

THE interpretation of the development of geographical features in accordance with the general theory of baselevelling has received two notable contributions during the past year. The first is by Hayes and Campbell on the Geomorphology of the Southern Appalachians (Nat. Geogr. Magazine, VI., 1894, 63). The authors recognize the widespread occurrence of more or less fully denuded peneplains at two levels, one of late Cretaceous, the other of late Tertiary date, thus extending the conclusions reached by others farther to the north. They then proceed to measure the amount of deformation that the peneplains have suffered by drawing contour lines upon them. It appears very clearly that the axes of elevation along which these old lowlands have been arched up, coincide closely with the Appalachian axis; thus adding two more dates to the many others at which this line has been the scene of deformation. The tilting of the surface of the deformed peneplains is regarded as of importance in determining the capture and diversion of certain streams by their rivals; this principle being further illustrated by Campbell in a separate article on 'Tertiary changes in the drainage of southwestern Virginia' (Amer. Journ. Science, XLVIII., 1894, 21).

GRADED RIVERS.

A RIVER that ceased the active deepening of its valley is by various writers described as having reached its baselevel. Thus A. Winslow writes: "The streams of the prairie country . . . . . have, in large part, reached base level, and are developing meander plains." (Missouri Geol. Survey, VI., 1894, Lead and Zink deposits, 310.) H. Gannett figures a bit of the Great Plains of Colorado as 'near base level,' although the contour lines indicate altitudes of over 4000 feet. (Monogr. XXII., U. S. Geol. Survey, 1893, pl. viii.) Now it is true that streams which have ceased the active deepening of their valleys serve as *local* baselevels for their tributaries—as Powell's original definition stated; but it seems unadvisable to speak of these streams as themselves having reached baselevel; still less is the country which slopes down to them necessarily near 'baselevel.' If the term is used in so general a sense as this, then an important feature in the development of rivers will remain undistinguished by any special name, and the attention of readers will not be forcibly brought to it. It is well known that when a river has cut down its valley and reduced its velocity to such a value that its capacity to do work in transporting waste is just equal to the work that it has to do, any further change in the profile of the stream-channel can take place only as fast as a change in the amount of land-waste offered to the streams shall allow. If the amount of waste slowly decreases, as is commonly the case, the stream will slowly assume a flatter and flatter slope (except so far as the development of meanders may lengthen its course and thus retard the deepening of its valley). If an increase in the amount of waste takes place after equality of capacity and task is reached, as sometimes happens, then the stream must aggrade its valley for a time. If the climate of the region changes, a new slope may be

called for. Of two regions, similar in all respects except that one is made of resistant rocks, and the other of weak rocks, the first will develop a stronger relief during its mature dissection than the second. The Great Plains of the West are often referred to as a region of considerable elevation, in which, however, the rivers are unable to cut deep valleys on account of the rapid disintegration of the tributary slopes, and the consequent necessity of maintaining steep-sloping channels in order that the streams may do their work of bearing the plentiful waste of the land to the sea.

All this series of considerations is confused if it is said that a river which has established an equality between its capacity and its task is 'at baselevel.' From whatever profile of slope it began to work on, it has developed a profile of equilibrium, as certain French writers would phrase it; or, following a suggestion by G. K. Gilbert (Chicago Journal of Geology, II., 1894, 77), it has graded its slope; it is a graded river; it is almost balanced between degrading and aggrading its valley, and most of its activity may be given to lateral sapping. No better English term than 'grade' has been suggested for the expression of this important idea.

GEOMORPHOGENY OF NORTHERN CALIFORNIA.

THE second contribution to the general subject alluded to above is by A. C. Lawson, in account of the Geomorphogeny of the coast of northern California (Bull. Dept. Geol., Univ. of Cala., I., 1894, 241–242), which students of this new-named subject will do well to consult. Although only the report of a rapid reconnoissance, the paper announces the determination of a well-marked, uplifted and dissected peneplain, in which a fully developed system of subsequent drainage is exhibited on an extensive scale. The district is recommended to students as an inviting field for further investigation. The author brings out the point that a constructional mass of resistant rocks will never at any stage of its denudation yield a topography that may be reached at certain stages in the denudation of a mass of weaker rocks; and he therefore suggests that in the accounts of topographic development, or geomorphogeny, a factor should be introduced indicative of the rate as well as of the stage of degradation of the region concerned.

THE ESSENTIAL PRINCIPLES OF BASE-LEVELLING.

THE results gained in the two papers mentioned above, and in many other similar articles, are based on the essential principles of baselevelling: Any region must in time be reduced to a nearly featureless peneplain close to sea level; during the progress of its denudation, the forms assumed follow a tolerably well defined sequence, depending chiefly on the structure of the wasting mass; the features and arrangement of the drainage lines are essentially systematic and not arbitrary in their development. A generally accepted corollary of these principles is that a surface of denudation, having faint relief and no control by structure, can be produced only close to its controlling baselevel; and that such a surface represents the peneplain stage, attained close to the end of the cycle of denudation in which it was developed. It is evident that if a plain of denudation can be produced at a considerable altitude above baselevel, and independent of structure, then the conclusions of various investigators regarding land movements, based on the occurrence of elevated, warped or faulted peneplains, must be critically revised. It therefore behooves those who accept and employ the doctrine of baselevelling to examine carefully any alternative hypothesis by which peneplains are explained independently of baselevels.

THE GEOGRAPHICAL EDUCATION OF OUR TOPOGRAPHERS.

Some engineers hold the opinion that it is not necessary for a topographer to have an understanding of the forms that he maps; it is sufficient for him simply to record what he sees without knowing its meaning. If all topographers could sketch with minute accuracy, if they all worked on a large scale and without limitation of time, they might perhaps manage to get along without an appreciative knowledge of the subject of their sketching. But the topographers by whom our maps are made cannot as a rule sketch with minute accuracy; and even if they could, their talent would be of little avail, for time could not be given to its use; moreover, maps of a scale large enough for minute accuracy are too expensive to undertake in so vast a country as ours. In many parts of the country the land is hardly worth as much per mile as it would cost to map it in an elaborate manner. Our maps must be made on a relatively moderate scale—seldom more than an inch to a mile; expensive detail cannot be permitted; and very slow work must give way to methods that will give results more rapidly. A great deal of our topographical work must be done by rapid sketching between measured points; the sketching must always be generalized; and every thing that will promote the production of good results from rapid and generalized sketching must be taught to the topographer.

Looking at the subject in this practical manner, there can be no question that an appreciative understanding of topographical features is of great value. Rapid work by a topographer who does not understand the country before him will produce an unappreciative portrait. Generalizations by a surveyor who does not understand the relations of the forms that he generalizes will produce an unsuggestive and inaccurate map. A good understanding of physiography should therefore be regarded as an essential qualification of a topographer; and schools of engineering should see to it that adequate teaching of this subject is provided for their students.

WINSLOW'S EXPLANATION OF THE MISSOURI PLAINS.

Such an alternative hypothesis is offered by A. Winslow in his recent report on the lead and zinc deposits of Missouri (Geol. Survey of Missouri, Vol. VI., 1894). He describes certain parts of southern Missouri as exhibiting broad expanses of nearly flat land. A 'prominent feature' of the district is 'the steepness of the hills adjacent to the stream valleys' (p. 306). Another part of the same region is a dissected plateau of carboniferous strata, terminating eastward in an irregular escarpment. The even interstream uplands of both plain and plateau are not regarded as of constructional origin, for the region has long been above sealevel; the possibility of either upland having once been a smooth peneplain of baselevel erosion is considered and rejected; and the following hypothesis is offered in its stead: "These prairie and plateau plains are primarily due to the fact that the slope of the surfaces has always been and continues slight. . . . . Consequently, the flow of the streams has been so sluggish that general atmospheric degradation has nearly kept pace with the corrasion of the streams and formation of the valleys. As a result, the whole surface has been denuded simultaneously. This condition is attributable, first, of course, to the gentleness of the original constructional slope; the horizontality of the stratification has helped to perpetuate it. . . . . Secondarily as a factor in the production of these surfaces, it is probable that, where streams have corraded so slowly, broad flood plains have been developed at different levels at different times. Thus many flat stretches, which may be removed

from the formative streams, are, perhaps, to be considered as of the nature of terraces marking the flood plains of a past stage of erosion" (p. 322, 323). Change of altitude of the region, or in other words, change of baselevel, is not referred to as essentially involved in the problem.

The plateau surface, sloping to the west and terminating eastward in an escarpment Carboniferous strata, seems to depend on the greater resistance of these strata. It might be called a structural plain; a stripped surface on which general denudation has hesitated by reason of the endurance of the exposed strata, although the streams have deeply trenched it.

With the prairie plains the case is different, for much of their area "is underlain by coal measure rocks, which are readily acted on by sub-aerial agents of erosion" (p. 323). If the streams of the region were not enclosed by steep-sided valleys, but wandered across the plains in channels hardly beneath the general surface level, then it might be admitted that the whole surface would waste away about as fast as the streams degraded their courses. But as the streams are in well-enclosed valleys, it does not seem logical to admit that the interstream plains can have wasted as fast as the valley forces. If the streams of the region even now distinctly incise its surface, all the more strongly must they have done so before long continued denudation had reduced its original altitude to its present altitude. The steep valley sides should long ago have been ravined, and the interstream plains should thus have been unevenly dissected. If this process had been long in progress, the region might already have reached or passed through the stage of most varied relief—topographical maturity; but it could not have attained an even surface distinctly above the level of its streams. Similarly, it does not seem admissible to suppose that streams, which are now running in rather narrow, steep-walled valleys, should ever, when still higher above baselevel, have had broad flood-plained valleys, beneath which they have incised the narrow existing valleys, yet without being prompted to this change of behavior by any change of altitude in the region.

A decision as to the origin of these plains must be left to workers on the ground; but opinion as to the sufficiency of the process suggested for their production may be formed by any one who has familiarized himself with the general principles of denudation here involved. In the writer's mind Winslow's hypothesis does not invalidate the generally current principles of the baseleveling theory.

GANNETT'S MANUAL OF TOPOGRAPHIC METHODS.

THE general principle that the topographer should be well trained in physiography is strongly affirmed in Gannett's Manual of Topographic Methods (Monogr. XXII., U. S. Geol. Survey, 1893, issued in 1894). The volume contains a concise account of the surveys thus far undertaken in the United States; an account of the map now in progress by the U. S. Geological Survey, this containing much of interest to the geographical reader; and a treatment of the more technical matters of astronomical determination of position, horizontal location, secondary triangulation, sketching, and office work. In the chapter on sketching, there is an interesting discussion of the origin of topographic forms, with illustrations taken from various map sheets in the Survey office; this discussion being introduced 'as an aid in the interpretation of the various topographic forms which present themselves' to the topographer. Here we read the sound statement that "it is in the matter of generalization that the judgment of the topographer is most severely tested. He must be able

to take a broad as well as a detailed view of the country; he must understand the meaning of its broad features, and then must be able to interpret details in the light of those features. Thus, and thus only, will he be competent to make just generalizations" (p. 107).

THE UPLIFT OF THE EXISTING APPALACHIANS.

THE origin of topographic forms has as yet received so small a share of attention from the greater number of field geologists and geographers, and the presentation of the problems involved has as yet gained so little attention from teachers in schools of higher grade that contributions to the subject from a man of Mr. Gannett's experience and qualifications are of great value. Yet in certain parts it seems to the writer that his plan of presentation is open to criticism. He states first that topographic features originate by uplift, by deposition and by erosion. Under the heading of uplift, he writes: "The ridges and valleys of the Appalachian region are the result of uplifts, with numerous sharp folds and faults, which raised at various angles an alternation of hard and soft beds, from which erosion has since carved the existing alternations of ridge and valley" (p. 109). In spite of the qualifications of a preceding paragraph, to the effect that forms produced by uplift are during and since their rise greatly carved by erosion, the reader can hardly acquire a correct understanding of the facts concerning the Appalachian ridges and valleys from Gannett's statement; nor can he easily acquire from the Appalachians an idea of the nature of forms produced by uplift with folding and faulting. Such forms can be illustrated best by the selection of young topographic districts, on which erosion has as yet made little advance. Our western country possesses many and excellent examples of this class. Furthermore, it is no more allowable to describe the Appalachian ridges and valleys as the 'result of uplifts, with numerous sharp folds and fault' than it would be to associate the fiords of Labrador with the ancient deformation of the old rocks of that region. The Appalachian uplifts with folds and faults have long ago been consumed; the uplift from which the existing ridges and valleys are carved was a broad arching of the region, without folding or faulting of perceptible measure. It is true that the up-arched mass possessed a structure given ages before by folding and faulting; but that more disorderly kind of uplift had little in common with the broad and even uplift of the region by which its present relief was initiated. The essay by Hayes and Campbell, already referred to, gives sufficient demonstration of this important conclusion.

A FRENCH OPINION.

THE following abstract from an essay entitled *'L'age des formes topographiques'* by A. de Lapparent, the eminent geologist (Revue des questions scientifiques, Oct., 1894), expresses an opinion concerning the personnel of a topographic corps that is somewhat surprising as coming from France, where we had supposed that the propriety of the military control of official geographical work was unquestioned. De Lapparent writes in effect: The distraction of our professional geographers by the study of arbitrary political boundaries in the early part of this century would have been lessened if the work of detailed mapping had been left to men ready to interest themselves in the many questions provoked by the manifold forms of land relief. Unfortunately the reverse was done in decreeing that cartography should be exclusively a function of the department of war. Up to 1830 there was in France an excellent institution, that of the geographical engineers. Well prepared in the École polytechnique, the

officers of this corps devoted themselves entirely to geodesy and topography. Thus occupied they came to have a lively appreciation of the relation between internal structure and external form. Truly, geology was at that time but little advanced, but this productive combination of two orders of studies must have been of mutual advantage, had not an always regrettable decision caused the suppression of the corps of geographical engineers, and the transfer of their duties to the officers of the army staff. Certainly there was no lack of capacity among the latter, but it was nevertheless a capital mistake to entrust a service essentially civil, and even scientific, to military officers who could not devote themselves exclusively to it. Consequently, even though the maps have been well made, there has been a slow advance of what may be called appreciation of topographique form (*l' intelligence du terrain*). Certain of the more sagacious geologists in vain showed how the meaning of topographic form is illuminated when it is studied in relation to internal structure ; the divorce of 1830 continued to exercise its unlucky influence, and all the more because other nations, following the example of France, have for the most part identified topographical work with that of the national defense. But a reaction has gradually set in, and to this none have contributed more effectively than the Americans ; and here the author goes on to pay a high tribute to the scientific results of our western surveys.

Accepting the correctness of the principles stated by de Lapparent, it follows that our topographers can succeed in their great work only when imbued with a truly scientific spirit. There is small likelihood of this spirit being generally attained so long as engineering schools give so little attention as at present to the study of the great subject on which their topographic art is to be exercised. For this reason, such works as Gannett's Manual are particularly welcome.

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THE NEEDS OF METEOROLOGY.

To state a problem clearly is to contribute much towards its solution ; to realize one's wants and make them known may bring the needed help ; therefore I accept with pleasure an invitation to speak of the needs of meteorology.

Considered as a source of climatological statistics bearing on every branch of human activity, on land and sea, meteorology has been handsomely supported for a century by all governments and scientific organizations. This feature of our work is now carried on by the U. S. Weather Bureau and the State Weather Services with increasing thoroughness from year to year.

Considered as a system for the prediction of storms andweather for a day or two in advance, meteorology has received enthusiastic support by our own and all other nations. We are now doing about all that can be done by the mere utilization of the telegraph and weather map and the cautious application of general average rules, but we are still powerless in the presence of any unusual movement of the atmosphere. Indeed, I do not see that even our West Indian hurricanes are predicted any better to-day than they were in my ' Probabilities ' of August, 1871.

Meteorologists can never be satisfied until they have a deeper insight into the mechanics of the atmosphere. Something more is needed than the most perfect organization for observing, reporting and publishing the latest news from the atmosphere. It is not enough to know what the conditions have been and are, but we must know what they will be, and *why so*. We must have a deductive treatise on the laws governing the atmosphere as