law, and we conclude finally that, although in the common phrase there may be something in it, yet our assumed law is in fact no law at all.

Again I examine my table of squares, and I find a rule of this kind: The second differences of the squares are constant, and equal to 2. I make many trials of this rule and never find an exception. Others do the same and always the same result is found. We conclude therefore that we have at length discovered a real law that exists in the formation of squares; but at the same time we invite every one to make the examination for himself, and if possible to find an exception. A. Hall.

Washington, D. C., December 17, 1880.

PROFESSOR TAIT AND MR. HERBERT SPENCER.

In another column we have referred to the controversy between Professor Tait and Mr. Spencer. Since this was put in form we have received a copy of Mr. Spencer's reply and, with pleasure, give his own explanation, which appears in *Nature* of the 2d instant:

"I pass now to his implied judgment on the formula, or definition, of Evolution. And here I have first to ask him some questions. He says that because he has used the word 'definition' instead of 'formula,' he has incurred my 'sore displeasure and grave censure.' In what place have I expressed or implied displeasure or censure in relation to this substitution of terms? Alleging that I have an obvious motive for calling it a 'formula,' he says I am 'indignant at its being called a *definition*.' I wish to see the words in which I have expressed my indignation; and shall be glad if Prof. Tait will quote them. He says—'It seems I should have called him the *discoverer of the formula!*' instead of 'the inventor of the definition. Will he oblige me by pointing out where I have used either the one phrase or the other? These assertions of Prof. Tait are to me utterly incomprehensible. I have nowhere either said or implied any of the things which he here specifies. So far am I from consciously preferring one of these words to the other, that, until I read this passage in Prof. Tait's lecture, I did not even know that I was in the habit of saying 'formula' rather than 'definition.' The whole of these statements are fictions, pure and absolute.

"My intentional use of the one word rather than the other, is alleged by him *àpropos* of an incidental comparison I have made. To a critic who had said that the formula or definition of Evolution 'seems at best rather the blank form for a universe than anything corresponding to the actual world about us,' I had replied that it might similarly be 'remarked that the formula—"bodies attract one another directly as their masses and inversely as the squares of their distances," was at best but a blank form for solar systems and sidereal clusters. Whereupon Prof. Tait assumes that I put the 'Formula of Evolution alongside of the Law of Gravitation,' in respect to the definiteness of the provisions they severally enable us to make; and he proceeds to twit me with inability to predict what will be the condition of Europe four years hence, as astronomers 'predict the positions of known celestial bodies four years beforehand.' Here we have another example of Prof. Tait's peculiarity of thought. Because two abstract generalizations are compared as both being utterly unlike the groups of concrete facts interpreted by them, *therefore* they are compared in respect to their other characters.

"But now I am not unwilling to deal with the contrast Prof. Tait draws; and am prepared to show that when the conditions are analogous, the contrast disappears. It seems strange that I should have to point out to a scientific man in his position, that an alleged law may be perfectly true, and that yet, where the elements of a problem to be dealt with under it are numerous, no specific deduction can be drawn. Does not Prof. Tait from time to time teach his students that in proportion as the number of factors concerned in the production of any phenomenon becomes great, and also in proportion as those factors admit of less exact measurement, any prediction made concerning the phenomenon becomes less definite; and that where the factors are multitudinous and not measurable, nothing but some general result can be foreseen, and often not even that? Prof. Tait ignores the fact that the positions of planets and satellites admit of definite prevision, only because the forces which appreciably affect them are few; and he ignores the fact that where further such forces, not easily measured, come into play, the previsions are imperfect and often wholly wrong, as in the case of comets; and he ignores the fact that where the number of bodies, affecting one another by mutual gravitation, is great, no definite prevision of their positions is possible. If Prof. Tait were living in one of the globular star-clusters, does he think that after observations duly taken, calculations based on the law of gravitation would enable him to predict the positions of the component stars four years hence? By an intelligence immeasurably transcending the human, with a mathematics to match, such prevision would doubtless be possible; but considered from the human standpoint, the law of gravitation, even when uncomplicated by other laws, can yield under such conditions only general and not special results. And if Prof. Tait will deign to look into 'First Principles,' which he apparently prides himself on not having done, he will there find a sufficient number of illustrations showing that not only other orders of changes, but even social changes, are predictable in respect to their general, if not in respect to their special characters."

REVERSION IN FLORAL PARTS.

By William A. Buckhout.

One of the best plants for showing the reversion of floral parts to the form of leaves is the common red field-clover (*Trifolium pratense.*)

It is always easily obtained, and during the fall of the year these heads of reverted flowers are quite common. The pedicels of the flowers are much elongated, and somewhat reduced in number; hence the heads have a loose appearance, which, with their very leafy look and absence of color, makes them conspicuous among

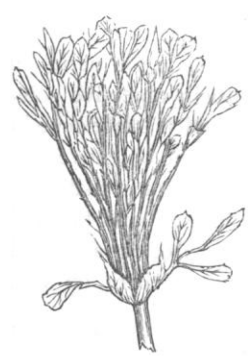

Fig. 1.

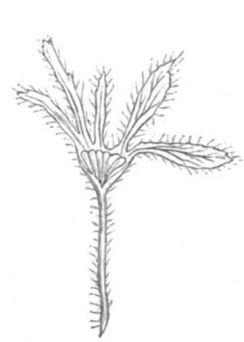

Fig. 2.

hose having well developed flowers. Fig. 1 gives at fair idea of one of these heads. A dissection of a flower shows that all parts have changed, and are decidedly leaf-like, though not to the same extent. Of the sepals (Fig. 2.) two are larger than the others, are very distinctly veined, and have a few small teeth near their tips; the remaining sepals are narrow, elongated, and have only the midrib without any lateral veins. The petals have lost their papilionaceous character entirely, though the vexillum may be recognized by its larger size. Each petal (Figs. 3, 4.) is leaf-like in shape, veining, and especially in the possession of a pair of stipules which are fused with its base precisely, as are the stipules of the leaf proper. The petals project but slightly from the tube of the calyx.


Fig. 3.

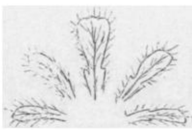
Fig. 4.

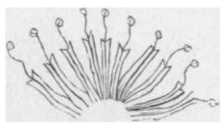
Fig. 5.

The stamens (Fig. 5.) are not diminished in number, but are separate, and each filament bears the stipules distinctly. They are joined with it nearly to the anther. This would seem to indicate that the sheath of united stamens in the *Leguminosæ* is made by the fusion of the stipular elements of the leaf alone.

Within the stamens, and occupying the centre of the flower, is a single, rather long-stemmed leaflet, apparently the middle one of the three so characteristic of the trifoliums. It is unmistakably a leaf in its veining, outline, color, etc., and upon its petiolar portions are borne —as might be expected—the stipules; in this case as plainly stipules as those which are borne by the true foliage leaves. No trace of a pistilline nature is to be seen. The reversion has been complete. All the parts, except the stamens are exceedingly hairy.

The peculiar feature in this case is the retention of the stipules as separate parts in all the whorls, excepting the calyx, where they are undistinguishably fused to form the cup-like portion of that organ.

The ease with which these reverted flowers can be obtained and studied, and the light which they throw upon the morphology of the parts of the flower make them worthy the attention of studen's who ought, as soon as possible, to gain a practical knowledge of the real nature of floral parts.

A demonstration in mathematics could not be more conclusive than this lesson from *Trifolium pratense*, our familiar red clover.

Pennsylvania State College, Dec. 20, 1880.

THE CLASSIFICATION OF SCIENCE.

By Rev. Samuel Fleming, LL. D., Ph. D.

I.

DEFINITIONS.

The term science has been variously defined. It is from the Latin *scientia* (from *scio*, I know,) which is defined as "a knowing, or being skilled in anything; generally, knowledge, science," The original sense of the term *scientia* involves the twofold conception, of the *thing*, or fact itself, which is the subject of knowledge, and the *knowing* the fact. The former is the *objective* signification, the latter the *subjective*. In defining the term, therefore, diverse forms of expression have been used, and different senses conveyed. In the edition of Webster's Unabridged Dictionary, published in 1878, modified definitions are given as follows: "Knowledge; the comprehension of truth or fact; truth ascertained; that which is known; hence, specifically, knowledge duly arranged, and referred to general truths on which it is founded." By some, the definition given is "systematic knowledge"; by others, "what is comprehended by the mind"; another definition is in the following language: "Science is the name for such portions of human knowledge as have been more or less generalized, systematized and verified." Herbert Spencer gives the following, corresponding with the general divisions of his "Classification of the Sciences": 1. That which treats of the forms in which phenomena are known to us; 2. That which treats of the phenomena themselves. Prof. Tice, after stating that "there is a broad distinction between knowledge and science," gives this distinction in the following terms: "Knowledge is a clear and certain perception of that which exists, or of truth or of fact. Science is a body of general principles: particular truths, and facts, arranged in systematic order."

The terms science and knowledge have sometimes been used as synonymous; frequently without due discrimination. It is evident that the facts of science, if not science itself, exist prior to, or irrespective of the mind which acquires the knowledge of them, if we except the science of the mind itself. Existence is one thing, the knowledge of such existence is radically another thing. Hence the propriety, and often great importance of recognizing this distinction, and of discriminating in the use of the terms. Scientific terms should be used with definiteness of meaning, for clearness and conciseness of written or oral instruction. If science and knowledge are synonymous terms, if the definition "science is knowledge" is the same with the terms transposed, thus "knowledge is science," every child and uneducated person who knows that "fire burns," is a scientist, without, it may be, knowing what fire is, or its causes. Then science would signify no more than knowledge. But all fundamentally distinctive ideas are appropriately expressed by different terms. And it is desirable that the demands of language be recognized, and this practical rule for the use of discrimniating words be observed. Synonymous words are properly those which are derived from different languages, and are used for euphony, or variety.

Further, there is a legitimate distinction between common, obvious, or non-scientific knowledge, and scientific knowledge. And this is not a distinction in respect to certainty; for common knowledge is often as certain as scientific knowledge, as in reference to the fall of a body to the earth: while much that is called scientific knowledge is far from being exact in its complete sense, as in respect to the nature of the ultimate cosmic forces, the aurora borealis, and other phenomena. Nor is it a difference simply in degree of knowledge, but a difference also in respect to kind and quality. Thus two persons may observe an eclipse of the sun or moon; one may know only that one body intercepts the light of another body; the other person may know the causes, the sizes, the distances, orbits, periodic times, laws of motion, and many other elements whose knowledge is essential to the determination of the phenomenon. The attainments respectively differ,—the former having only the knowledge of a single fact, the latter the knowledge of the whole system of facts, principles and laws pertaining to the phenomenon; the former possessing ordinary knowledge, the latter scientific knowl-