8. Let us suppose, however, that a group of organisms belonging to a plastic species is placed under new conditions of environment.

9. Those whose innate somatic plasticity is equal to the occasion survive. They are modified. Those whose innate plasticity is not equal to the occasion are eliminated.

10. Such modification takes place generation after generation, but, as such, is not inherited. There is no transmission of the effects of modification to the germinal substance.

11. But variations in the same direction as the somatic modification are now no longer repressed and are allowed full scope.

12. Any congenital variations antagonistic in direction to these modifications will tend to thwart them and to render the organism in which they occur liable to elimination.

13. Any congenital variations similar in direction to these modifications will tend to support them and to favor the individuals in which they occur.

14. Thus will arise a congenital predisposition to the modifications in question.

15. The longer this process continues, the more marked will be the predisposition and the greater the tendency of the congenital variations to conform in all respects to the persistent plastic modifications; while

16. The plasticity continuing the operation, the modifications become yet further adaptive.

17. Thus plastic modification leads and germinal variation follows; the one paves the way for the other.

18. Natural selection will tend to foster variability in given advantageous lines when once initiated, for (*a*) the constant elimination of variations leads to the survival of the relatively invariable; but (*b*) the perpetuation of variations in any given direction leads to the survival of the variable in that direction. Lamarckian paleontologists are apt to overlook this fact that natural selection produces determinate variation.

19. The transmissionist, fixing his attention first on the modification, and secondly the fact that organic effects similar to those produced by the modification gradually become congenitally stereotyped, assumes that the modification *as such* is inherited.

20. It is here suggested that the modification *as such* is not inherited, but is the condition under which congenital variations are favored and given time to get a hold on the organism, and are thus enabled by degrees to reach the fully adaptive level.

When we remember that plastic modification and germinal variation have been working together all along the line of organic evolution, to reach the common goal of adaptation, it is difficult to believe that they have been all along wholly independent of each other. If the direct dependence advocated by the transmissionists be rejected, perhaps the indirect dependence here suggested may be found worthy of consideration.

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NATURE STUDY AND INTELLECTUAL CULTURE. *

It is impossible to dissociate the intellectual effect of 'nature study' from the other factors in training which habitually accompany it. So far as I know, no 'pure culture' to determine the specific effect of nature study has ever been attempted; so that the best that can be done is in the way of reasonable inference. There can be no doubt that much of its effect is cumulative rather than specific, and so becomes merged and lost among other agencies. In addition to this general result, however, it is

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claimed that it has an effect of its own, not to be duplicated by any other subject. It is this specific effect of nature study that we are especially interested in discovering. The argument for nature study as a means of general training is based upon the claim that the subject-matter appeals more strongly to the interest of the young than almost any other that can be presented. The enormous momentum gained by interest is too well known to need discussion. That objects in nature, especially living objects, arouse the most lively interest in children, is the common testimony of all those who deal with children. It seems logical to take advantage of this interest in any intellectual training, and to press the subject matter to all its possible applications, thus reinforcing or even supplanting work technically belonging to other departments. The possible applications of nature study to numbers, to language, to drawing, are well known and extensively utilized. These propositions fail if interest in subject-matter is of no advantage in intellectual training, or if natural objects are not of large interest to children. My claim is that nature is not merely of large interest, but of supreme interest to children; that it supplies the most natural material by means of which the child may be developed intellectually in various directions; and that failure to use it is to neglect a broad highway and to attempt an advance through the thickets. I know that some will claim that power is developed by the resistance of the thickets; but it should be remembered that precisely the same power will be developed by covering a longer distance upon the highway, especially when the latter has the impetus of consent. The law of the conservation of energy has its application in things intellectual as well as in things physical. The greater the resistance, the less the distance, and *vice versa*. The method all depends upon whether we are seeking for resistance or distance; in both cases the resulting power will remain the same. I have never ceased to wonder at the systems of education which base their training, in effect, upon the proposition that the most natural impulses are to be repressed; that natural tastes are to be set aside for those artificially stimulated; that the great open book of objective nature is to be closed, and conventional subjective matter presented. From my own standpoint, this is intellectual distortion, as much as are the heads of Flathead Indians or the feet of Chinese women physical distortions. The subject is difficult to present in its true light, for we are still under the domination of a conventional education, which has worked out its results for centuries, and its good results are overwhelmingly in evidence because they are our only results. Now that the republican idea of larger rights for all subjects is persistently intruding itself, the old aristocracy needs most careful scrutiny. It has certainly done the best it could; but this is no reason why some other form of organization may not do better. The human mind develops in spite of subjects and teachers; but our purpose should be to remove all possible obstructions. It has been an annual experience of mine for many years to come in contact with the product of primary and secondary schools from which nature study has been rigidly excluded, and it must be confessed that the 'all round' training claimed has resulted in the narrowest conceivable intellectual product. The evils of early specialization are no where so apparent as in the schools which prepare for college. It is true that many colleges demand this specialization for entrance, continue it in their own courses, and then deny an adequate representation of nature study upon the ground that this means specialization. The tentacles of inquiry which the child naturally reaches out to nature become insensitive through dis-

use; and only here and there, in the later college experience, are some found still functional enough to be stimulated into activity. The public school system is seeking to better the product; but it is discouraging so long as colleges demand specialization rather than an 'all round' training.

It may be worth while to call attention to the fact that 'nature study' holds no relation to the study of the subject-matter as presented in text-books, and that such a presentation of it has no value in a scheme of education that does not belong to any other subject presented in the same way, and for purposes of training might as well be eliminated. The young mind does not reach out after the text-book, but after natural objects themselves. This distinction should be rigidly regarded, and text-book work should never be admitted into the category of 'nature study.' I grant to the old aristocracy all the strictures upon the results of science study it may care to impose if this study is to be one of text-books. One of the prominent things claimed for nature study is that it breaks the shackles of slavery to the book and introduces that intellectual freedom in which one sees and thinks for himself.

This position of nature study, however, as a means of general culture, as providing the most favorable subject-matter for arousing interest, is aside from the chief purpose of this paper, which is to discover its peculiar intellectual result, a result which cannot be obtained by the use of any other subject, and without which intellectual development is incomplete.

It is commonly stated that the prominent results of nature study are the cultivation of the power of observation and of drawing conclusions from observed facts. This is certainly a beneficent result, but it cannot be claimed as one peculiar to nature study; for it simply depends upon a method, the laboratory method, which may be applied to a wide range of subjects. It is certain that nature study has introduced the laboratory method into education, but having introduced the method it cannot lay claim, as a subject, to all the results. It is, perhaps, true that the laboratory method is most conveniently and completely applied in nature study; and that in most cases the definite training in observation and deduction is still obtained from nature study; but this will become less true as proper educational methods are developed. For this reason I take issue with a statement too frequently made by those who have had no training in science, that the function of science in an educational scheme is to teach laboratory methods. It is true that science, by its example, has been the great teacher of the laboratory method, but that is not its function any more than the device of algebraic symbols is the function of mathematics. A method is not a purpose, but has a purpose in view.

Another conception of the function of nature study is that it cultivates the power and habit of analysis, and that its purpose is analysis. This is a persistent conception of science in the popular mind, and also in the minds of many teachers of science, judging by their methods. This, however, is no more the purpose of nature study than is the laboratory method. The latter is its method, the former its preliminary step. This preliminary step, called analysis, is no more peculiar to nature study than are observation and deduction; although it may be more extensively and definitely cultivated in the so-called laboratories of science than in other laboratories. The ultimate purpose of nature study, and its peculiar function in a system of education is through analysis to reach synthesis. Its purpose is a constructive one, based upon facts which analysis reveals. It may seem strange to some to regard the purpose of science as a synthetic one, and the final

synthesis, which gives significance to analysis, certainly does not find any place in the practice of many teachers, but without it the real purpose is missed. It may be claimed justly that the reaching of synthesis through analysis is no more peculiar to nature study than are observation, deduction and analysis; but the mental attitude involved in reaching this synthesis *is* peculiar. This peculiar mental attitude may be most clearly stated, perhaps, in the form of a comparison. A very commonly used classification of studies in general is that which divides them into the 'humanities' and the 'sciences.' It lies outside of my present purpose to take exception to this exceedingly crude and misleading classification, but for the sake of comparison it will serve as well as any other. The 'humanities' are dominated by literature in the broadest sense, and are claimed to develop in the student a kind of culture especially desirable, a flavor especially characteristic of the educated man. To this claim I would not offer the slightest objection, for the 'humanities' have been and must continue to be a noble course of intellectual development, without which an education is certainly incomplete. I realize the difficulty to-day in sharply defining those studies which should be included under the 'humanities,' and a difficulty equally great in defining those to be included under 'sciences,' for it is often a thing of method rather than of subject-matter which determines the position of a study. However, there is no misunderstanding as to the general significance and effect of the group of studies known as the 'humanities.' It is the most ancient and best known form of culture, and being ancient and bound up with the development of mankind it must continue necessarily to hold high rank.

The general effect of the humanities in a scheme of education may be summed up in the single word *appreciation*. They seek so to relate the student to what has been said or done by mankind that his critical sense may be developed, and that he may recognize what is best in human thought and action. To recognize what is best involves a standard of comparison. In most cases this standard is derived and conventional; in the rare cases it is original and individual. In any case, the student injects himself into the subject; and the amount he gets out of it is measured by the amount of himself he puts into it. It is the artistic, the æsthetic, which predominates, not the absolute. It is all comparative rather than actual. The ability to 'read between the lines' is certainly the injection of self into subject-matter. It would seem fair, therefore to state the peculiar effect of the 'humanities' as being the power of appreciation or self-injection.

My claim is that any education which stops with this result is an incomplete one, and that there is another mental attitude which is a necessary complement before a full-rounded education can be claimed, and this complementary mental attitude is developed by a proper study of the so-called 'sciences.' It has been a matter of wonder to me that the student who confines himself to 'humanities' is so often spoken of as the 'all-round' student; while the one who studies the 'sciences,' and from whom the 'humanities' are as a matter of course demanded, is spoken of as the narrow student. In the very nature of things, in the very structure of our educational schemes, the student of science is compelled to be the broadest, most 'all-round' student we have. If the study of nature is conducted so as to cultivate merely a sentimental appreciation of natural objects, it does not fall within the category I am considering, and can in no way be considered a study which acts as a complement to the humanities. It is merely more of the same thing. Teachers of science are too apt to cultivate a factitious interest in

their subject-matter by this attempt at self-injection, and so destroy the peculiar advantage of the subject in intellectual training. If the proper intellectual result of the humanities is *appreciation*, whose processes demand *self-injection*, the proper and distinctive intellectual result of the sciences is *law*, to obtain which there must be rigid *self-elimination*. Any injection of self into a scientific synthesis vitiates the result. The standard is not a variable, an artificial one developed from the varying tastes of man, but absolute, founded upon eternal truth.

It is evident that this basis of distinction will result in a classification of subjects differing considerably from the ordinary grouping under 'humanities' and 'sciences,' but I am convinced that from the standpoint of mental development it is fundamental. It would even result in the divorcing of certain subjects now commonly included under one head. For example, it would certainly sharply cut off certain phases of language-study from literature proper, a fact which the universities have long recognized. This further emphasizes the fact that no hard and fast lines can be drawn separating the specific effects of the various studies. In our analysis we strip off the flesh and lay bare the skeleton, and are apt to lose sight of the fact that the contour is a composite result. Although the skeletons of the humanities and of the sciences may differ from each other in the fundamental way described, I cannot conceive of the resulting contour of the one as distinct from combination with the other. The self-elminating result of science must be associated with the self-injecting result of the humanities, even though science alone be studied; and the power of appreciation developed by the humanities must always be tempered by the scientific instinct. And yet the two processes and the two results are so distinct and so complementary that any system of education which does not provide for the definite cultivation of these two mental attidudes, and which leaves the complementary part merely to the chances of teaching methods and mental structure, is in constant danger of resulting in mental distortion.

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THE FATE OF A EUROPEAN BISON HERD.

In a paper entitled 'Das allmähliche Aussterben des Wisents (*Bison bonasus* Linn.) im Forste von Bjelowjesha'* Mr. Eugen Büchner gives a detailed history of the bison herd in the Bieloviejsha (or Bialowitza) forest, Province of Grodno, in Lithuania, Russia, during the present century. In his opening paragraph the author states that his purpose is two-fold: to make a critical historical study of this herd during the period for which the necessary data are available; and to find what light, if any, this history may throw on the general subject of the extinction of the larger mammalia.

Up to the year 1832 the accounts of the condition of the bison in the Bieloviejsha forest are conflicting and untrustworthy, but the number of animals in the herd during that period is estimated at from 300 to 800. Since 1832 a yearly census of the bison has been taken by the government of the forest. The count is made each winter immediately after the first snowfall, but must necessarily be only approximately accurate. The figures show an apparent slow increase from 770 head, the number recorded in 1832, to 1,898 head, the maximum reached in 1857. After 1857 there was a steady decrease until the minimum of 380 head was reached in 1889. During the three succeeding years there appears to have been a slight increase.

After presenting these figures the author at once attacks the question as to the cause

*Memoires de l'Academie impériale des sciences de St. Petersburg, Vol. III., No. 2, p. 1–30, 1895.