After the technic is learned the anastomosis may be completed in a few minutes. Under local anesthesia we performed such an anastomosis between the radial artery of a man with the proximal end of the basilic vein of his wife and readily transferred some of his blood to her circulation. This method would be applicable to any case of hemorrhage not amenable to ordinary methods. We are unable to resist the conclusion that the factor of hemorrhage may, under favorable circumstances, be eliminated.

The tracing shows a case of resuscitation after apparent death from hemorrhage. Dog A., weight 6.8 kg.; dog B., weight 8.1 kg. 1. Time, 30 per minute. 2. Respiration of bled animal. 3. Blood pressure curve (carotid artery) bled animal. 4. Base line bled animal. 5. Arterial pressure donor (animal supplying blood). 6. Base line of donor. On the upper half of the cut is represented the blood pressure and the respiration of the animal bled; on the lower half is represented the blood pressure of the animal from which blood was transferred (donor). Reading from right to left, note in the upper tracing the abrupt fall in the arterial pressure during hemorrhage of 300 c.c. arterial blood. The animal was bled until there was neither pulse nor respiration wave recorded and there was no sign of life. Two minutes later transfusion from the carotid artery to the jugular vein was begun. Note the fall in the blood pressure of the donor and the rise in the donee (bled animal). The ventricular beat had stopped and was inaugurated by rhythmic pressure on the chest. On account of the freshly oxygenated blood transfused, artificial respirations were unnecessary. Both animals promptly recovered. Recovery would have been even more prompt had the transfusion been given into an artery toward the heart. Also, when a longer time has elapsed after apparent death adrenalin injected into the artery is required. The least favorable conditions were purposely chosen for this experiment.

WHAT IS THE EFFECT ON PROGENY OF THE LOSS OF TEETH IN ANCESTRY?*

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In almost every country family there is a sub-family of dogs and my father's household was no exception to this rule. When I was a boy, there was born into our sub-family a pup with a short stump of tail, identical in proportion to his father's, whose tail had been cut off to suit the prevailing style.

This fact attracted my attention very strongly, and in looking over my research work I can see it has had great influence on my opinion as to variation in species and the law of heredity; to the end that I believe acquired defects in teeth as well as in tails can be inherited from ancestry.

DARWIN AND HEREDITY.

De Vries, Haeckel and others, in recent work, have made advances in working out details of Darwin's theories of inheritance, variation and natural selection, but none have cited evidence to disprove his main position; on the contrary, most research tends to establish and to strengthen him, hence I shall quote freely from his "Origin of Species."

In the chapter on "Variation and Inheritance," on page 11, he says:

> Any variation which is not inherited is unimportant for us. But the number and diversity of inheritable deviation of structure, both those of slight and those of considerable physiologic importance, are endless. Dr. Prosper Lucas' treatise, in two large volumes, is the fullest and the best on this subject. No breeder doubts how strong is the tendency to inheritance; that like produces like is his fundamental belief; doubts have been thrown on this principle only by theoretical writers. . . . Everyone must have heard of cases of albinism, prickly heat, hairy bodies, etc., appearing in several members of the same family. If strange and rare deviations of structure are really inherited, less strange and commoner deviations may be freely admitted to be inheritable. Perhaps the correct way of viewing the whole subject would be to look at the inheritance of every character whatever as the rule and non-heritance as the anomaly.
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> The laws governing inheritance are for the most part unknown. No one can say why the same peculiarity in different individuals of the same species, or in different species, is sometimes inherited and sometimes not so; why the child often reverts in certain characteristics to its grandfather or grandmother or more remote ancestor.

Variation under domestication is more rapid than variation under Nature, for in the former we have conscious selection of variations, and in the latter unconscious or selection by chance. The study of these laws led Darwin to advocate his belief in natural selection or the law of survival of the fittest. On page 121, he says:

> In one sense the conditions of life may be said not only to cause variability, either directly or indirectly, but likewise to include natural selection, for the conditions determine whether this or that variety shall survive. But when man is the selecting agent, we clearly see that the two elements of change are distinct; variability is in some manner excited, but it is the will of man which accumulates the variations in certain direction; and it is this latter agency which answers to the survival of the fittest under nature. From the facts alluded to in the first chapter I think there can be no doubt that use in our domestic animals has strengthened and enlarged certain parts, and disuse diminished them; and that such modifications are inherited. Under free nature we have no standard of comparison by which to judge of the effects of long continued use or disuse, for we know not the parent forms; but many animals possess structure which can be best explained by the effects of disuse.

It would seem that the intelligence of man lays him the more liable to degenerative effects, except in intellectual progress, for our protected lives favor fluctuating variability and accumulate the variation. Man's intelligence is strenuously exercised to improve his beast, but under our present social system his own qualities can not be bred for improvement. Undoubtedly we grow physically weaker as we grow intellectually stronger. Fisk says that in man, "the ape and the tiger will become extinct and a process of psychologic change take its place. Henceforth, the dominant aspect of evolution in man is to be, not the genesis of species, but the progress of civilization." There can be no doubt, however, but that the evolution of both mind and body in man, will keep him and leave him in his proper and natural place, for such are these laws of our Creator.

DETERIORATION OF TEETH.

If modifications appear constantly under the tedious and accidental selection of Nature, conscious selection under the wholesale extraction and disuse of teeth in man must accumulate this variation and result in the deterioration of these organs. This extraction of teeth, however, can not properly be called conscious selection, for there is no premeditation in this sense, neither is there any fight for life in these organs, in the sense

* Read in the Section on Stomatology of the American Medical Association, at the Fifty-seventh Annual Session, June, 1906.

this term was used by Darwin. On account of artificial environment and misuse of the teeth, incident to civilization (if one might be allowed the liberty), this process in man could be called by the paradoxical term, artificial natural selection. Deterioration of teeth in man might be supposed to have begun when he ceased to use them as organs of defense, or when he began to build fires and cook his food, a thing wholly unknown to Nature, except with man. With fires and cooking, no doubt, many degenerative features began in his physique.

There is much discussion as to whether acquired variations or mutilations are inherited. Darwin says: "The evidence that accidental mutilations can be inherited is at present not decisive. But the remarkable cases observed by Brown-Séquard in guinea-pigs, of the inherited effects of operations, should make us cautious in denying this tendency." In another place under the head of abortive organs, he says: "We have plenty of cases of rudimentary organs in our domestic productions, as the stump of a tail in tailless breeds, the vestige of an ear in earless breeds of sheep, the reappearance of minute, dangling horns in hornless breeds of cattle," etc. The teeth of man certainly can be no exception to this tendency.

VARIATIONS AND HEREDITY.

Variations are divided into two classes. First, those that are congenital or inborn, such as appear at birth and have no discoverable origin aside from life force; second, those that appear after birth, and seem to be due to environment, such as use or disuse, the effects of food, climate, conscious mutilation, conscious selection. Syphilitic and other diseases, peculiar to civilization, often produce defects and variations which are also inheritable.

Conscious Selection.—While we could hardly expect to see an unusual development of the hands of a child because its father or mother is an expert pianist, we do, under conscious selection, see most extraordinary developments in the pouter, fantail, and other varieties of pigeons, the original stock of which was the well known rock pigeon. Again, in color, size and varieties, of horses, dogs and cattle, we have features of the laws of heredity, which are hard for us to understand. These anomalies appear when least expected. For instance, when we have been breeding for certain features and have followed rules that formerly brought definite results, now and then unlooked-for freaks appear.

Defective Tooth Structures.—Most of us can cite instances of families in which there is a defective, malpoised, or absent tooth, often a superior lateral, running through several generations. May not this defect or mutilation have started from the loss of a tooth or from a badly decayed tooth in some ancestor? May not a principle have been fixed, by the almost universally defective sixth year molar running back for centuries or generations?

In view of the foregoing, is it not reasonable to assume that the general lack of resistance to decay of the teeth in most races of men is due to the loss of and disuse of teeth in ancestry, with the consequent defective tooth structure in progeny? A condition which seems to grow worse with each generation. Has this not become a fixed principle? It is found by examination of the skulls of aborigines, as well as of existing tribes of men, that with few exceptions all tribes have been and are subject to bad teeth and defective jaws to nearly the same extent as civilized man. This fact has been confirmed recently by Dr. W. J. Younger's examinations of Egyptians and Egyptian mummies. I believe one would be safe in assuming that a large majority of the human race have lost one or more teeth before the age of thirty, and a very large per cent. have lost eight, ten, or more. The first loss, more frequently, being the sixth year molar. In each case there is a loss of bone as well as of teeth, and what we know of heredity would make one believe that these mutilations can be handed down, if not in total absence of tooth or bone, at least in defective structure.

Talbot lays stress on unstable or defective nervous system as a cause of these heredity defects and goes more largely into degeneracy of the head, face, jaws and teeth, but I believe does not discuss to any degree, the question of defective teeth, or the loss of teeth in ancestry as affecting these special organs in progeny. One can easily admit that an unstable nervous system can effect the whole being. Any animal born perfect, with the exception of one organ, may perish immediately. Defective organs, such as eyes, ears or teeth, necessarily weaken the entire organism so that in the wild state, the creature soon dies or lives for a time in an imperfect condition. The nervous system, as well as other organs being unstable and inefficient, the animal succumbs to disease or to natural enemies long before its allotted time; hence the law of survival of the fittest. This law is not so strenuous with man, especially civilized man, since his intelligence and sympathy result in the protection and preservation of imperfect individuals. And imperfect humanity, under civilized protection, seems to be the class that propagates more freely than others, with the result that we have great numbers of degenerates, in one form or another, who continue to hand down their defects to their progeny, and no one organ seems to suffer this degeneracy more than the teeth, they being greatly prone to decay, accessible to removal and held in light esteem. Talbot supports the truth of inheritance of mutilation, giving statistics to show that circumcision in the Jewish race results in absence of, or defective prepuce in about 3 per cent. of male Jewish children.

NUMBER OF TEETH LOST ANNUALLY.

In endeavoring to get some fixed idea of how many teeth are lost annually, I secured an estimate from a prominent manufacturer, of the number of artificial teeth produced each year in the United States. His estimate was the astonishing figure of thirty-five millions. There may be various reasons *pro* and *con* for this not being a fair figure to calculate from, but it has a basis of truth and is the best plan I know on which to proceed. Thirty-five million teeth lost annually to the people of the United States would leave us, at the average age of 30, with only two teeth apiece, and this evidently is not the case. If, however, we assume the average loss to each one in a lifetime to be 5 and assume the average age to be 30, this would make an average annual loss to each individual of one-sixth of a tooth, or 13,333,333 for the United States. This means 40,400 pounds (330 teeth to the pound) or a large freight car loaded to its full capacity each year with human teeth, lost in the United States alone. Assuming the population of the earth to be one billion, five hundred million, the annual loss to mankind would be 757,576 pounds, or 18 carloads of 40,400 pounds each. These numbers are almost unthinkable, yet I believe they approach the truth.

TEETH HELD IN LIGHT ESTEEM.

Reparative dentistry is almost wholly unknown with the common people of all nations, and even with people

able to pay, comparatively little dentistry is done where it should be, and numbers of teeth are lost to every one that is repaired or replaced. Throughout civilization there is no other organ of the body held in so slight esteem. Blacksmiths, barbers, physicians and even dentists dispose of teeth without thought of their importance. The only requirement in nearly all instances is that the patient himself wants the tooth out. One might say that the loss to future generations is never considered, and few really consider seriously the loss to themselves. If they can only get rid of the offending organ they are satisfied. In their desire to save their teeth they are little better than savages. I also believe that almost as many teeth are lost from disease of the gums as are lost from decay and accident.

The ability of civilized man to compensate for these losses, by the use of cooking and other methods of premasticating and preparing foods, enables him to live almost a normal healthy life with no teeth at all, or with poor substitutes. This compensation by intelligence applies to all disorders and conditions and accounts for the lack of application of survival of the fittest to man in the same degree that it does to other species of organic life, not affected by civilization. Defective or diseased eyes or ears nearly always cause the affected individual to make efforts to save them, or to make them better; the same is true of other organs of the body; but the teeth seem to be of less importance to the majority, otherwise dentists would be many times more numerous and in much greater demand. Who knows the far-reaching effects on the present or future generations from the loss of these organs at the present rate. The effect does not stop with the mouth and teeth, for the condition of each separate organ affects the whole organism either to a limited or to a greater degree, and it must be of the greatest importance to life and health that this vestibule of the body, through which all the nourishment of life must pass, should be kept in as perfect condition as possible.

THE LAW OF INHERITANCE: THEORIES.

The law of inheritance has been deeply studied by many of our most scientific minds for generations, yet up to the present, the practical results of breeding in plants and animals give us most of our knowledge. To go deeper into the subject means to take up the study of cell life, but when one has gone into this branch of biology far enough to discuss intelligently the idioplasm theory of Naegle, along with the beautiful theories of others, we are still left with only the facts as brought out by conscious and systematic breeding. This is indicated by Professor Edmund Wilson:[1] "Yet the splendid achievements of cell-research in the past twenty years stand as the promise of its possibilities for the future, and we set no limit to its advance. . . . We can not foretell its future triumphs, nor can we doubt that the way has already been opened to better understanding of inheritance and development." To go deeper than cell life means to debate whether heredity is heredity, or whether it is variation and modification due to environment; to go farther still, is to discuss the point as to whether all matter is dead, or all alive, and so on into unthinkable propositions.

LUTHER BURBANK AND PRACTICAL RESULTS.

On the side of thinkable and practical results, we have many assiduous workers, but no one seemingly has done so much, with such telling results as Mr. Luther Burbank, whose new creations in plant life seem to have upset some ideas, heretofore accepted as laws. In place of conclusions based on observations of dozens or hundreds of plants, Mr. Burbank decides only after observation on thousands or millions of individuals and many generations of tests. His experiments seem the only ones which at all compare in figures with the enormous losses of human teeth.

By keen and intelligent selection from millions of specimens he accomplishes in ten years what natural selection would probably require ages or æons to do, and does it with a much greater benefit to mankind and to science. Regarding the so-called Mendelian Laws, which refer to heredity in the breeding of plants, his biographer says:[2]

> Over and over again, through a series of many years, dealing with millions of plants, and on a scale which dwarfs all other experimentation, Mr. Burbank has disproved these laws. . . . Leading scientists have maintained, and their followers have added the weight of their evidence that acquired characteristics are never transmitted. In the limitless fields of operation before him, Mr. Burbank has not only disproven this over and over again, but has established the opposite, that acquired characteristics are the only ones that are transmitted. . . .
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> Regarding the laws governing mutation or saltation, Mr. Burbank, times without number, has produced these strange mutations at will. They can be produced, he says, by anybody who systematically sets to work to disturb the life habits of the plants. Thus the peculiar phenomena which scientific observers on a small field have so sedulously studied, and have at last come to consider the result of a supreme act of Nature, are entirely within the province of any market gardener or amateur plant breeder. . . . Putting the matter in condensed form, Mr. Burbank says, "Heredity is the sum of all past environment." Heredity now becomes something far different from what it had before been held to be. "Every plant, animal, and planet," he holds, "occupies its place in the order of Nature by the action of two forces, the inherent constitutional life force, with all its acquired habits, the sum of which is heredity; and the many complicated outside forces or environments."

If then, it be a law of heredity that variations and acquired habits are the ones transmitted and that this "principle is indelibly fixed by repetition," also the mutilations may be inherited, what should we expect in the case of such enormous losses of teeth as are now, and for so many ages have been, going on in the human race?

Under these laws and conditions we would not expect the absence of one or more teeth in thousands, or may be of hundreds of thousands of individuals, but we would expect to find, as indeed we do, teeth of most inferior quality prevading the whole of civilization, with the consequent ravages of disease from their lack of resisting power. A principle of heredity supporting this view is found in the presence of rudimentary incisors in the upper jaw of the calf, which do not erupt, and the rudimentary teeth in the baleen whale, which always appear in the gums, as in the calf, but never erupt and are never of any practical use. There seems to be no question about the law, as previously quoted, that the disuse of parts results in their reduced size and their rudimentary quality, also that the result is inherited.

To sum up the matter, it does not seem that we are in danger of a toothless future, since teeth are always likely to persist in mammals, yet we can imagine a future state in which the teeth of man might be rudimentary, as in the calf. In fact, it is not uncommon

1. "The Cell in Development and Inheritance," p. 434.

2. Harwood: "New Creations in Plant Life," p. 342.

now for our wisdom teeth to be diminutive in size, or not to erupt at all. In structure our teeth are perceptibly rudimentary, and in consequence, they are lacking in power to live a normal, healthy life. In a former paper I stated that man can live, under civilization, a moderately normal and comfortable life without teeth. This is due to cooking and other methods of premasticating and preparing foods, but it is very much more desirable in every way to preserve our teeth as far as possible. Our specialty is making good progress in this direction, though one could wish our knowledge of prophylaxis in this line were greater, to the end that we would escape many diseases and much pain, handing down to progeny stronger jaws and better teeth.

DISCUSSION.

DR. EUGENE TALBOT, Chicago, said that there is no question but that we can produce a new species by mutilation, and that the jaws and teeth are affected by certain conditions that persist in this counry and abroad. Perhaps no better illustration of the inheritance of acquired defects can be found, he said, than that seen in the Boston terrier. Dr. Talbot spent some time studying that animal and declared that it is a singular thing that the inheritance of acquired defects is more beautifully illustrated in this than in any other animal he ever studied. The Boston terrier is about twenty-five years old, it is a cross between an English bull dog and an English terrier. Environment and breeding have produced this new race. These dogs used to have normal tails, and twenty-five years ago the parent dogs had their tails cut off, and by breeding in and in, the present breed with greatly deformed tails has been produced. Professor Wiseman believes deformities are not inherited. Dr. Talbot has many times shown the inheritance of acquired deformities. He has cut off the tails of mice and bred these animals in and in, and in the seventh generation mice have appeared without tails. If he were a young man he should breed dogs with cleft palates and hare lips. If any young man who is ambitious and were to take up this thing, in a few years he would be able to produce a new class of animals. In regard to the jaws and teeth, in some places dentists are in the habit of extracting the first permanent molars, but Dr. Talbot believes that the continual extraction of the first permanent molars, in eight or ten generations will shorten up the jaw. He knows this is possible, because the face, jaws and teeth are degenerating. The constant extraction of the first permanent molar as has been done in certain localities has been shown to produce people with deformed jaws, arrest in development, and irregularities of the teeth. The fact is, the face, jaws and teeth are degenerating for the benefit of the brain under the law of economy of growth laid down by Aristotle, who first discovered the inheritance of acquired defects. Decay of the teeth is a natural process in the evolution of man, and when there is an abnormal nervous system, as in degenerates—in the idiot and in the deaf, dumb and blind asylums—the teeth degenerate very rapidly, indeed. Teeth decay to a greater extent in England than in any other country, due to the fact that the English are a little farther along in the line of evolution.

DR. M. L. RHEIN, New York City, referred to the discussion on this subject at Portland, last year. He considers the key note of the situation to be Dr. Fletcher's statement that according to Burbank it is unquestionably proved that acquired defects can be transmitted. This, he said, removes at once all the contention that appeared between Dr. Fletcher, Dr. Talbot, and himself in last year's discussion. At that time, in reference to Dr. Talbot's point as to the eventful dentureless condition of the human race, Dr. Rhein took the position that such a condition would never exist, because something would always intervene that would interfere with any such deterioration in the physical condition of the race as a whole. He thought that the trend of this discussion illustrates the correctness of his remark on that occasion, because, if, according to Dr. Fletcher, acquired defective conditions can be transmitted, it follows as a logical sequence, that restorations of malformations of the maxillæ and teeth can be transmitted in a like manner. The superiority of American dentistry during the past three-quarters of a century has induced in this country an increased attention to the preservation of the natural physiologic condition of the hman mouth. Dr. Rhein believes that the mission of American dentists for the regeneration of mouth defects has just begun. The lack of appreciation of the value of the preservation of the first permanent molar by the majority of dentists during the past fifty years has had a very important bearing on the oral deformities met with at the present day. We are just beginning to see, according to Dr. Talbot's well-defined ideas, the effect of transmitted acquirements of such defects. Something, however, has occurred effectually to stop this destructive tendency. The instrument which has intervened not only to prevent any further retrogression from the normal condition but which has become a huge instrument tending toward the restoration of abnormal mouths to the normal physiologic state, is the advanced school of orthodontia, instituted by Dr. Angle. These men have succeeded, not only in calling the attention of the dental world to the necessity of the preservation of the first permanent molar, but have so simplified the work of orthodontia and placed it on such a scientific plane, that the results in the shape of physiologic mouths restored from deformity and malformation are no longer a rarity but a very frequent occurrence in every part of the civilized world where the graduates of this institution have seen fit to locate. The normal development of this condition means in the future that human mouths will approach more nearly to the physiologic than they have in the past few hundred years.

PHYSICAL ECONOMICS.*

[Comprising a mathematical formula for the normal earning ability of the body by which, with the requisite data a person may be either rated, or his economic value may be ascertained, and thereby damages to his body from injury or disease, with an indemnity to be allowed therefor, may be determined in a manner equitable to all concerned.]

ERASTUS EUGENE HOLT, A.M., M.D., LL.D.

PORTLAND, MAINE.

An oculist, when called on to ascertain damages to the eyes from an injury, frequently meets with other disabilities of the body which occurred at the same time. If he works in connection with other physicians and surgeons who are to determine damages to other parts of the body, it is highly important that there should be standard methods of procedure which can be applied to every system and organ of the body so that each may understand the other and work together to obtain results on a scientific basis. The object of this paper is to promulgate methods by which this may be accomplished in a manner equitable to all concerned.

The problem is a mixed one, inasmuch as we must have a method for ascertaining the economic value of a person both before and after he has been damaged from injury or disease. All recognize the importance of scientific methods for solving this problem, but no one has had the temerity to attempt to overcome the difficulties surrounding it. It occurred to me, however, while I was disabled from an injury, received in 1903, that if, when the eyes were damaged, the remaining earning ability could be determined by a mathematical formula, based on the principles employed in the natural sciences in measuring any power, as had been done by Magnus[1] of Germany, the principle might be utilized for the whole body. I, therefore, spent many of the long weary hours of my disability in thinking how this

* Read in the Section on Ophthalmology of the American Medical Association, at the Fifty-seventh Annual Session, June, 1906.

1. "Visual Economics," by Dr. H. Magnus of Breslau, Germany, translated with additions by Dr. H. V. Würdemann, Milwaukee, Wis.