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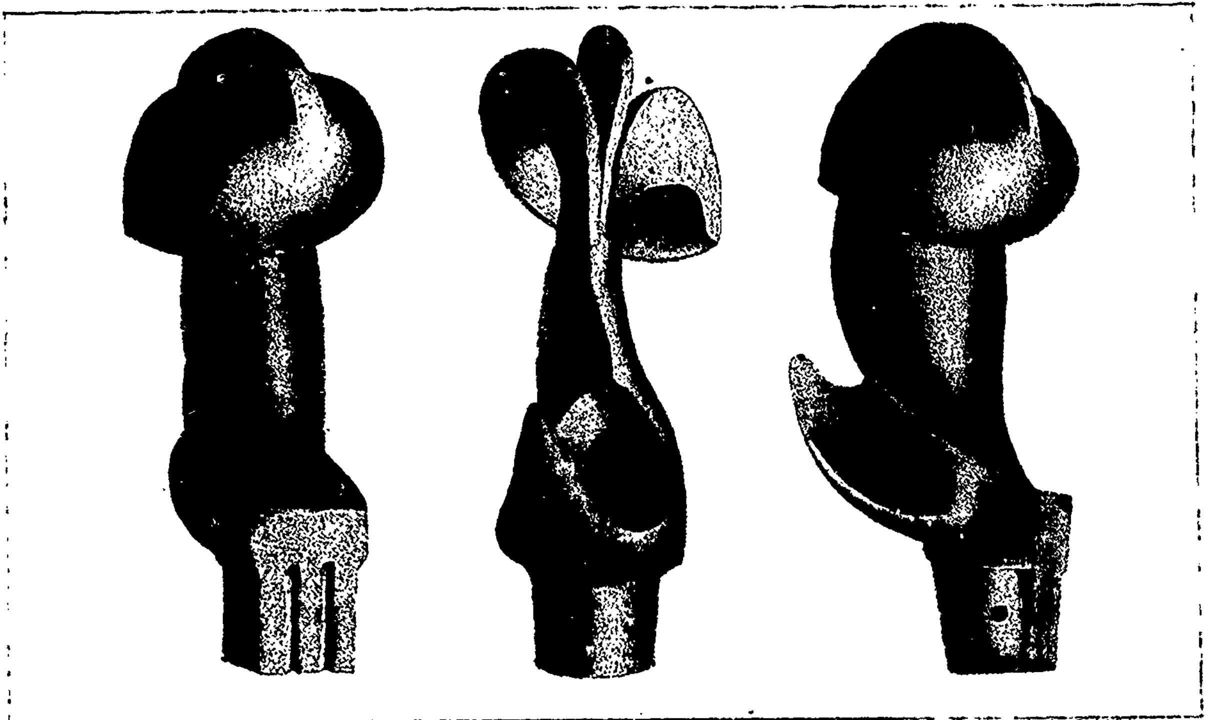

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Handle of Bronze Fibula, Lake of Bienne.

THE CANADIAN JOURNAL.

NEW SERIES.

No. XCV.—JULY, 1877.

LEFTHANDEDNESS.

BY DANIEL WILSON, LL.D., F.R.S.E.

Under the title of "Righthandedness," the specialities of this common attribute of man, and the sources and characteristics of the occasional deviation from it, have been discussed in a former paper.* I now propose, under the present title, to supplement it with some additional suggestions and illustrations.

If righthandedness can be referred to any anatomical cause—such as the position of the viscera, their relative weight on the two sides of the body, the development of the subclavian arteries, or the predominance of one of the cerebral hemispheres,—then its general prevalence, or assumed universality, among all races and in all ages, is easily accounted for; and lefthandedness may be traced, with reasonable probability, to a reversal of the normal anatomical conditions of the body. But no theory is of any value which fails to account for the exceptional lefthandedness, no less than for the prevalent righthandedness. The evidence of righthandedness as a predominant habit is obvious; but its source is not yet certainly determined, and acquires a fresh interest in so far as this natural endowment or habit is peculiar to man.

If righthandedness is referable to anatomical causes, some traces of it may be looked for among mammalia generally, and especially

* Canadian Journal, N. S., Vol. xiii., p. 193.

among the anthropoid apes; and the occasional occurrence of left-handedness should be easily accounted for. If, on the other hand, it has its origin in a habit engendered by enforced usage resulting from combined action, as in the reaping field, at the oar, at the forge, or in concerted military action, this involves only the concurrent use of either hand; and it need no more surprise us to find lefthanded races, than to observe that our usage in writing from left to right reverses that of ancient semitic nations. On the latter assumption indeed it would seem opposed to all probability that, alike in the Old and the New World, nations living apart, in utter ignorance of each other, should be found uniformly manifesting a preference for the same hand. But no example of a lefthanded race is known, unless a vague reference previously quoted from Stobæus can be accepted in proof of it; while the preferential use of one hand, long anterior to any historical evidence of righthandedness, is proved by terms for right and left hand occurring in the vocabularies alike of ancient civilized nations, and of untutored savages, such as those of New Zealand, Polynesia, and Australia; as well as among the rudest tribes of the New World. It only remains to determine whether in every case the so-called right hand has been the member of that side of the body to which we apply the term. If the superiority of one hand over the other is no more than the result of acquired habit, consequent on the necessity for uniform action in many combined operations, then it is inconceivable that among races isolated, and without intercourse throughout the historic period, as in the Pacific Islands, Australia, and America, all should have chanced to adopt the same hand. But if, on the contrary, the dexterity of the right hand is dependent on organic causes common to man, then the exceptional and abnormal character of lefthandedness becomes obvious. Hence the desirableness of observing the manifestations of any preferential use of one or the other hand among savage races. The Maories of New Zealand, as already noted, manifest a prevalent righthanded-ness, especially in the use of the musket in their war dances. The musket, it has to be borne in remembrance, is purposely constructed for a righthanded people; and hence, as a righthanded instrument, it would have sufficed to determine the bias, among any people previously using either hand indifferently; but the Maori tongue proves the existence of a native righthandedness altogether prior to European intercourse; and the same appears to be characteristic of

most, if not all, of the Polynesian languages. The word *tau*, which in the Hawaian signifies *ready*, in the Tahitian *right, proper*, and in the New Zealand *expert, dextrous*, is the common Polynesian term for the right hand. In the Vitian language, as spoken in various dialects throughout the Viti or Fiji Islands, the distinction is still more explicitly indicated. There is first the common term *linga*, the hand, or arm; then the ceremonial term *dáka*, employed in speaking of that of a chief, but which, it may be presumed, also expresses the right hand, as, while there is no other word for it, a distinct term *sema* is the left hand. The root *se* is found not only in the Viti, but also in the Samoa, Tonga, Mangariva, and New Zealand dialects, signifying to err, to mistake, to wander; *semo*, unstable, unfixed; while there is the word *matau*, right, dexter, proving the recognition of the distinction.

An occasional correspondent of the *Times* communicated a series of letters to that journal in the latter part of the past year (1876), in which he embodied anthropological notes on the Fijians, obtained, as he states, both from his own observations during repeated visits to the Islands, and from conversation with English, American, and German settlers, who may be met at the port of call and on the route in either direction between San Francisco and the Australian Colonies. "The Fijians," he says, "are quite equal in stature to white men; they are better developed relatively in the chest and arms than in the lower limbs; they are excellent swimmers, and, if trained, are good rowers. Lefthanded men are more common among them than among white people; three were pointed out in one little village near the anchorage."

Observations of this class will no doubt accumulate when attention is more fully directed to the inquiry, and so help to determine whether or not man is congenitally righthanded, and has, from anatomical structure, a specific right and left side. On this subject Sir Thomas Browne quaintly remarks in his "Religio Medici:" "Whether Eve was framed out of the left side of Adam, I dispute not, because I stand not yet assured which is the right side of a man, or whether there be any such distinction in nature." Dr. Struthers, Professor of Anatomy in the University of Aberdeen, who has long directed his attention to this subject, thus writes to me: "I have again and again verified the fact in my own children, that in early childhood there is no preference for one hand more than the other."

But though this is undoubtedly true of the majority, a certain number of children will be found to manifest a distinct preference, at a very early age, for one or the other hand. In the case of a niece of my own, the lefthandedness showed itself very early; and in my grandson, it was independently observed by its mother and nurse, and brought under my notice, that so soon as he was able to grasp an object and transfer it from one hand to the other, he gave the preference to the left hand. A like decided preference for the right hand, though doubtless also comparatively rare, is more frequent; and the further research is carried, the more manifest does it appear that the preferential use of what we designate the right hand is natural and instinctive with a sufficiently large number to determine the prevalent usage. With a smaller number an equally strong impulse is felt prompting to the use of the left hand; but my opinion remains unchanged, that with the majority righthandedness is no more than the result of prevalent custom and education.

Attention has already been drawn to the indications pointing to the simultaneous use of the right and the left hand by two fellow flint workers in the primitive flint-pits of Norfolk, styled "Grime's Graves." But some more recent disclosures are suggestive of the preferential use of the right hand among the men of Europe's palæotechnic dawn.* The recovery of specimens of imitative art, the work of the Troglodytes of the Mammoth and Reindeer Periods of Southern France, has familiarized us with carvings and etchings, executed with a remarkable degree of freedom and artistic truthfulness, by a people living at the head waters of the Garonne, under social and climatic conditions closely analogous to those of the Esquimaux of the present time. In dexterity of handling and faithful portraiture, the specimens of primitive art greatly surpass the most ingenious examples of drawing or etching executed by modern savages. The drawing especially of the mammoth, traced with a pointed implement on a tablet of ivory, found in La Madelaine Cave, on the river Vézère, is replete with interest, alike as a piece of contemporary portraiture of the long-extinct proboscidian of Europe, and as an evidence of the intellectual development of contemporary man. But the drawings and etchings on ivory thus executed by contemporaries of the mammoth and reindeer of Southern France have also a value for us

* *Vide* Prehistoric Man, 3rd Ed., Vol. i., p. 107.

in their indication of a preference given to the right hand by the draughtsmen of that remote age. The mammoth drawing, and other palæographic tablets representing groups of reindeers, horses, &c., are executed in profile, looking to the left, as a righthanded draughtsman naturally does, from the greater facility of execution, when no special reason prompts him to deviate from that direction. They are, in fact, righthanded drawings; and the examples thus far adduced seem to point to this as the uniform characteristic of the etchings of the Troglodytes of the Vézère.

As already shown in the former paper, the member of the body designated the right hand among the ancient Hebrews, Greeks and Latins, and probably among the Sanskrit-speaking Aryans, was the same as we now understand by that term. But all of those were civilized races, and in sufficient geographical propinquity to have derived the same custom or usage from a common source. It is otherwise with the primitive cave-dwellers. In the rudest states of society man as a tool-using animal has the preferential use of one hand engendered in him, so soon as he engages with others in combined operations. As he progresses in civilization, and improves on his first rude weapons and implements, the habitual use of them in one hand leads to their adaptation specially for it, and thus the lefthanded workman is placed at a further disadvantage; and an additional bias is given to righthandedness. But here, also, the inveterate lefthanded manipulator at times re-instates himself on a fair equality with his rival, by providing himself with lefthanded tools and other appliances. I have recently learned of two lefthanded carpenters, with benches so adapted to their own special use; and am told of a scythe adapted to the requirements of a lefthanded mower. But it is more frequently in the pastimes of leisure hours that the lefthanded operator is tempted to put himself on an equality with others in the special adaptation of his tools. The favourite Scottish game of golf is one in which the implements are of necessity righthanded, and so subject the lefthanded player to the greatest disadvantage, unless he provides his own special clubs. The links at Leith have long been famous as an arena for Scottish golfers. King Charles I. was engaged in a game of golf on these links when, in November, 1641, a letter was delivered into his hands, which gave him the first account of the Irish Rebellion. According to the anecdote, as recorded in the *Archæologia Scotica* by Mr. Tytler, of

Woodhouselee, on reading the letter, he suddenly called for his coach, and leaning on one of his attendants, in great agitation drove to the palace of Holyrood, from whence he set out the following day for London. The same links were a favourite resort of his younger son, James II., while still Duke of York; and some curious traditions preserve the memory of his keen relish for the game. There accordingly golf is still played with keenest zest; and among its present practisers is an ambidextrous golfer, who has provided himself with a double set of right and left drivers and irons; so that he can use either hand at pleasure according to the character of the ground or the position of the ball, to the general discomfiture of his one-handed rivals. The Scotchmen of Montreal and Quebec have transplanted the old national game to Canadian soil; and the latter city has a beautiful course on the famed historical battle-field, the scene of Wolfe's victory and death. There their experience recently induced the Quebec Golf Club, when ordering spare sets of implements for the use of occasional guests from the Old Country, to consider the propriety of ordering a lefthanded set. In the discussion to which the proposal gave rise, it was urged to be unnecessary, as a lefthanded player generally has his own clubs with him; but finally it was compromised by ordering two lefthanded drivers; so that on a lefthanded golfer turning up he will have to putt with his driver. The considerateness of the Quebec golfers for their lefthanded rivals was no doubt stimulated by the fact that there is a skilled golfer of the Montreal Club whose feats of dexterity as a lefthanded player at times startle them. One of the Quebec golfers writes to me thus: "There is one lefthanded fellow belonging to the Montreal Club who comes down occasionally to challenge us; and I have watched his queer play with a good deal of interest and astonishment."

Such illustrations of the growing disadvantage to which the lefthanded workman is put, as civilization develops arts and pastimes with tools or implements specially adapted to the right hand, all the more strongly demonstrate the innate constitutional tendency to lefthandedness in a certain percentage of cases: since the whole tendency of such artificial righthanded appliances is to foster a uniform prevalent usage, and as far as possible to eradicate lefthandedness. But this is only a result of the innate tendency of the majority. We learn from the palæographic tablets of the Vézère caves, that at

a time vastly more remote than Hebrew or Greek records, and among a people in the most primitive condition of savage life, the preference appears to have been given to the same hand which has been recognized as the right hand among all civilized nations of historic times. Such concurrent evidence seems to point to a uniform preference for the same hand from remotest times, such as could not fail to eradicate any mere exceptional habit; and so suggests with renewed force that the use of the right hand is traceable to some peculiarity of organic structure, or to some physiological law generally affecting the human organization. Nor is it necessarily limited to man. As already shown, there are indications suggestive of a disposition in some at least of the lower animals to employ one limb in preference to the other.

A writer in the *Cornhill Magazine*, when referring to one remarkable class of manifestations which seem to show that the faculty of speech is mainly if not wholly dependent on the left side of the brain; or at any rate that *aphasia*, or the loss of the power of vocal expression of ideas, is accompanied with disease of that side of the brain: says, "Rightsidedness extends to the lower races. Birds, and especially parrots, show rightsidedness. Dr. W. Ogle has found that few parrots perch on the left leg. Now, parrots have that part at least of the faculty of speech which depends on the memory of successive sounds, and of the method of reproducing such imitation of them as a parrot's powers permit; and it is remarkable that their left brain receives more blood, and is better developed than the right brain." The same writer expresses his doubt as to monkeys showing any tendency to righthandedness. This is a point to which careful attention should be directed where opportunity offers. In my former paper I noticed the interesting treatise by Dr. Buchanan, Professor of Physiology in the University of Glasgow, on the "Mechanical Theory of the Predominance of the Right Hand over the Left." But I was not then aware that Professor Struthers had followed up his observations by a series of careful investigations, the results of which are set forth in his paper entitled, "On the relative weight of the viscera on the two sides of the body; and on the consequent position of the centre of gravity to the right side." He there notes that, "While the viscera of the quadruped have the same general lateralized position as in man, there is a reason why this should be carried to a greater extent in man than in the quadruped, owing to

the much greater lateral development of the chest and abdomen of the human figure, in order to adapt it to the erect posture, as contrasted with the great lateral flattening of the trunk in quadrupeds. The equipoise is therefore more disturbed in man than in the quadruped; and it may be observed that the same consideration applies to the child, in whom the chest is at first narrow, and in whom it undergoes rapid increase of breadth when the child begins to walk: the period at which, according to the gravitation theory, the predominance of the right hand should begin to be developed. To this reason why the position of the centre of gravity to the right side should have more influence in man than in the quadruped, may be added the fact of the erect posture, enabling the gravitating influence to operate at once on the whole one side of the body."

The necessities of the monkey as a climber no doubt tend to bring all its limbs into constant use; but possibly careful study of the habits and gestures of monkeys may disclose, along with ambidextrous facilities, some traces of a preference for the limbs on the one side. The elephant has been repeatedly affirmed to betray a strongly marked rightsidedness; and this has recently been reiterated in a communication made by Mr. James Shaw to the Anthropological sub-section of the British Association, where he noted the "curious fact that elephants have been frequently known to use the right tusk more than the left in digging up roots, and in doing other things." But the statement is vague, and, even if confirmed by adequate proof, can scarcely be regarded as the equivalent of right-handedness. I formerly referred to the greater development of the left tusk of the walrus in a specimen in the Museum of the University of Toronto. I have since learned of other examples of this; and am assured by an old Hudson's Bay factor that it is of frequent occurrence both in the walrus and narwhal. On this subject Dr. Struthers remarks: "When we examine the instances of unequal development on the two sides, among animals constructed on the symmetrical plan, it does not appear that there is any preference in nature for one side more frequently than for the other. Among the mammalia, we observe that it is the left tusk of the narwhal which is normally so greatly developed. In birds the ovary and oviduct which are developed are almost always the left. In serpents, the lung which is so much developed, compared with the other, is the right. Among fishes, the pleuronectidæ, or flat fishes, present a remarkable a-sym-

metry in the twisting of both orbits, and partly of the mouth, to one side, that which they present to the light. In the sole it is the right side, in the turbot it is the left side, to which the eyes are turned; but it is not uncommon to find this reversed, and in the flounder the eyes are found nearly as often on the left as on the right side." The question of anatomical symmetry is, however, a different one from that of equipoise, and the whole question of a preferential rightsided action in the case of the lower animals is still an open one. Dr. P. H. Pye-Smith says, "The primitive human condition we must suppose to have been one of perfect symmetrical structure and ambidextrous function. For this is the condition of all the higher vertebrates which can be best compared with man; complete bilateral symmetry of all the organs is the state of the human embryo at an early stage; and all the simpler actions, such as climbing, rowing, swimming, are performed with both hands. The alternate action of the limbs in the horse, and that of both sides together in the camel, would equally imply complete symmetry of the nervous centres; though even here we seem to have the first step to differentiation, indicated by the preference for the right foot to lead with in the canter, which is impressed on saddle-horses for our convenience." The communication of Mr. Shaw, above referred to, is only known to me from the very brief notice of it in a local paper; but so far as appears, he merely repeated previous statements relative to the preferential use by the elephant of its right tusk. The general result which he is indicated as affirming, in reference to the main question, is that "there is a constitutional reason for the preference given to the right hand; but this tendency he believed had been much strengthened by habit."

The archæological evidence in proof of the antiquity of the use of the right hand may be expected to increase when attention is directed to the subject. The Vézère relics suggest its prevalence in an era when man and the mammoth were contemporary in Central Europe. The handle of a bronze sickle found in 1873 at the lake-dwelling of Möringen, on the Lake of Brienne, in Switzerland, still more conclusively demonstrates the habit in a later, though still prehistoric age. Bronze sickles have long been familiar to the antiquary among the relics of Europe's Bronze Age, and their forms have been shown in various archæological works, and included among the illustrations of Dr. Ferdinand Keller's "Lake Dwellings;" but the example now referred to is the first known illustration of the complete hafted

implement. The handle is of yew, and is ingeniously and tastefully carved so as to lie obliquely to the blade, and allow of its use close to the ground. But a greater interest attaches to the fact that it is a righthanded implement, carefully fashioned so as to adapt it to the grasp of a very small hand, and as incapable of use by a left-handed shearer as a mower's scythe. Its peculiar form is shown in the accompanying illustration; and Dr. Keller, in noting that the handle is designed for use by the right hand, adds: "Even in the Stone Age, it has already been noticed that the implements in use at that time were fitted for the right hand only." This, however, like other generalizations on the subject, is an assumption resting on very insubstantial evidence. Examples of implements of the Stone Age, whether palæolithic or neolithic, suggestive of any discrimination in the use of one hand in preference to the other, must be exceedingly rare; and so far as the deer's horn picks recovered from "Grime's Graves" flint pits afford any illustration of this, primitive tools are not invariably righthanded.

When formerly treating of righthandedness, I was not aware of an interesting article by Dr. Pye-Smith, in the "Guy's Hospital Reports for 1870–71," from which I have quoted above. I am indebted to the author for a revised reprint, entitled "The connection of Left-handedness with transposition of the Viscera and other supposed Anatomical Causes." The theory that lefthandedness is due to the transposition of the viscera, or to the exceptional origin in certain cases of the left subclavian artery before the right, as shown in my former paper, not only lacks confirmation, but is contradicted by ascertained facts. The first of these explanations, which refers left-handedness to the transposition of the viscera, is noticed by Dr. Pye-Smith as "the only explanation, so far as I know, which has been offered of the peculiarity." This theory has been often proposed, has received the high sanction of Professor Hyrtl, of Vienna, and is supported by some undoubted cases in which the two conditions coexisted. But, as Dr. Pye-Smith remarks, "A few such instances only prove that transposition of the viscera does not *prevent* the subject of the abnormality from being lefthanded. Though attention has hitherto been little drawn to this point, there are enough cases already recorded to show that for a person with transposed viscera to be lefthanded is a mere coincidence." In confirmation of this, Dr. Pye-Smith refers to four cases, one of which came under his own

observation in Guy's Hospital, where the subjects of the abnormal disposition of the viscera had been *right*handed.

Dr. Struthers has shown from a series of very carefully conducted observations by himself and others, that "as far as the viscera alone are concerned, the right side is at least 22¾ ounces heavier than the left, and that this is reduced 7¾ ounces by the influence of the contents of the stomach, leaving a clear preponderance of at least 15 ounces in favour of the right side." The preponderance of the right side, he adds, is probably considerably greater than 15 ounces, and it is rendered still more so in the erect posture. The *total* weight of viscera on the right side he states at 50¾ ounces, while that of the left side is only 28 ounces, giving a visceral preponderance on the right side of 22¾ ounces, which he reduces, as above stated, by deducting 7¾ ounces for the contents of the stomach. But if this relative excess of weight on the right side be the true cause of the prevalent righthandedness, the transposition of the viscera ought to be invariably accompanied with a corresponding lefthandedness; whereas this is proved not to be the case.

The other theory, which refers lefthandedness to the abnormal arrangement of the blood-vessels, and especially of the right and left subclavian artery, is more difficult to test, since, with rare exceptions, the evidence lies beyond reach of observation in the living subject. So far, however, as ascertained facts can be appealed to, they fail to sustain the theory. Dr. Pye-Smith states that he found the deviation from the normal arrangement of the primary branches of the aorta, in which the right subclavian arises from the third part of the aortic arch, occur four times in 296 dissections. As this variation, he says, "cannot be recognized during life, its connection with lefthandedness is not easy to investigate. But in one case, at least, Dr. Peacock ascertained for me that the subject of this abnormality, whose heart and arteries he had examined for another purpose, was righthanded during life."

It thus appears that the source of right or lefthandedness is not traceable either to the transposition of the viscera, or to the disposition of the subclavian arteries. We are therefore led to seek for a physical cause for the preferential use of the one or other hand in the central nervous system. In this direction the eminent anatomist, Professor Gratiolet, looked for a solution of the difficulty. He maintained that in the early stages of fœtal development, the anterior and

middle lobes of the brain on the left side were in a more advanced condition than those on the right side, the balance being maintained by an opposite condition of the posterior lobes. Hence, in consequence of the well-known decussation of the nerve-roots, the right side of the body—so far as it is influenced by brain-force—would, in early fœtal life, be better supplied with nervous force than the left side; and thereby movements of the right arm would precede and be more perfect than those of the left.

This statement of Gratiolet, relative to the earlier development of the left than of the right side of the brain, has been challenged by other observers; but many phenomena accompanying certain local injuries of the brain lend confirmation to the theory that the left lobe of the brain influences the action of the organs on the right side of the body, and *vice versa*.

"The opinion," says Dr. Pye-Smith, "that some difference between the two sides of the brain has to do with our preference for the right hand over the left may, perhaps, be supported by two very interesting cases of aphasia occurring in lefthanded persons, recorded by Dr. Hughlings Jackson and Dr. John Ogle. In both these patients there was paralysis of the *left* side, so that it seems likely that in these two lefthanded people the right half of the brain had the functions, if not the structure, which ordinarily belong to the left. To these cases may be added a very remarkable one published by Dr. Wadham (St. George's Hosp. Rep. 1869). An ambidextrous, or partially left-handed lad was attacked with left hemiplegia and loss of speech; he had partly recovered at the time of his death, twelve months later, and then the right insula, and adjacent parts, were found softened."

The remarkable difference in the convolutions of different brains, and the consequent extent of superficies of some brains over others apparently of the same size, have been a matter of special observation, with results lending confirmation to the idea that great development of the convolutions of the brain is the concomitant of a corresponding manifestation of intellectual activity. But the degree of development, and the complexity in the arrangement of these convolutions, often differ considerably in the two hemispheres of the same brain; and it seems not improbable that lefthandedness may prove to be traceable to certain structural differences between the right and left hemispheres. The variations in shape and arrangement of the convolutions in either hemisphere may be no more than the accidental

folds of the cerebral mass in its later development in the osseous chamber of the skull, and within ordinary limits they probably exercise no appreciable influence on physical or mental activity. From long and careful observation, especially of children, I am satisfied that with the great majority righthandedness is mainly the result of education, or a compliance with prevailing usage. Little effort would be needed with such to superinduce lefthandedness. But there are a sufficient number of persons naturally and instinctively righthanded to determine the bias of the majority; though they cannot influence another, though smaller number, who have an equally strong and ineradicable impulse to the use of the left hand. Wherever, therefore, opportunity is afforded for examination of the brain, it is desirable that in every case of marked inequality between the two hemispheres, inquiry should be instituted as to the concurrence of a strongly pronounced right or lefthandedness.

But it has also been affirmed as the result of repeated observations, that there is often a decided difference in the weight of the two hemispheres of the brain. M. Broca states that in forty brains he found the left frontal lobe heavier than the right; and Dr. Boyd, when describing the results obtained by him from observations on upwards of 500 brains of patients in the St. Marylebone Hospital, says: "It is a singular fact, confirmed by the examination of nearly 200 cases at St. Marylebone, in which the hemispheres were weighed separately, that almost invariably the weight of the left exceeded that of the right by at least the eighth of an ounce." But the careful independent observations of Professor Wagner and Dr. Thurnam failed to confirm these results. From the weighing of the two hemispheres of eighteen distinct brains, Professor Wagner found the right hemisphere the heavier in ten, and the left in six cases, while in the remaining two they were of equal weight. Dr. Thurnam, without entering into details, states that the results of his weighings did not confirm Dr. Boyd's observations; adding that "fresh careful observations are certainly needed before we can admit the general preponderance of the left hemisphere over the right."

It has to be borne in remembrance that though the two hemispheres of the brain are sufficiently indicated in every case, there is no natural separation between them, and the division in the exact median line is a delicate operation, in which a very slight bias of the operator's hand will suffice to beget such a deviation from the true

line as would fully account for the conflicting results referred to. On the assumption that right and lefthandedness are traceable to the relative development of the two hemispheres of the brain, the results very well accord with actual manifestations. There is a noticeable excess in the examples of greater weight of the left than of the right hemisphere; but apparently a still larger number of cases are to be found where it is difficult to determine any noticeable bias either way. But other observers have assigned much more comprehensive functions, and a nearly independent action, to the two hemispheres of the brain.

Dr. Brown-Sequard, who strongly favours the idea of the superiority alike in size and weight of the left over the right hemisphere, reverts to an argument derived from lefthandedness when discussing his theory that the two hemispheres practically constitute two distinct brains, each sufficient in itself for the full performance of nearly all mental operations, though each also has its own special functions, among which is the control over the movements and the organs of opposite sides of the body. "Every organ," he says, "which is put in use for a certain function gets developed, and more apt or ready to perform that function. Indeed, the brain shows this in point of mere size; for the left side of the brain, which is used most, is larger than the right side. The left side of the brain also receives a great deal more blood than the right side, because its action preponderates; and every organ that acts much receives more blood." He accordingly affirms that the growth of the brain up to forty years of age, if not indeed to a considerably later period of life, is sufficiently marked to require the continued enlargement of the hat. Speaking of himself, as having then passed his fifty-sixth year, he says:—"There is no period of six months that has passed that I have not found my hat, if neglected and put aside, has become too small. The head growing is very strong proof that the brain grows also." The opinions advocated by the leading anatomists of Europe in the earlier years of the present century, differed widely from this. It was indeed maintained by Sœmmering, the Wenzels, and Tiedemann, that the brain attained its greatest development not later than at seven or eight years of age. But, without going so far as Dr. Brown-Sequard is prepared to do, the old idea as to the complete development of the brain in youth is now abandoned, and the latest observers have produced evidence in proof of the brain increasing in weight,

o that the greatest average weight occurs between thirty and forty years of age. They do not, however, indicate any such increase in actual bulk as Dr. Brown-Sequard implies; nor does the evidence lend confirmation to the idea of any very prevalent difference in the size or weight of the two hemispheres. In the majority of cases, indeed, the comparatively early ossification of the sutures would alone suffice to preclude the possibility of such a growth of the head as Dr. Brown-Sequard assumes to be demonstrable even beyond the age of fifty-six. Without due allowance for the stiffness of a new hat, and the shrinking of an old one when out of use, the hat-measurements on which he relies may prove very deceptive. But, on his assumption relative to the normal excess of the left hemisphere of the brain, there ought to be a greater equality between the two hemispheres in a lefthanded than a righthanded person, owing to the more equal employment of the two sides of the brain by the latter. But he fails to appreciate the bearings of his own argument in the case of a lefthanded person conforming in many ways to the usage of the majority, yet instinctively giving the preference to the left hand. He dwells on the fact that very few lefthanded persons have learned to write with the left hand, and that those who can do so do not write nearly so well with it as with the right hand. "Therefore," he says, "the left side of the brain, even in persons who are lefthanded naturally—so that the right side of the brain controls the reasoning faculties and their expression,—can be so educated that the right hand, which that side of the brain controls, produces a better handwriting than that by the left hand, though that is controlled by the better developed brain." The reasoning here is alike partial and misleading. The lefthanded person systematically submits to disabilities in his efforts to comply with the usage of the majority, not only in holding his pen in the right hand, but in the direction and slope of the writing. A lefthanded race would naturally write from right to left, sloping the letters towards the left, and so would place the righthanded penman at a like disadvantage, wholly independent of any supposed change in the functions or preponderating energy of either hemisphere of the brain. But even in the absence of practice, the command of the left hand in the case of a truly lefthanded person is so great that very slight effort is required to enable him to write with ease with that hand.

A striking illustration of this has recently been communicated to me. The Chief Manager of one of the Canadian Banks had occasion to complain of the letters of one of his local agents as at times troublesome to decipher, and instructed him in certain cases to dictate to a junior clerk who wrote a clear, legible hand. The letters subsequently sent to the manager, though transmitted to him by the same agent, presented in signature, as in all else, a totally different caligraphy. On inquiry it turned out that his correspondent was lefthanded, and by merely shifting the pen to the more dextrous hand, he was able, with a very little practice, to substitute for the old cramped penmanship, an upright, rounded, neat, and very legible handwriting.

In formerly treating of this subject, under the title of "Right-handedness," I entered with some minuteness into my own personal experiences, as one in whom the instinctive preference for the left hand remains unaffected by education and the enforced habit of a lifetime. At the Buffalo meeting of the American Association for the Advancement of Science, I was attracted by the facility with which Professor Edward S. Morse used his left hand when illustrating his communications by crayon drawings on the blackboard. His ability in thus appealing to the eye is well known. The Boston *Evening Transcript*, in commenting on a course of lectures delivered there, thus proceeds: "We must not omit to mention the wonderful skill displayed by Professor Morse in his blackboard drawings of illustrations, using either hand with facility, but working chiefly with the left hand. The rapidity, simplicity, and remarkable finish of these drawings elicited the heartiest applause of his audience." Referring to the narrative of my own experiences as a naturally left-handed person subjected to the usual right hand training with pen, pencil, knife, &c., Professor Morse remarks: "I was particularly struck by the description of your experiences in the matter, for they so closely accord with my own; my teachers having in vain endeavoured to break off the use of the left hand, which only resulted in teaching me to use my right hand also. At a short distance I can toss or throw with the right hand quite as accurately as I can with my left. But when it comes to flinging a stone or other object a long distance I always use the left hand, as coming the most natural. There are two things which I cannot possibly do with my right hand, and that is to drive a nail, or to carve, cut or whittle. For several

years I followed the occupation of mechanical draughtsman, and I may say that there was absolutely no preference in the use of either hand; and in marking labels, or lettering a plan, one hand was just as correct as the other." I may add here, that in my own case, though habitually using the pen in my right hand, yet when correcting a proof, or engaged in other disconnected writing, especially if using a pencil, I am apt to resort to the left hand without being conscious of the change. In drawing, I rarely use the right hand; and for any specially nice piece of work, should find it inadequate to the task.

The remarks with which Professor Morse follows up the above reference to his own personal experience furnish an apt, though undesigned, commentary on those above quoted from Dr. Brown-Sequard, relative to the education of the two sides of the brain, and the controlling of the right or left hand by the better developed hemisphere. The varying caligraphy of the letter of Prof. Morse exhibits features familiar to me in my own use of the pen; and he thus proceeds: "You will observe that the first page is written with the right hand, the upper third of this page with the left hand, the usual way [but with reversed slope], the middle third of the page with the left hand, reversed [*i.e.* from right to left], and now I am again writing with the right hand. As I have habitually used the right hand in writing, I write more rapidly than with the other." In the case of Professor Morse, the indications of the hereditary transmission of left-handedness nearly correspond with my own. His maternal uncle, and also a cousin, are lefthanded. In my case, the same habit appeared in a paternal uncle and a niece; and my little grandson, not yet three years old, so far manifests a decided preference for the left hand. Dr. Joseph Workman, for many years Medical Superintendent of the Provincial Lunatic Asylum at Toronto, thus writes to me: "As to hereditament in lefthandedness, I believe in it. I had a maternal uncle lefthanded, and I well remember my mother's having many a battle with one—nay, I believe two—of her sons to suppress the proclivity." Cases of direct hereditary transmission—in one example, at least, through three generations,—were referred to in the former paper. But it is curious to note, in the above cited cases, how the tendency appears more generally to manifest itself collaterally than in the direct line of descent.

A Canadian friend, whose sister-in-law is lefthanded, thus writes to me: "I never heard of any of the rest of the family who were

so; but one of her brothers had much more than the usual facility in using both hands; and in paddling, chopping, &c., used to shift about the implement from one hand to the other in a way which I envied. As to my sister-in-law, she had great advantages from her lefthandedness. She was a very good performer on the piano, and her bass was magnificent. If there was a part to be taken only with one hand, she used to take the left as often as the right. But it was at needle-work that I watched her with the greatest interest. If she was cutting out, she used to shift the scissors from one hand to the other; and would have employed the left hand more, were it not that all scissors, as she complained, are made righthanded, and she wished, if possible, to procure a lefthanded pair. So also with the needle, she used the right hand generally; but in many delicate little operations, her habit was to shift it to the left hand."

In those and similar cases, the fact is illustrated that the left-handed person is necessarily ambidextrous. He has the exceptional "dexterity" resulting from the special organic aptitude of the left hand, which is only paralleled in those cases of true righthandedness where a corresponding organic aptitude is innate. Education, enforced by the usage of the majority, begets for him the training of the other and less facile hand; while by an unwise neglect the majority of mankind are content to leave the left hand as an untrained and merely supplementary organ. From the days of the seven hundred chosen men of the tribe of Benjamin, every one of whom, lefthanded, could sling stones at a hair's-breadth and not miss, and of Ehud, the lefthanded Benjamite, the deliverer of Israel from their servitude to Eglon, king of Moab, the skill of the lefthanded has been noticeable. Milton, in sportive satire, plays, in one of his sonnets, with the name of "Colkitto, or Macdonnel, or Galasp." The name—which is that of the Earl of Antrim's deputy, by whom the invasion of Scotland, on behalf of the Stuarts, was attempted in 1644,—does not assume a less strange aspect in its more genuine form of Alastair MacCholla-Chiotach; that is, Alexander, son of Coll, the Lefthanded. This was the elder Macdonald, of Colonsay, who was noted for his ability to wield his claymore with equal dexterity in the left hand or the right; and hence his soubriquet of Coll Kittoch, or Coll, the Lefthanded.

The skill of lefthanded artists has been repeatedly noted. Foremost amongst such stands Leonardo da Vinci, skilled as musician,

painter, and mathematician, and accomplished in all the manly sports of his age. Hans Holbein, Mozzo of Antwerp, Amico Aspertino, and Ludovico Cangiagio, were all lefthanded: though the two latter are described as working equally well with both hands. In all the fine arts the mastery of both hands is advantageous; and accordingly the lefthanded artist, with his congenital skill and his cultivated dexterity, has the advantage of his righthanded rival, instead of—as is frequently assumed,—starting at a disadvantage.

According to a brief report in the *Glasgow Herald* of a discussion in the Anthropological subsection of the British Association on the paper of Mr. James Shaw, already referred to, Dr. Robertson appealed to the demonstration by Dr. Struthers, that there is greater solidity on the right side of the body than on the left, as a fact which probably accounted for the tendency to use the right hand. But assuming this to be demonstrable, the deduction by no means follows as a necessary result. Dr. Struthers has justly said, in the treatise referred to, that "the phenomenon to be explained is not why each individual uses one hand in preference to the other, the reason of which is evident, but why all nations and tribes of mankind yet known to us should prefer the same hand. It will be admitted," he adds, "that any theory which professes to explain this remarkable phenomenon—which has ceased to attract the notice of physiologists only because it has baffled satisfactory explanation,—deserves examination, especially when it supposes the cause to be a physical one acting within each individual." Hence the careful investigations of Dr. Struthers, with a view to determine, *First*, the exact usual position of the several abdominal and thoracic viscera in relation to the middle line of the body; and *Second*, the relative weight of the parts of those viscera which lie on either side of the middle line, as well as to determine the absolute weight of each viscus. The results, as already stated, rest on the most satisfactory data; but they fail to account for lefthandedness. In so far indeed as the investigations were made on adults, who had through a prolonged lifetime systematically given the preference to one side over the other, some of the observed facts may have resulted from this. It is, at least, much to be desired that opportunity should be found for repeating the same class of observations on well defined lefthanded subjects. In all such reasoning there is need of a clear discrimination between cause and effect, as well as between what is natural and seemingly instinctive, and what is the result of education or

enforced habit. The extent to which education is systematically directed so as to develop the use of the one hand at the expense of the other, is illustrated by the conventional rules for the use of the knife and fork. It is not sufficient that the knife shall be invariably held in the right hand. The child is taught to hold his knife in the right hand and his fork in the left when cutting his food; but when either the fork or spoon is used alone, it must forthwith be transferred to the right hand. All voluntary employment of the left hand in any independent action is discountenanced as awkwardness or gaucherie; and thus the left hand, with a large majority, especially among the more refined and artificial classes of society, is rendered a comparatively useless member, employed at best merely to supplement the other.

Guided mainly by my own personal experience, I remarked incidentally, when drawing the former paper to a close, "that the same influences appear to affect the whole left side, as shown in hopping, skating, foot-ball," &c. But this is more partial and uncertain. Dr. Brown-Sequard affirms that rightsidedness affects the arms much more than the legs, and in proof of this he states that "it is exceedingly rare that the leg is affected in the same degree by paralysis as the arm." Dr. Joseph Workman thus writes to me: "When you say that leftfootedness is (only) as frequent as lefthandedness, I am quite sure you are in error. I remember well, when I was a boy, observing the fact among labouring men engaged in what was called in Ireland sodding potatoes, in ridges about five feet wide, instead of planting in drills: in any given number of men, from four up to a dozen, right and leftfootedness prevailed about equally. Each pair carrying up the work of a ridge required to be right and leftfooted men. I am myself leftfooted; and of eight brothers, I believe about four were left and four rightfooted. Sir Charles Bell, in asserting that 'no boy, unless he is lefthanded, hops on the left foot,' asserts far more than the fact. I believe every boy will hop on his *spade foot;* at least I do so, and I am not lefthanded; and I instinctively do so because I dig with this foot. You have appealed to your observation as to lefthandedness in reapers. I can corroborate your statement that it was very rare to see in Ireland a *boon* of reapers without one lefthanded among them."

The use of the lower limbs is much more independent of direct conscious volition than that of the hands, and the purposes to which

their action is applied are rarely of a nature to invite special attention to them. There is, however, an instinctive tendency with many, if not indeed with the majority, to use one foot in preference to the other. In football, for example, it is not with most players a matter of mere chance which foot will be used in starting the ball. Possibly the same reason may help to account for the invariable tendency of a blindfold walker to deviate to one side or the other. It is scarcely possible to walk in a straight line with the eyes shut. The one leg apparently tends to outwalk the other.

In summing up the whole, it appears that lefthandedness is inherited and transmitted, though in an irregular manner and with varying intensity; that the range of the influence, to whatever source we may trace it, affects other organs of the same side only partially and uncertainly; but that, wherever lefthandedness is strongly developed, it is accompanied by more than average dexterity in the organ thus specialized. The full use of both hands, however, largely depends on education. The left hand is, with the majority of mankind, systematically reduced to the condition of a comparatively useless member of the body, alike contrary to reason, and without any justification either in the anatomy of the hand or in the requirements of the mind. Wherever the early and persistent cultivation of the full use of both hands has been accomplished, the result is greater efficiency without any counteracting awkwardness or defect. The experience of every thoroughly lefthanded person shows the possibility of training both hands to a capacity for responding to the mind with promptness and skill; yet at the same time it is none the less apparent that in cases of true lefthandedness there is an organic specialization which no enforced habit can wholly supersede.

ON THE PROBABLE NATURE OF THE SUPPOSED FOSSIL TRACKS

KNOWN AS PROTICHNITES AND CLIMACTICHNITES.

BY E. J. CHAPMAN, PH.D.,
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The Potsdam sandstone of Beauharnois and Vaudreuil (near the junction of the St. Lawrence and Ottawa rivers), and the same formation in the vicinity of Perth in Eastern Ontario, is well known to exhibit in places some remarkable track-like impressions, commonly known as "Protichnites tracks." These were at first supposed by Professor Owen to have been made by a tortoise, but were afterwards regarded as the tracks of several species of some unknown crustacean, "wholly distinct from anything presented by the crustacean forms of later geological periods or of the present day." They may be described generally as presenting in some cases a continuous —and in others an interrupted—central furrow, with a series of small pit-marks or indentations, at a distance of two or three inches on each side, along the entire length of the impression. The central furrow, or line of broken furrows, is regarded, by those who assume these impressions to be of animal origin, as having been formed by a ridge on the plastron of the crustacean, or perhaps by a styliform appendage attached, as in the limulus, to the abdomen of the animal, whilst the creature propelled itself by its numerous feet in shallow depths of water, or dragged itself along the exposed sea shore. In at least one of the discovered impressions, however, the lateral indentations are absent, and the impression consists simply of a strongly-marked central furrow, with a few parallel grooves on each side, the outermost of these being at a distance of a couple of inches or thereabouts from the median furrow. The absence of lateral pit-marks in this case, and the occurrence in their place of narrow grooves, was occasioned, it has been suggested, "by the limbs of the animal having been dragged along while the body was afloat." The impressions are

evidently more or less fragmentary, but many of them are continuous over lengths of nine or ten feet; and in places they run in different directions, and occasionally cross one another.

The track-like aspect of these impressions is so striking, that any attempt to cast doubt on their animal origin may seem altogether futile. The fact that no crustacean remains (or other vestiges of animals by which they could have been produced) have been discovered in connection with them, is, of course, of no moment: as undoubted foot-tracks of reptiles and birds occur in the Connecticut Valley, and elsewhere, under similar circumstances. There is one point, nevertheless, and I think a strong point, which militates against their animal origin. The lateral indentations or supposed feet-impressions vary in number, as regards their grouping, in different "tracks," thus forcing Professor Owen to establish no less than four distinct species: *Protichnites multinotatus*, *P. octonotatus*, *P. septemnotatus*, and *P. alternans*, with a provisional species, *P. lineatus*, to include the track without lateral pit-marks.* The association of so many different species, if the supposed tracks be really of animal origin, is at least a very remarkable circumstance: one, indeed, that might cause doubt in unprejudiced minds as to the real nature of these impressions. But, if not the tracts of crustaceans or other animals, to what, it may be asked, can these impressions be due? I would suggest, but with all due apology for the heresy of the suggestion, that they may be nothing more than the impressions of large fucoids. Many of the existing *Melanospermæ* grow to a great length: and in many genera with flattened or riband-like fronds there is a well-defined midrib, sufficiently hard to make a distinct indentation when the frond is pressed on damp sand. The lateral indentations of our Potsdam impressions may have been made by groups of spores or sori arranged (as seen in many existing forms) along the sides of the frond. If it be said that the sori in existing fucoids could scarcely accomplish this, it would not be more unreasonable to infer that in these ancient sea-weeds the spores were of a somewhat harder or denser nature, than to have to admit with Professor Owen that the

* It may perhaps be urged that these species collectively are only intended to be provisional: the names applying not to the animals, but simply, as terms of convenience, to the "tracks." But if some of these impressions were really made by a crustacean with seven pairs of feet, whilst others were made by crustaceans having eight pairs, &c., they must certainly have been made by distinct, even if by closely related, species: using the term species in its conventional or commonly understood sense. In the crustacea, and indeed throughout the animal series generally, the number of the feet or legs, as a distinctive character, is especially definite.

crustaceans, by whose feet the indentations are commonly supposed to have been made, were "wholly distinct from the crustacean forms of later geological periods or of the present day." Even apart from sori, the air-bladders in many algæ, as I have often proved, are capable of making very distinct impressions on moist sand.

If the impressions be fucoidal, the otherwise remarkable character of these lateral pit-marks, in differing in number and grouping in different impressions, becomes easily explained without the necessity of having recourse to imaginary specific distinctions. In the impressions in which they do not appear, it may be inferred that the fucoid had already scattered its spores, or that the development of the latter had not taken place, when the frond was cast upon the ripple-marked shore of the old Potsdam sea.

The supposed fucoidal origin of these impressions would not, I confess however, have been thus advanced, were it not for their association or connection in at least one locality—the vicinity of Perth, in Eastern Ontario—with impressions of an analogous character to which an animal origin can scarcely be atttibuted on any rational grounds. These are the impressions known as *Climactichnites*. It is probable that the supposed animal origin of these latter impressions would never have been conceived, but for their general relations to the *Protichnites* impressions. The two, it was seen, must evidently have had an analogous origin; but in view of the peculiar character of the *Climactichnites* impressions, the aid of some unknown mollusk was called in to explain their formation, although by some observers they have been looked upon as the trails of Trilobites. They may be described, generally, as being in the form of a band of several feet in length, although clearly fragmentary, with a width of from five to six inches. In their general dimensions they agree, therefore, very closely with the *Protichnites* impressions. But they differ from the latter in being traversed transversely by a series of narrow parallel ridges, about an inch and three-quarters apart, and by having a kind of beaded edge or border—the impression, as remarked by Sir William Logan, thus somewhat resembling a rope-ladder, whence the name *Climactichnites*. In some examples there is also a central groove or ridge running roughly parallel with the length of the impression.

The points here to which attention should be chiefly directed are, first, the presence of these numerous transverse ridges; secondly, their constancy, and the uniform clearness of their outline, throughout

the impression; and thirdly, the unbroken continuity of the impression throughout its entire length. It must be evident that there are only two ways—both exceedingly improbable—by which these impressions could by any possibility have been made by any animal, whether crustacean or mollusk, or member of any other group. If the impression be really a track, the animal must either have had, or have been able to assume, the form of a complete sphere or cylinder with ribbed surface, and it must have possessed sufficient internal force to roll itself over and over throughout a length of many feet; or otherwise the creature must have moved forward by a series of spasmodic jerks or jumps, alighting always in an exact line with the end of the trail, so as to avoid the *slightest overlap* or other *break of symmetry* in the entire impression. Any other mode of progression would unavoidably have effaced or smudged the transverse grooves or ridges as the body of the animal passed over them. If formed by a mollusk also, we might naturally expect to find the shell of the creature (or at least casts of the shell) in the surrounding strata, because, if the transverse ridges were formed by the creeping foot, the beaded rim must be attributed to the aperture of the shell; and the latter, consequently, must have been of large dimensions, and the shell itself of considerable weight and solidity, and thus not unlikely to have become fossilized. The casts of gasteropod shells—*Ophileta*, *Pleurotomaria*—but none to which these impressions can be attributed, are not altogether absent from our Potsdam beds: and if these have been preserved, why not others? There is also another point which appears to be in complete opposition to the assumed track-origin of these impressions. In places, two, or even three, of these supposed tracks cross one another, but at the crossing points there is no sign of disturbance or smearing, so to say, such as must inevitably have occurred if one trail had been carried across another. As shown especially in Sir William Logan's original figure, representing a group of several "tracks" (Geol. of Canada, p. 107), the one impression simply conceals or lies over the other at these points, as would happen if two fucoid-fronds, or other similar bodies, were drifted together to a sandy shore, and were there covered simultaneously with sediment.

In attributing these impressions to large fucoids, we encounter, on the other hand, no real difficulty. Many algæ, it is well known, present transverse furrows; and a salient example of this character may be seen in our *Arthrophycus Harlani*, so abundant in many of the

Medina and Clinton beds. Whilst there are various strong objections, therefore, to the assumed animal origin of these *Climactichnites* impressions, there would appear to be really nothing of any moment to militate against the assumption of their fucoidal origin. I am not, of course, sanguine enough to imagine that the views advanced in this communication will be readily accepted. Prejudices and preconceived opinions are not easily abandoned: nevertheless, in view of the very doubtful nature of these impressions, I would suggest that the generic names by which they are at present known should be modified respectively into *Protichnides* and *Climactichnides*. The change, whilst involving but a single letter, saves us from a too definite expression of what may be, and to my thinking most assuredly is, an erroneous view.

University College,
Toronto, May 21st, 1877.

ON THE CONSERVATION OF ENERGY AND THE NATURE OF FORCE.

By JOHN GALBRAITH, Esq., M.A., C.E., Port Hope, Ontario.

Read before the Canadian Institute, March 17th, 1877.

The progress of scientific investigation has led to the discovery of innumerable laws by which the modes of material action are governed, and to which the various phenomena of the physical universe are referred. Having given certain observed facts and one or more of these natural laws as premises, we can, by a mere logical process, infer the resulting phenomena, the constant agreement of inferences thus drawn with observation affording accumulating evidence as to the truth of the laws.

Nevertheless, these laws are mysterious; and although we feel certain of their truth, there are many of us who cannot feel satisfied until we have discovered how and why they are as they are.

There is a space not yet bridged over between what are generally considered the necessary or essential properties of matter and its various laws of action. For instance, the ideas of form, extension in three dimensions, impenetrability and mass, seem to be properties without which we cannot conceive a material body to exist; but it is quite otherwise with gravity, or the various attractions and repulsions manifested in chemical and electrical phenomena. The fields open to science cannot be considered as fully explored until these laws have been shown to be necessary consequences; that is to say, logical deductions from the essential properties of matter, and some hypothesis as to the arrangement of matter.

The scientific world is at present divided into two great classes in regard to the nature of the action of matter on matter. One of these is content to rest with the assumption that it is possible for one body to affect the motion of another at a distance, according to the observed

modes of action, without the intervention of a material connection between the two; the other class, on the contrary, maintains that this is impossible and inconceivable, and endeavours, from the hypothesis of a material connection, to show that the observed laws necessarily follow from the essential properties of matter.

These theories are known respectively as the doctrines of action at a distance, and action by contact.

In order to compare these theories, it will be necessary to fix upon some possible arrangement of the universe to which both classes of thinkers may yield assent, and then decide upon the merits of each of the above doctrines by applying them in explanation of natural phenomena, or by testing their consistency with inductions from natural phenomena other than the laws of attraction and repulsion.

Imagine then material bodies to consist of very minute indivisible particles of continuous matter, separated by minute intervals of space; also, suppose that all these bodies are surrounded and saturated, so to speak, with a highly elastic medium of extreme tenuity, which itself consists of much more minute particles of matter, separated by empty spaces. The first-mentioned matter corresponds to what may be called *gross matter*; the second, to the luminiferous ether. It is true that there is a conception of the constitution of matter which at first sight may seem to be different from the above, and which of late years has found great acceptance, viz., the notion that an atom is a vortex ring in a frictionless fluid; but the arrangement above assumed may include this, as the vortex atoms, if such there be, may be constructed out of the assumed material.

In accordance with the theory of action at a distance, the above particles of matter all act on each other by means of certain attractions and repulsions with which they are indued, and also by collision.

In the action by contact theory, the various attractions, repulsions, elasticities, &c., are referred solely to the motions of the particles, and their collisions. The touchstone by which we intend to test the rival theories, is the principle of the conservation of energy. It is true that observation has not completely established the truth of this principle as a law of nature, but the conviction of its truth is becoming stronger day by day as our observations increase; and no theory of the constitution and modes of action (or forces) of matter can be considered as likely to be true, which can be shown to be inconsistent with this principle.

In answer to the question, What is understood by the doctrine of conservation? a better answer cannot be given than the following, extracted from a book called "Faraday as a Discoverer," and appended by Prof. Tyndall to his treatise, "Heat a Mode of Motion." It is as follows: "Of the inner quality that enables matter to attract matter, we know nothing; and the law of conservation makes no statement regarding that quality. It takes the facts as they stand, and affirms only the constancy of *working power*. That power may exist in the form of MOTION; or it may exist in the form of FORCE, *with distance to act through*. The former is dynamic energy, the latter is potential energy; the constancy of the sum of both being affirmed by the law of conservation. The *convertibility* of natural forces consists solely in transformations of dynamic into potential, and of potential into dynamic energy, which are incessantly going on. In no other sense has the convertibility of force at present any scientific meaning."

The following quotation from Tyndall's "Heat a Mode of Motion," will illustrate the application of the principle to a special case:— "Suppose a certain amount of heat to be imparted to this lump of lead, how is that heat disposed of within the substance? It is applied to two distinct purposes: it performs two different kinds of work. One portion of it excites that species of motion which augments the temperature of the lead, and which is sensible to the thermometer; but another portion of it goes to force the atoms of lead into new positions, and this portion *is lost as heat*. The pushing asunder of the atoms of the lead in this case, in opposition to their mutual attractions, is exactly analogous to the raising of our weight in opposition to the force of gravity, a loss of heat in both cases being the result. Let me try to make the comparison between the two actions still more strict. Suppose that a definite amount of force is to be expended upon our weight, and that this force is divided into two portions, one of which is devoted to the actual raising of the weight, while the other is employed to cause the weight as it ascends to oscillate like a pendulum, and to oscillate moreover with gradually augmented width and rapidity; we have then the analogue of that which occurs when heat is imparted to the lead. The atoms are pushed apart, but during their recession they vibrate with gradually augmented intensity. Thus, the heat communicated to the lead resolves itself in part into atomic potential energy, and in part into actual energy, which may be regarded as a kind of atomic music.

the musical part alone being competent to act upon our thermometers or to affect our nerves.

"In this case, then, the heat not only imparts actual energy to the vibrating atoms, but also accomplishes what we may call *interior work;* it performs work within the body heated, by forcing its particles to take up new positions. When the body cools, the forces which were overcome in the process of heating come into play; the heat which was consumed in the recession of the atoms being restored upon their approach."

These extracts will render the idea of conservation sufficiently plain. It may be explained that heat is communicated to a body either by the impulses of the ethereal waves, which is termed radiation, or by contact with the heating body, which is termed conduction; both these operations are combined in most cases of transference of heat.

Let us now consider the action of heating the lead from the point of view of the supporters of action at a distance.

One simple mode of conceiving the motion in this case is to suppose the particles in pairs, each pair revolving about its centre of gravity.

Since equal increments of heat produce equal increments of expansion within certain limits, the cohesive attraction between the particles of a pair must be constant between these limits, just as in raising a mass against the constant force of gravity the height to which it is raised is proportional to the energy expended. Again, while the temperature remains constant, the velocities will be constant. Hence the orbits will be circles. Since the increments of temperature and expansion are constant for equal increments of heat, they must bear a fixed relation to one another. Hence, as heat is applied, the increment of the radius must bear a fixed relation to the increment of the square of the transverse velocity corresponding to it. Thus, as the heat increases, the particles must be whipped around, as it were, in gradually widening spirals by the impulses of the ethereal waves, or of the particles of the heating body, or both; and when the temperature becomes stationary, the impulses must be so nicely adjusted as just to give the particles the velocity due to the circle in which they revolve at the final temperature, under the influence of the constant attraction. When one considers also that the planes of the revolving particles must be lying in every conceivable direction (since the dilatation is equal in all directions), which adds immensely to the chances of collision and consequent destruction

of the proper motion, he will be unable to conceive how the impulses can be directed and adjusted, except by an intelligence little short of miraculous.

It is inadmissible to regard the orbits as lying in parallel planes, since a certain amount of heat would be required to separate these planes which would destroy the constant relation between the increments of temperature and expansion.

There is another way of conceiving the motion of the particles, which might be preferred. Suppose the particles, perfectly elastic and united in pairs as before, attracted by a constant force. If the particles of a pair be separated to a certain distance and left to their mutual action, they will approach each other with gradually accelerated motion, strike and rebound, retrograding through exactly the same degrees of velocity, come to rest at the original distance of separation, then repeat the motion. Thus we have a vibrating element. We may suppose the impulses of the ethereal waves, or of the particles of the heating body, to be such as constantly to renew motion lost by resistance. When the impulses are increased by additional heat, they may be such as to increase the amplitude of the vibrations in the same proportion as the actual energy is increased. On this supposition the average dynamic energy will represent the temperature, and the average amplitude the distance due to potential energy. So far all seems well, but there is a fatal objection to this arrangement, viz., the vibrations, as the heat is increased or diminished, will not be isochronous, which they must be to agree with observation. They might perhaps be made isochronous by supposing peculiar alterations in the impulses of the ether, but then the increments of potential energy would not correspond with the increments of heat, as they should to account for proportionate expansion.

The only attractive force which will give isochronous vibrations is one varying with the distance, which is inadmissible for the above reason.

The above are the simplest arrangements which can be devised on the theory of action at a distance, and we see how they fail.

If we suppose more particles admitted into a system, or other laws of attraction, we only increase the difficulty of arranging vibrations of the ether, which are required to explain observed phenomena. There is another objection to this theory which seems fatal to it. If I remember aright, it was noticed by Faraday.

If there be a system of say two particles revolving about each other, under their mutual attraction they have a definite amount of energy, actual and potential. Now, let a third particle come within the sphere of attraction of either particle, it will increase the energy of the system; there is no limit to the number of particles which might not become similarly incorporated with the system. Thus energy would be continually created by the chance proximity of other particles. We may perhaps get out of this difficulty by supposing the spheres of attraction of every particle to include all other particles, but we shall hereafter see that a supposition of this kind, which as far as our observation goes can only be made in the case of the attraction of gravitation, will be of no service.

Sir John Herschel, although a believer in action at a distance, shows very clearly, in a lecture on the "*Origin of Force*," that the principle of conservation, regarded merely as asserting the periodic restorations of actual or dynamic energy, cannot, from the very nature of the case, be proved—that, in fact, it is almost inconceivable that it should express a law of nature. He could be led to no other result, holding as he did the theory of action at a distance.

We now come to the theory of action by contact. The first question naturally asked is, what is understood by the term contact. Contact is to be taken in the same sense as in geometry. Two geometrical figures are in contact when adjacent surfaces, lines, or points, as the case may be, are coincident, and there is at the same time no space of three dimensions common to both. What is force according to this theory? This question may be answered thus: when two atoms are in motion, so that each would occupy a certain space at a certain time if the other did not exist, they will come in contact; and on account of their impenetrability, or, in other words, since two bodies cannot occupy the same space at the same time, their motions must be changed, and to this action the name force is given. It is simply collision or impact. It is measured in the usual way by the changes of momentum and direction, referred to certain space considered fixed.

Sir John Herschel, in the same lecture referred to above, shows most conclusively that the dynamic energy of a system constituted thus must infallibly diminish, and that at length a state will be reached when all relative motion will be destroyed; or that, where it does exist, the moving parts will fly off into space, never to meet

again. It may be remarked that the atoms are assumed to be rigid. Herschel's reasoning is based upon the assumption that relative motion is necessarily destroyed in the collision of rigid bodies.

A rigid body is such that the distances between its parts are invariable. It is possible that rigidity is a necessary condition of continuous matter. However that may be, we shall assume our continuous atoms to be rigid, the truth of the assumption to rest on the coincidence of results with observation.

We have now to discuss the question, *Whether is it* true, or probable, that the collision of rigid bodies involves the diminution of relative motion?

It may be premised that the laws of collision have been deduced from experiment; the question now being whether the experimental results have been attributed to their proper causes?

The following are the results of experiment, as far as the change in relative motion by collision is concerned. When bodies collide, they change their form and acquire a common motion, in which case they are called inelastic; or else, after undergoing a certain amount of compression, they partially or wholly regain their form, to all appearance; in which case, they separate with a relative velocity which is always less than their relative velocity before impact; in this case, they are termed imperfectly elastic.

Besides the above changes, motions always continue in the interior of the bodies after they separate, or after they have acquired a common motion as wholes. These motions sometimes take the form of heat, sometimes of visible or audible vibrations, or both combined.

As before noticed, where the bodies are inelastic the change of form is always greatest, other things being equal.

Also, the time occupied by the impact is greater, as the change of form is greater for the same bodies. Where the change produced in the relative velocity by the impact is less, it is always found that there is less change in the condition of the bodies themselves, less heat is developed, the vibrations are of smaller extent, the change of form is less, and the time of contact is less.

From all these phenomena, it is fair to draw, as a very probable conclusion, that the principle of conservation of energy holds with regard to these bodies—that where the energy of the bodies considered as wholes is diminished, we always find a certain amount of energy in the parts; and we may be satisfied that if we could measure

the energies due to heat, vibrations, etc., and add these to the energy of the bodies considered as wholes, that the sum would be the total energy before impact. I do not think that any scientific man of the present day would controvert this.

It may be said that the more perfect the elasticity of a body is, the greater is its tendency to yield up the motion of its parts before contact ceases, and that if perfectly elastic, it would be perfectly at rest in its interior when contact ceased.

If a helical spring be suspended horizontally as a pendulum, and be allowed to fall endwise against a vertical wall, its coils will be noticed to be in a state of intense vibration after contact ceases, and I think no one would assert that it is possible to conceive it to be so elastic as not to vibrate. The assertion would even involve a contradiction of terms.

The fact is, that a perfectly elastic body would vibrate for ever, external resistances being supposed removed; and that this is not the case in imperfectly elastic bodies, is simply because their vibrations are gradually destroyed by internal friction being converted into heat, which is in turn communicated to surrounding bodies.

Again, take a number of balls placed very close together, and connected two and two by elastic strings of such tension that if the end ball be pulled away from the others, the motion is communicated through the system with the same velocity as it is when the end ball is struck towards the others; and imagine two such systems with a different number of balls in each to collide endwise in the line of their common axis. Calculate now the motion on the supposition of the conservation of relative motion as between each ball, and it will be found that the relative motion of the systems as wholes after impact is less than it was before impact, and that the motion of the parts will exactly account for the difference.

Thus we have an example of bodies made up of perfectly elastic parts in the sense in which the word has hitherto been used, which as wholes collide like imperfectly elastic bodies.

Now in all these cases, what is it that we see invariably to accompany the loss of relative motion. Is it not motion among the parts?

Do we not see that as the motion of the parts is diminished the relative motion becomes greater? Is not the loss of relative motion less when the bodies are harder, more able to retain their form, and

at the same time less elastic (in the sense of being subject to vibrations) and less liable to be heated; and in this case, also is not the time taken up by impact less?

What is the proper inference? Is it not that in the case of bodies whose parts are incapable of motion among themselves, the relative velocity after impact will be the same as before impact, and the impact will be instantaneous.

Hence rigidity, instead of being inconsistent with the doctrine of conservation of energy, is the very condition necessary to its existence as regards the relative motions of the bodies as wholes.

From a remark Newton makes in his illustrations of the third law of motion, it seems that Huyghens and Wren held this idea concerning rigid bodies, but since their time it seems to have fallen completely out of view.

The greatest change of form always occurs when relative motion is destroyed. Is it natural to suppose that where no change of form occurs the same result would follow. And yet this has always been assumed.

This conclusion as to rigid bodies is the very foundation of the action by contact theory, without which it would only result in absurdities.

We now proceed to discuss some cases of collision of rigid bodies, but first it will be necessary to gain perfectly clear ideas respecting space, time and motion. What is the difference between the following terms: "A geometrical point," "an indefinitely short line," "an indefinitely small surface," "an indefinitely small solid." It is a difference of kind—they are not homogeneous. No amount of multiplication or division of any one of these will change its kind. An infinite number of geometrical points cannot occupy the smallest part of space of any dimensions; they cannot constitute a line, a surface, or a solid.

The summation of indefinitely short lines, indefinitely small surfaces or solids will produce lines, surfaces and solids respectively, and nothing else. So with time. An instant, in the sense in which we shall use it, corresponds to a geometrical point, separating two parts of a line.

It has no duration, and differs totally from an indefinitely short period of time. An infinite number of instants thus defined can occupy no time.

What is meant by the motion of a moving point at a given instant? Properly speaking, there is no such thing; but what we mean in speaking thus is the motion which takes place in an indefinitely short time in which that instant lies.

Similarly the motion of a moving point, at a given point in space, is understood to mean the motion which takes place through an *indefinitely small space in which the fixed point lies.*

Having now gained some definite notions, we are ready to answer some objections which have been made to the law of conservation on the contact theory.

It has been objected that when two rigid atoms rebound from each other, the motion of each must have been totally destroyed when impact took place, and immediately recreated.

We may reply thus: If the motion had been destroyed, there must at least have been an indefinitely short time during which there was no motion, duration being absolutely necessary to motion; but the contact was instantaneous, it did not occupy time, hence the motion was never destroyed.

Again: the two atoms passed through no space while in contact, for the same reason, hence they cannot acquire a common motion. If this were not so, what would the result be? If adjacent surfaces of two atoms were in contact, that is, coincided, and they had no relative motion, there would be no real division between them. In passing from the interior of one atom to the interior of the other, we should come across nothing whereby we could assert that they were not continuous; in fact, they would form one rigid atom. But if we consider the matter, we shall see that it would be perfectly impossible, by any force, however great, to press the atoms together so that they can form one continuous atom. The only forces with which we are acquainted being blows or collisions, we should have to strike the atoms together; they would rebound; and no matter how hard or how fast we struck them, they would rebound at every blow. All pressures consist of a rapid succession of minute blows. We recognize no such thing as dead pressure, or a force acting without being the result of motion. That pressure is possible between two surfaces which are not constantly striking and rebounding is, from our point of view, absolutely inconceivable. All our forces are the result of relative motion in the direction of the space between the bodies considered.

A tangential motion between two surfaces is impossible, if the surfaces are in contact, since the matter would be continuous in passing from one side of the surface to the other, and continuous matter is rigid by our assumption. Tangential motion can only take place between two surfaces when they are really divided, that is, when there is a vacuum space, no matter how thin, between them.

Suppose a smooth rigid particle falling down a smooth curved tube under the action of gravity, what is the nature of the reaction of the tube, which is supposed to consist of continuous matter, and consequently to be rigid?

The motion conferred by gravity on the particle may be resolved into a component at right angles to the tube, and one tangential to it. The reaction is due to the rapid impacts which arise from the former motion, and the velocity is due to the latter motion. The particle never remains in contact with the tube. Its contacts are instantaneous, that is to say, occupy no time. It is always in the air, so to speak.

Thus no forces can be exerted between the parts of a rigid body, simply because no motion can take place between them. It will be observed that our definition of force is based upon rectilinear motion; but there is another kind of motion which gives rise to actions between the parts of bodies. This is angular motion. If a body be set spinning about an axis, we know that a strain takes place in it, and if the angular motion is very great, the body may fly to pieces.

Is there no strain between the parts of a rigid body when thus set spinning? We answer, No. We can explain all strains in ordinary bodies by our definition of force, but the idea of rigidity is utterly incompatible with the idea of forces acting between the parts of the rigid body. We are thus relieved from the necessity of attempting to pursue the idea of force through a never-ending division of matter, to which those are subjected who hold the idea that the conservation of relative motion depends upon resilience.

Rigidity is an elementary idea, which can be defined but is incapable of being analyzed or accounted for.

It will be observed that we do not assert that a body necessarily moves when forces act on it. Thus a rigid body, struck by equal blows on opposite sides at the same instant, will not move. The whole motion in this case will be confined to the striking bodies.

In confirmation of these ideas as regards pressure, is the explanation of the pressure and elasticity of gases given by Professors Clausius, Ioule and others. Their investigations go to prove that these properties are owing to the molecules of the gases moving in all directions with great velocities, pressure being due to the momenta, masses and number of molecules within a given space, and elasticity to the *vis viva* or energy of the molecules within the same space.

A similar mode of action must be assumed for the luminiferous ether; that is to say, in still ether, as in still air, the constituent particles are moving in straight lines with immense velocities, subject to no actions except their impacts on each other and the atoms of gross matter. These motions are to be carefully distinguished from the ethereal waves, which correspond to the sound waves in air.

We can now explain forces of cohesion, and all kinds of tensile forces. Without the assumption of the existence of ether, constituted as above, such forces could not be explained.

How these forces are produced, may be illustrated by the various pneumatic phenomena, which may be classed under the popular idea of suction.

When the air in a receiver is rarified, the particles, having greater space to move in, do not impinge the same number of times in a unit of time against each other, nor against the sides of the vessel, their velocity being supposed to remain unaltered; hence the pressure is less on the inside than on the outside, and there results an apparent tension or attraction of the parts of the receiver towards the inside. Similarly, if two flat surfaces are pressed together, the same phenomena are witnessed; in this case, it perhaps is possible that the air, instead of being rarified, may be condensed; in which case, the results would be accounted for by supposing the velocities of the particles of confined air to have been lessened to some extent. If the velocities of the particles are unaltered, the elasticity is proportional to the density; if otherwise, it is not.

Now, substitute for air the luminiferous ether, and for the flat plates the sides of two atoms, and it becomes evident how they may cohere. If this be the explanation of cohesion, we must assume all atoms that are known to unite with others to have flat faces. The luminiferous ether alone, in the present state of our knowledge, can be supposed to consist of spherical atoms.

It must be remembered that a pair of atoms thus connected may be in a constant state of minute vibration, so to speak, even in still ether, since the ether pressure really consists of rapid impulses.

All the different degrees of chemical affinity may be accounted for by differences between the masses of the atoms, the extents of the faces which can possibly come in contact, the number of faces, and the different degrees of elasticity of the intermediate ether.

It may be objected that the vibrations of the ether are transversal, and those of common air longitudinal, so that the two cannot be analogous.

The undulations of common air consist both of longitudinal and transversal components; so do those of the ether. The ear is so constructed as to be sensible only to longitudinal vibrations, and the eys so that the transverse vibrations alone affect it. An objection of much greater force is the following. Experience shows that radiant heat is capable of evincing all the phenomena of polarization, which can only be explained by the transverse vibrations. How is it then that the thermo-electric pile is affected in the same way as the eye. Similarity of construction would scarcely to taken as a satisfactory explanation in this case.

Prof. Challis, in his "Principles of Mathematics and Physics," shows, on the hypothesis of an ether constituted as above, that in certain cases of polarization the direct vibrations become very much reduced in intensity compared with the transverse vibrations. If this should be found to be the case, wherever the polarization of heat corresponds with that of light, the objection would be answered.

One great difficulty which the action by contact theory has yet to solve, is the attraction of gravitation. Astronomical observations, so far, have not shown that gravity has a sensible aberration like light. The inference is, that the velocity of the gravity impulses must be extremely great compared with the velocity of the earth, and much greater than that of light. What is there in the nature of a universe, constructed as we have supposed, to render it self-contained? We must answer, Nothing. We are obliged on the contact theory either to suppose matter to be coextensive with space, or else, if we consider only our own portion of the universe, we may suppose its boundaries to be indefinitely distant, in which case any changes going on at the limits of the universe would be inappreciable to us.

We have thus noticed some of the chief objections to the contact

theory, merely to show that there are no evident inconsistencies between this theory and observation. The mechanical explanation of natural phenomena must depend to a great extent upon the advances to be made in hydrodynamics and its cognate sciences.

We shall now show that potential energy can be predicated of a system of bodies only in a few instances.

(1.) One case is that in which there are only two bodies in the system, whatever be the law of attraction, provided it be a function of the distance. The distance between the bodies at any instant is that due to their potential energy. Thus in a falling body, its distance at any instant above the earth's surface is that due to its potential energy.

(2.) When there are any number of bodies in the system, provided that the law of attraction is that of the direct distance. In this case, the point to which potential energy can be referred is the common centre of gravity of the system.

Besides these two general cases, there are many what may be called solitary cases, in which a system may have potential energy, but which cannot be classed under any general head.

To illustrate this still further. Suppose a system of say six bodies attracting according to the law of gravitation, and let them move from rest at a given instant. Will they fall together? No; in such a system there is no point, line or surface to which potential energy can be referred. If such a system has no potential energy, can the principle of conservation be affirmed of its actual energy? No; its actual energy is constantly changing. Can it even be asserted that the actual energy will periodically go through the same changes? No; to assert this we should have to calculate the motions, and the problem is so complex in its general form, that it is beyond the power of mathematical analysis to solve it. What assertion can be made then with regard to its energy? We can only say that the chances are almost infinite against a periodic restoration of energy.

Again, there are no instances of case two in nature, as far as we know, nor of case one. We know of no instances in nature of a system of two bodies entirely unaffected by the presence of other bodies; that is to say, all systems of two bodies really form parts of a larger system, and thus cannot have a common point to which potential energy can be referred. All the instances which we have of potential energy, are instances in which the word is used in an approximate

sense. Thus, in the illustration given in case one of the falling weight, it is possible to call its distance from the earth's surface that due to potential energy, simply because the influence of all other bodies in the universe, on the motion of the falling body, is inappreciable; but strictly speaking, they influence its motion, and it is falling towards the same point of the earth's surface at no two successive instants of time.

We see thus that this term potential energy, which can only be used under conditions which do not obtain generally in nature, and which obtain with only an approach to strictness in a very few cases, has no right to be included in the expression of a law which professes to represent not an approximate, but an absolute truth of nature.

We have also seen, by the foregoing example of six bodies whose motions are governed by a law which actually holds in nature, that the chances are almost infinitely great against the conservation of actual energy, even in the sense of periodic restorations.

What must our conclusion be? Is it not that the principle of conservation cannot be predicated of the material universe if the observed laws of force are laws of action at a distance? On the other hand, the conservation of dynamic or actual energy is a necessary result of the action by contact theory, if we admit the rigidity of the atom.

It may be asked, How are the phenomena of latent heat, of liquefaction and evaporation, to be explained on these principles. We have not to go far for an answer. Liquidity and gaseity are modes of motion of matter as well as heat. We do not expect the sensible vibrations of an elastic ball to affect the thermometer, neither should we expect the motions of liquidity and gaseity to do so. In a liquid the molecules are gliding around each other in all directions. In a gas the molecules are flying about in straight lines in all directions. To these motions is due the pressure in both cases. Since the pressure is equal in all directions at a given point, the inference is that the molecules are moving in all directions.

Whenever a motion appears in a heated body which itself is not such a motion as would affect the thermometer, a corresponding amount of heat necessarily disappears. Just as in a steam engine, heat disappears as the motions of the parts of the engine and the attached machinery increase. If the machinery be applied to doing work, that is, to setting other bodies in motion, a corresponding amount of heat disappears.

So in the case of liquefaction or evaporation, besides the heat which has its equivalent in the motions of liquidity and gaseity, an amount has also disappeared in working against the ether pressure which exists in the states of solidity and liquidity—that is to say, it has disappeared in setting the ether in motion.

When the source of heat is removed the motion of the molecules is gradually communicated to the ether and to surrounding bodies; in other words, the heated body loses heat by radiation and conduction, while at the same time the pressure of the ether—consisting, be it remembered, really of blows of the ether atoms—is driving the molecules back into their original positions. How this pressure can be exerted so as always to force the molecules back into positions similar to what they occupied before heat was applied, we do not profess to explain; but it seems just as possible as that sounds should be conveyed in all directions without intermingling by means of a medium, whose action is acknowledged not to depend on any mysterious forces of cohesion or repulsion, but simply on the number, masses, velocities and collisions of its particles.

It will be observed that what is usually termed the conversion of actual into potential energy in explaining the above phenomena, is considered in the contact theory as consisting partly of the transfer of actual energy to the molecules in the form of motions of liquidity or gaseity, and partly of the transfer of the same kind of energy to the ether, the pressure of which resisted the separation of the molecules.

It is no more necessary to consider that the actual energy thus transferred to the ether should consist of motions capable of affecting the thermometer, than that the act of drawing a piston in an air-tight tube against the pressure of the atmosphere, should cause a sound wave.

Why we object to retaining the term potential energy in the case of a body which has been moved through a certain space against a certain pressure, as in the instance considered above, is this. The term would imply that the pressure was always in existence, and ready to move the body back again as soon as the prime mover was removed; now this may be so, or may not. It is a mere accidental circumstance that has nothing to do with the doctrine of conservation of energy. This principle simply asserts that the energy of the prime mover was transferred to the body moved, which in turn transferred it to the bodies which caused the resisting pressure, they

in turn to other bodies, and so on. It does not assert that when the prime mover ceases to act, the bodies which resisted the motion will then drive the body back to its original position.

Take for instance the illustration just mentioned, of drawing a piston in an air-tight tube against the pressure of the atmosphere. If we draw the piston partly up the tube, we communicate a certain amount of actual energy to the air, which energy becomes diffused through the atmosphere. If we let go the piston the pressure of the atmosphere will drive it to the bottom of the tube, but this is not in consequence of the energy which had been previously communicated to the atmosphere; that energy is by this time diffused through space, and the principle of conservation asserts that it is still in existence and never *can* be destroyed. It cannot assert *that* when the piston is let go it will be forced to the bottom of the tube. That depends upon the pressure of the air being continued, about which we do not necessarily know anything. It happens *that it does* so in this instance, and we have a case of so-called potential energy. In boring a hole with an auger, we do not expect that when we let go the handle of the auger it will be immediately turned round and worked out of the hole, acquiring an amount of energy equal to that which had been expended. Why is not energy restored in this case as well as the other. It is plainly owing to circumstances that the principle had nothing to do with. What the principle does assert is, that in both cases a definite amount of actual energy has been imparted to the resisting parts, and that this energy is always in existence somewhere as actual energy. So if it were possible for the molecules of bodies in cooling to remain apart, the principle of conservation would be in nowise affected thereby.

Thus the convertibility of natural forces can only be taken to mean the transferences of actual energy from one portion of matter to another which are incessantly going on.

In conclusion, we may sum up our results as follows:

On the theory of action at a distance—

(*a*) The principle of conservation cannot hold in nature.

(*b*) The term potential energy, from its definition, is incapable of strict application to any natural system of bodies.

(*c*) The principle of conservation, regarded merely as expressing periodical restorations of actual energy, cannot hold in nature.

On the theory of action by contact—

(*d*) The principle of conservation of *actual* energy depends on the nature of the atoms.

(*e*) The conservation of relative motion after impact can only hold in the collision of rigid bodies.

(*f*) The assumption of rigid atoms is therefore necessary to the conservation of actual energy, which assumption may be made, as it involves nothing inconsistent with nature; but, on the contrary, makes possible the explanation of a wide range of natural phenomena, otherwise inexplicable.

(*g*) There is no such thing as dead pressure. All forces, pulls, thrusts, frictions, attractions, repulsions, etc., etc., consist of collisions. That there should be action between two bodies without relative motion is inconceivable.

(*h*) The use of the term potential energy, even when the forces are of the above kind, is inadmissible, since it implies results with regard to which the principle of conservation makes no assertion, and thus leads to false ideas regarding the principle.

ON THE NATURE OF ROOTS AND WORDS.

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The fact that Glottology is still a young science is nowhere more strikingly illustrated than in that branch of it which treats of the nature of primitive language and its sources. The student, standing on the threshold, and approaching this subject free from all preconceived opinions, cannot fail to observe that in this particular at least the inductive stage has not yet been reached. Here facts are rarest and theories most abundant; here disputes are hottest and loudest, and the angry disputants frequently forget the courtesy of scientific discussion, as was the case in the late attack of Professors Steinthal and Max Müller on Professor Whitney. So unsatisfactory indeed have been the results of the discussion hitherto, that many of the most eminent glottologists have given up the enigma in despair, and become thoroughly sceptical as to the possibility of our ever arriving at any definite or positive knowledge on the subject of the origin of language. Bopp, Pott, Lepsius, and many others consider the veil of mystery hanging over this question as absolutely and inexorably impenetrable. Benfey and Schleicher would remove the consideration of this question from the jurisdiction of linguistic science altogether: the former handing it over to Psychology, the latter to Anthropology;* while the Société de Linguistique de Paris absolutely forbids the admission of any communication on this subject by its statutes.

Of late, however, a more hopeful tone has prevailed, owing largely, no doubt, to the increased study of the languages of savage nations, and the philosophic consideration of the phenomena presented by them. For it is here we approach most nearly to primitive man in the matter of language, as in point of every department of culture, and from such facts as we can here gather we must make our inductions as to the nature of primitive language.

* Geiger, Ursprung der Sprache, p. 37, *et seqq.*

It is the object of this paper not to attempt to penetrate any mystery, or to go behind the veil, but rather to show that there is no veil to go behind, no mystery to penetrate; and to point out the fact that in the known phenomena of existing speech we have ample materials for deciding on the nature of primitive language; for I firmly believe that the greater part, if not the whole, of the obscurity in which this subject is shrouded, or supposed to be shrouded, has been created by the dust raised by the disputants battling in behalf of their respective theories, and from their failure to perceive that while, on the one hand, no one theory is sufficient to account for all the phenomena of speech, yet, on the other, all the theories advanced contain a large amount of truth; and error commences in each case at the point where any disputant endeavours to establish his own theory as the only true rule of faith, to the exclusion of all others.

I shall also try to point out that there is no necessity to have recourse to miraculous phenomena of any sort in this inquiry. Those who support the theory of the directly divine origin of language are not the only ones to call the miraculous to their assistance. To my thinking, at least, Bleek's theory of the evolution of language is the most miraculous of all; and not far behind it in this respect is Professor Max Müller's attribution of the power of abstraction to man in his primitive state: of both of which theories, more hereafter.

Before inquiring, however, into the nature of primitive language, it will be necessary to define language itself, more especially in its relation to the first language makers. Language and its object may be defined as "the *intelligible expression of thought in articulate sound as a means of communication between man and man.*"

Some writers define language as being the expression of thought *and feeling*, but I would reply with Schleicher,* that the immediate expression of feeling is not one of the primary objects of language, and that language expresses feeling only in the form of an idea or a thought.†

Having now defined what language is, let us next determine where our inquiries are to commence—at what stage of human progress. There are extreme evolutionists, in linguistic as in biological science,

* Die deutsche Sprache, p. 4.

† The interjections, of course, are the direct expression of feeling, and as such must be excepted from this statement in so far as they are to be considered as a constituent element of language; a point which will be subsequently discussed.

who would trace the origin of speech to the inarticulate cries of the anthropoid ape or pithecoid man, I do not know which. Let Wilhelm Bleek, cousin of the archievolutionist Haeckel, state his own case.

"The fact," he says,* "that conditions similar to those of humanity can no longer develop themselves from animal speechlessness, proves nothing; just as the fact that the progress of a language like that of the Hottentots to the stage of development reached by its no very distant Indogermanic relatives is now impossible, proves nothing."

But if this fact proves nothing, we may at least require that the evolutionist should prove something. I do not, of course, demand that he should develop language from animal cries by actual experiment; but I do most emphatically demand that he should prove the possibility of such development, or of the capacity for such development in the lower orders.

The substance of his argument on this point is contained in a note to the passage above quoted, which reads as follows: "Those classes of animals that stand next to man are, if not externally at least internally, in a different condition from that in which they were at the period when humanity arose. Being as yet hardly formed, they were then not only more susceptible of change, but there also lay in them a stronger impulse toward further progress, and the attainment of a higher stage. This impulse had to be satisfied, as was done in the case of human beings; or, if it remained long without satisfaction, it would necessarily be extinguished, and therewith ceased the possibility of their freeing themselves from the condition in which they were. This condition became all the while more and more confirmed; and what at first was the uncertain advance of a forward impulse toward formation, and, at the same time, the first steps towards a further development of this power, forms now the petrified, stereotyped forms of a species of animals which seems to have long ago been deprived of the possibility of internal change."†

Here, in order to prove something, two groundless assumptions are made to fill the gaps in the logic of facts, to supply the "missing link" in the evolutionary chain, viz.: first, a miraculous impulse of which no proof is given; and, secondly, an equally miraculous capa-

* Origin of Language: American Translation, p. 46.

† I regret exceedingly that the original was not accessible, as the carelessness of the American translator has made the translation barely intelligible.

city for developing that impulse which rests on a similar foundation. In other words, the capacity for development, the *onus probandi* of which lies with the advocate of this view, is taken for granted.

Let us attempt to follow Bleek, however, in the further development of his theory. "Sound," he says,* "is a mere accessory to feeling. Not only is there feeling without it, but it is comparatively seldom that feeling is made perceptible to the ear." Precisely so; and yet from this comparatively rare manifestation of feeling he would derive all language. But the converse of this is also true, viz., that "it is comparatively seldom" that speech is the manifestation of feeling, though perhaps somewhat less seldom with primitive than with civilized man. The object of the first communication between man and man was not to convey feeling, but to satisfy immediate and pressing wants, as we shall see again further on; and to indicate these wants, it was necessary to give names to the things that would satisfy them. If I should have an opportunity at some future time of treating, as I propose to do, of the sources of language, I shall give Bleek's synopsis of his own theory in full, that my readers may judge of it for themselves. For the present, however, I shall content myself with stating that he proceeds to develop interjections from animal cries by the awakening of consciousness, and then to develop all articulate speech from these latter, by a process which I frankly confess my inability to understand.

If this evolutionary theory be the true one, Schleicher is no doubt perfectly justified in relegating the consideration of this question to the domain of other sciences. But comparative lexicography has given the death-blow to the theory that interjections are the only source of language, and has demonstrated the impossibility of such origin for the great majority of Aryan roots at least.

As long, however, as no more positive evidence than this can be adduced in support of the development of speech from the inarticulate cries of animals, the glottologist who desires to avoid the imputation of mere theorizing, and to rely on facts alone, must look elsewhere for the sources of language, and may reasonably refuse to carry back his researches further than to the earliest period at which we have positive evidence of the existence of man *as man*; that is, as a creature endowed with higher attributes than the apes. The startling discoveries made within the last forty years, by the explorations of geologists

* Origin of Language: American Translation, p. 56.

and archæologists, have been assumed to relegate the earliest traces of the existence of our race to a period so immensely remote, as to startle and confound the boldest imagination; an antiquity of hundreds, nay, thousands of centuries being demanded for man. These discoveries have at least proved beyond a doubt that man was an inhabitant of Europe, not only when the mammoth, the woolly rhinoceros, the reindeer and other arctic fauna inhabited the south of France, but also when the lion, the hyæna, the hippopotamus and other animals now peculiar to tropical countries, ranged as far north as Great Britain.

This question of the antiquity of man is, however, of no direct interest to the glottologist, except in so far as it gives a greater lapse of time for the great changes which language must have undergone since its birth. He is more concerned in inquiring whether there be any evidence as to the intellectual capacity of the first of our race, to whose existence these records bear witness.

What manner of men were they, then, of whom we have the earliest traces; the contemporaries of the mammoth and other extinct animals? The river-drift gravel-beds of the Somme, the subterranean cave-dwellings of Germany, France and Great Britain, the older among the lake-dwellings of Switzerland, the shell-mounds of Denmark, all give the same answer: the first men were tool-makers and tool-users. Their tools were, to be sure, of the rudest description; but they have outlasted the remains of the men themselves. The direct evidence as to the personal structure of primeval man is confined to a few remains of bones, more particularly to two portions of skulls. Of the more ancient of the two, the Engis skull, considered by Sir Charles Lyell to be undoubtedly coëval with the mammoth and other pleistocene mammalia, Prof. Huxley* says: "It is, in fact, a fair average human skull, which might have belonged to a philosopher, or might have contained the thoughtless brain of a savage."†

The nature of the stone axes and arrow-heads, the flint-flakes, the bone awls, &c., unearthed by these discoveries, is sufficiently familiar to the general reader, and it is only necessary to state that the earliest specimens consist of unpolished stones, rudely chipped to the required

* Man's Place in Nature, p. 156.

† The antiquity of the other relic, the Neanderthal skull, which is "the most pithecoid" of known human crania, is not so well established; and Prof. Huxley himself says (Man's Place in Nature, p. 159), that "the fossil remains of man hitherto discovered do not seem to take us appreciably nearer to the lower pithecoid form."

shape, and bearing what are known as palæolithic characteristics, and that they greatly exceed, in number at least, and probably also in antiquity, any remains of human bones yet discovered. These data may seem very meagre ones from which to draw any valid conclusion as to the intellectual, moral and social condition of these first tool-makers. But it is in the solution of this problem that the science of primitive culture, in the hands of such men as Sir John Lubbock and Professor Wilson, has achieved its greatest triumphs, and been raised to the rank of an inductive science. The archæologists have pointed out that primitive man, so far from being extinct, and known only by his remains, still occupies a considerable portion of the habitable globe, and that "primitive" is synonymous with "savage." They have applied the comparative method, which has produced such wonderful results in the study of language, to their own science, and have inferred the condition of the first men from the phenomena actually observable among existing savage races, many of them still in the palæolithic stage, manufacturing and using tools which are exact reproductions for the most part of those found with the remains of extinct mammalia. Sir John Lubbock* pictures primeval man as ignorant of pottery, spinning and agriculture, having no domestic animals, perhaps not even the dog, unable to count to ten, "his weapons of the rudest character, and his houses scarcely worthy of the name." As to his moral condition, we may add that he was probably destitute of all religious ideas, or of any conception of a future state, and that he was in some cases, though exceptionally, a cannibal. As to his social state, he was certainly gregarious, living in communities of greater or less extent. In fact, he was a savage, wretched indeed, clad in skins and living by the uncultivated products of the earth and the spoils of the chase, hunting the lower animals with most rudimentary weapons of stone, bone, flint, &c.; his wants few, but pressing, and dictated by hunger, thirst and cold.

The picture is dark enough, yet not too dark to be a faithful representation of many savage races at the present day: The Hottentots and Bushmen of Africa, the Veddahs and Andaman Islanders of Asia, the Australians and Feejeeans of Australasia, the Esquimaux and Nootka-Columbians of our own northern half-continent, the Brazilians, Patagonians and Fuegians of South America. Of this any one may satisfy himself by a glance at Sir John Lubbock's most

* Prehistoric Times, 2nd ed., ch: xvi.

interesting sketch of the manners and customs of modern savages, contained in chapters xiv.–xvi. of his "Prehistoric Times."

What then are the characteristics which separate modern savages from the lower animals? They are three in number, viz.: the faculty of making and using tools, the use of fire,* and last, but not least, articulate speech. We have already seen that the earliest human beings of whose existence we have positive evidence, the contemporaries of the mammoth, were, like the lowest of modern savages, tool-makers and tool-users. Traces of their use of fire have been discovered at the lowest depths and in conjunction with some of the most ancient remains in many caves of Great Britain, according to Mr. W. Boyd Dawkins.† How stands the case then with regard to the third point, the capacity for articulate speech? Leaving the use of fire out of the question, and confining ourselves to the first and third points, the argument may be stated in syllogistic form as follows:—

(i) *All* tool-makers and tool-users are capable of articulate speech;
(ii) The first men of whom we have remains were tool-makers and tool-users; therefore
(iii) The first men were capable of articulate speech.

As, however, we know of no case of the direct invention of language, it remains to be seen whether there is anything in the nature of language to make its direct invention by creatures of such limited mental capacity, as the first men may be assumed to have been, an impossibility or even improbability.

Before, however, we enter upon the discussion of this question, there is another to be answered. We have already seen what manner of men the primitive language-makers, in all probability, were. Let us *next* inquire *why* they spoke at all—what interests gave them the first impulse to the invention of speech.

This motive is contained in the definition of language given above, as "the intelligible expression of thought in articulate sound *as a*

* Alvaro de Saavedra, as quoted by Lubbock, *op. cit.*, p. 547, mentions a race of savages who were ignorant of fire; and Captain Wilkes, U. S. N., made the same statement of the inhabitants of the island of Fakaafo. The latter statement, however, is questioned by Mr. Taylor (Early History of Mankind, p. 230), on the ground that their language contains a word for "fire." It should be added that some Australian tribes are unable to produce fire, though not ignorant of its use.

† Cave-Hunting, chap. viii.

means of communication between man and man." In other words, the primary purpose of language, or the reason that man talked at all, was that he wanted something, and wanted some one else to know it and to help him in supplying his wants. His motive in using articulate sounds was not the communication of his feelings; his emotions of pain, anger, &c., could have been made known readily and completely enough by inarticulate cries, groans, howls and growls. The motive was the pressing want of the moment. His wants may be summed up in two words: nourishment and warmth. The natural objects which supplied the means of satisfying these were at once the primary cause and object of his first words. These would be edible roots, the fruits of the earth, the earth in which they grew, the plants which bore them; further, the animals he hunted, their skins, bones, &c., and the implements with which he hunted and worked—natural and artificial—sticks and stones, bows and arrows, axes, awls, &c. As man is a social animal, and the unit of society is, as Sir Henry Maine* has pointed out, not the individual but the family, we must add himself, his relations and friends. The sun, moon and stars, the sea and the sky, were all objects of less primary importance to him. From the nature, then, of the names given to himself, his relations and allies, to the edible products of the earth and the plants producing them, to the beasts and implements of the chase, we should be able to infer the principles on which primitive language was formed; and, as we have disposed of the why, we now come to the consideration of the question: What manner of language was it that primitive man made use of?

The answer to this question must be obtained in the same way as we arrive at the determination of primitive man's intellectual, moral and social condition, viz., by the comparative method, by an inquiry into the nature of language as we find it spoken at the present day. Nor will it be necessary to have recourse for this purpose to the languages of savage nations, since the qualities most essential towards the determination of the present problem are, as we shall see, inherent in all language by its very nature, and are intensified in proportion to the degradation of the users of language in the scale of culture. In illustrating the following argument, I shall confine myself almost entirely to ground familiar, more than any other, to the general student of language, viz., the Aryan roots.

* Early Village Communities, Lecture iii.

L. Geiger, in his "Ursprung der Sprache," has shown, with equal force and clearness, that the great distinguishing characteristic of these roots is infinite variability. I shall endeavour to illustrate this fact by examples, drawn partly from his work, and partly from other sources.

If any one will glance at a dictionary of Aryan roots, and the meanings attributed to them, he can scarcely fail to be struck by the fact that here confusion seems to be the order of the day; that, in fact, the state of primitive language answers, to speak with Geiger,* to Ovid's description of Chaos:

> "*Prima fuit rerum confusa sine ordine moles*
> Unaque erant facies, sidera, terra, fretum."

This confusion arose from two causes: 1st, that one and the same root was used to name totally different actions or objects, sometimes entirely unconnected with, sometimes remotely akin to each other; and 2nd, that the same action or object was indicated by a number of different roots; so that, in reality, any combination of sounds might be used to indicate any action or object, and conversely the same object or action might be indicated by any number of different combinations of sounds.†

The examples illustrative of these variations may be arranged under the following four categories:

I. Variations of meaning in roots identical in sound.
II. Variations of meaning in different words derived from the same root, or from different roots identical in meaning.
III. Variations of meaning in the same word (as distinguished from a root).
IV. Various roots or words expressing the same idea.

I.—Variations of Meaning in Roots Identical in Sound.

On referring to Leo Meyer's Lexicon of Indogermanic Roots (the partial Italian translation is the only shape in which the work is accessible to me‡), I find that of the first fifty-four roots (beginning with the simplest in form) exactly one-half have two or more meanings assigned to them. Of these twenty-seven, fifteen have double mean-

* *Op. cit.*, p. 153.

† *Ibid.*, p. 89, *et seqq.*

‡ Compendio di Gram. Comp. d. antico, *Indiano*, Greco ed Italico di A. Schleicher, e Lexico d. radici Indo-*Italo-Greche* di L. Meyer, recati in Italiano da D. Pezzi. Torino e Firenze, 1869.

ings, and five treble; single instances occurring of four, five, seven, eight, and even nine meanings attached to roots identical in sound. It will only be necessary to give the few following examples:—

PA="drink;" whence Skr. *pi-bâ-mi*="I drink;" Gr. *pe-pô-ka, po-sis* (="drink"), &c.; Lat. *po-tus, po-to, po-culum*, &c.

PA="protect," "maintain," "rule;" whence Skr. *pâ-mi*="I protect;" Gr. *po-sis* (="husband"), *des-poi-na, des-po-tês, po-tnia, pa-têr;* Lat. *pa-ter, po-tis, po-tens, po-tiri, pa-sco, pā-bulum*, &c.*

DA="give," "divide," "bind."

AD (a variety of DA?)="eat," "smell," "hate."

KAR, or KAL (*r* and *l* being interchangeable)="call," "do," "move," "curl," "divide," "conceal," "cook," "gladden."

II.—VARIATIONS OF MEANING IN DIFFERENT WORDS DERIVED FROM THE SAME ROOT, OR FROM DIFFERENT ROOTS IDENTICAL IN MEANING.

My illustrations under this head will be taken from Geiger's work,† already so frequently referred to, and will be confined to derivatives traceable to the single idea of "binding," as represented by different roots, all containing that meaning. The root DA="bind," mentioned above, which occurs in the Gr. *deô* (whence *diadem*, and perhaps *dei*, implying necessity), is referred by Geiger to an older form, *dja*. With this is closely connected the root *dam*="tame," whence, in this signification, Lat. *domare, dominus*, &c. The primary signification was doubtless "bind," "join," &c., whence Gr. *demas*, "body," "frame;" *dêmos*, "community," "people;" *damar*, "wife" (*con-jux*); *demô*, "build," and *domos*, "house;" Lat. *domus*. Corresponding to this root *dam*="tame," we have the Skr. *jam*, with the same signification. Then we have the root *ju*="unite," "bind," to which the same authority refers *zônnumi*, and to which may also be referred the Lat. *jus*, and Engl. *justice, jury*, &c. Closely akin to this in sound and meaning is the root *jug*, or *jung*, Lat. *jungo*, Gr. *zeugnumi*, to yoke or harness, Lat. *jugum* (and *con-jux*), Germ. *joch*, Eng. *yoke*. To *dam* and *jam* Geiger adds another root, *gam*. Skr. *dampatî* and *gampatî*="husband and wife;" *jama*="twin" and *gami*="brothers and sisters" (*Geschwister*), Lat. *gemini*. Skr. *jâmi*="sister" and "daughter-in-law;" for the latter we have also *gâmâ; gâmâtri* and *jâmâtri*="son-in-law." With this are connected Gr. *gambros*, Lat.

* I only give derivatives with the first examples, as they are sufficiently well known to the general student.

† *Op. cit.*, p. 80, *et seqq.*

gener, "son-in-law, and Gr. *gamos*, wedlock." By the side of this word *gambros* we may place *pentheros*, the Greek word for a father-in-law (from the root *bandh*, whence also Eng. *bind*, and Gr. *penthos* ="grief"), with the passing remark that Euripides and Sophocles invert these significations, the former using *gambros* for "father-in-law," the latter *pentheros* for "son-in-law. From other various roots of similar signification are derivable the Germ. *Schwager*, *Schwäher*, *Schwieger*, all indicating relations by marriage; the Lat. *socius*; the various Indogerm. names for *sister;* the Lat. *nepos*, Gr. *anepsios*, our *nephew*, *niece*, Germ. *Neffe*, *Nichte*, Old Norse *nift*="sister" or "bride," Old-High-Germ. *nift*="granddaughter," "niece," "step-daughter." Beside the Lat. *jus* from *ju*, as given above, we may place *lex*, from *lig* (whence *lig-are*), with the same meaning of binding. This by no means exhausts the illustrations that might be drawn from the same source; but quite sufficient has been said to show over what an immense field this one idea ranges, and I must refer my readers for further illustration to Professor Max Müller's interesting treatment of several Aryan roots in his "Lectures on the Science of Language."* The four words *house*, *wife*, *justice* and *yoke* are far enough apart, in fact, to show this, almost without further amplification. Nor do I hold myself responsible for the correctness of all Geiger's derivations: a sufficient number are beyond doubt to fully illustrate the point under consideration.

III.—Variations of Meaning in the Same Word.

These variations must of course be distinguished, on the one hand, from those which are the result of metaphor, or of application extended from one object to others on account of a real or fancied resemblance (*e.g.* the use of the word *beam* for the rays of light, &c.); and on the other, from words of different derivation, that have accidentally assumed the same form (*e.g. cleave*="to adhere;" Germ. *kleben;* and *cleave*="to split;" Germ. *klaffen*). The variations here meant are such as arise from mere indefiniteness of application, from failure or disinclination to invent a new word for the varying conception. As examples of the occurrence of this variation of the same word in different languages, I may mention the English *bell=tintinnabulum*, and the German *bellen*="to bark;" Engl. *dumb*="mute;" Germ. *dumm*="stupid" (the word "dumb" being commonly used in the

* First Series, Lectures vi., vii.; Second Series, Lecture vii.

United States in the latter signification, a use not unknown even in this country); Engl. *mist*=*nebula*; Germ. *Mist*="dung," &c. But we need not go beyond the limits of one and the same language for our illustrations. I have already referred to the change of meaning in the Greek *gambros* and *pentheros*, and the Skr. *gâmi*. In the common usage of Southern Germany, *Vetter* means, indifferently, "uncle," "cousin" and "nephew;" and the fem. *Base*, similarly, means "aunt," "cousin" and "niece." So the Skr. *varcas*="brightness" and "dirt,"* and the German *Lohe*="flame" and "tan-bark;"† the Lat. *nepos*="grandchild" and "nephew;" the Greek *kuanos* indicates shades as varying as blue and black. So the Engl. *black* and *bleach* are the same word originally; *fond* means "affectionate" and "foolish." To these might be added words the signification of which has gradually changed in course of time, such as *silly*, *slight* (German *selig*="happy;" ‡ *schlecht*="bad," formerly "straight" or "level,") &c.; but I have preferred to confine myself to varying meanings in use at the same time, and in the mouths of the same people. This variation of meaning is sometimes indicated by a slight change of sound, as Engl. *band*, *bond*, *bound*.

IV.—Various Roots or Words Expressing the Same Idea.

Turning again to the Lexicon of Roots, we find the conception of "binding" indicated by the five roots *da*, *sar*, *bandh*, *ju*, *dja*, if not by more; that of "rubbing," or "crushing," by *tar* (whence *tero*, &c.), and *kar*; that of "going," by *ga*, *ki* (Gr. *kinein*; Lat. *ci-ere*), *ar* (Lat. *oriri*), *par* (Gr. *poreuein*), *sar* (Gr. *hormân*), and others. Of various words in the same language expressing the same idea, we may instance the Engl. *sea* and *ocean*, with the corresponding Germ. *See* (fem.) and *Meer*; the Germ. *dunkel* and *finster*; the Engl. *room*, *chamber*, *apartment*; the German *Zimmer* and *Stube*. These examples might also be multiplied to a much greater extent; but those given are sufficient for our present purpose.

So much as to variability in the content, or meaning, of words and roots. If we consider next their phonetic form, we shall find the same characteristic of infinite variability equally developed.

Roots have been treated by grammarians as things fixed and invariable by their very essence; but many of them are admitted to

* Geiger. Urspr. d. Spr., p. 150.

† Geiger considers them to be the same word.—*Ibid.*

‡ The German *selig*, like the Engl. *happy*, is used in slang as equivalent to "intoxicated."

have phonetic forms primarily different. Thus *ga*="go" is referred to a primitive form *gva*, whence are derived Skr. *ji-gâmi*, "I go;" *a-gât*, "he went;" as well as Gr. *ebê*, *bai-nô*, *bi-bas*, &c., and Lat. *ve-nire*; *da*, *dja*, *ju*="bind," are mere variations of the same form; *kar* and *kal* have already been referred to as admittedly identical, and the same is the case with *tar* and *tal*; *va* and *vap*="weave;" *dvi* and *chi*="fear;" *ksi*, *ski*, *ska*="destroy;" *kru* and *klu*="hear;" *gal* and *gla*="shine" (as also *ghar*, which is surely only a variety of form). The roots might be greatly reduced in number by considering the variations of form and meaning, and classifying them accordingly. Thus *kar* and *kal*="curl," also "rub," "crush," may be reasonably regarded as mere arbitrary variations of *tar* and *tal*="rub," "crush," &c., if we take into account the inability of primitive man to distinguish different sounds.* So with *ar*, *par*, *sar*="go;" also *tar*="tremble," "move rapidly."

We must of course allow to primitive language an infinitely greater latitude in its phonetic changes than takes place in a speech more or less fixed by the introduction of writing, and we do, as a matter of fact, find that phonetic changes, as well as changes of signification, are much more rapid with savage than with civilized nations.

"The dialects of barbarian tribes," says Professor Sayce,† "are perpetually altering. There is nothing to preserve them—neither traditions, nor ritual, nor literature. The savage has the delight of a child in uttering new sounds, and exhibiting his power and inventiveness in this manner, with none of the restraints by which civilization confines the invention of slang to the schoolboy and the mob. . . . The barbarian is especially open to all the influences of external nature, climate, food, and so forth, with nothing to check the disintegrating effect these may have upon the combination of sounds." Further on ‡ the same authority says: "Nothing is really harder than to keep a language from changing where it is not protected by the habits of settled life." So Max Müller tells us that among the wild tribes of Siberia, Africa and Siam, "two or three generations are sufficient to change the whole aspect of their dialects."§ Nay, more than this, he quotes the statement of Moffat, the African

* Mr. Henry Sweet, as quoted by Sayce, "Principles of Comparative Philology," 2nd edition, p. 246.

† *Op. cit.*, p. 83.

‡ *Ibid.*, p. 85.

§ Lectures, First Series, p. 35.

missionary, that in that country "*in the course of one generation the entire character of the language is changed;*" * and also tells us of "missionaries in Central America who attempted to write down the language of savage tribes, and who compiled with great care a dictionary of all the words they could lay hold of. Returning to the same tribe after the lapse of *only ten years*, they found that this dictionary had become antiquated and useless. Old words had sunk to the ground, and new ones had risen to the surface; and to all outward appearance the language was completely changed."†

The multiplicity of barbarian dialects is another proof of this rapidity of change. Gabriel Sagard, missionary to the Hurons in 1626, as quoted by the same author, ‡ "states that among these North American tribes hardly one village speaks the same language as another; nay, that two families of the same village do not speak the same language." Again: § "In the neighbourhood of Manipura [near the Irawaddy] alone, Captain Gordon collected no less than twelve dialects. 'Some of them,' he says, 'are spoken by no more than thirty or forty families, yet so different from the rest as to be unintelligible to the nearest neighbourhood.'"

After this digression, let us return again to the changes of outward form. If we begin comparing the varying forms which the same roots have assumed in different derivatives, the examples crowd upon us to such an extent that it is hard to say which we should take first. What can be more unlike in form than Lat. *semetipsissimus* and Fr. *même*; Lat. *canis* and Germ. *Hund*; Germ. *Zahn*, Lat. *dens*, Eng. *tooth* (the last of which has not a single letter in common with either of its foreign relatives)? But few words in an extract from Chaucer would remain unchanged in a modernized version, after the lapse of only a few centuries, which we are now taught to regard as a very trifling portion of the history of the human race. Nor should it be forgotten that phonetic laws originated and came into force, in the Aryan languages for instance, at a period much later than the existence of the language which consisted chiefly of the Aryan roots in the form which is assigned to them by comparative lexicography, when what afterwards developed into a phonetic *law* was merely a phonetic *habit* or *usage*, but still variable, and not prevalent to such

* Lectures, First Series, p. 56.
† *Ibid.*, p. 53. The italics are my own.
‡ *Ibid.*, p. 53.
§ *Ibid.*, p. 54.

an extent as to constitute any departure from it an anomaly, or even irregularity.*

Variations of form in the same word, within the limits of one and the same language, have of course been greatly reduced in number by the stereotyped character of written speech, and its diffusion in this form by the printing press. Still such duplicate forms are by no means rare. We write *inquiry* or *enquiry*; a few years ago we called a telegraphic message a telegra*ph* or telegra*m*; and English lexicographers differ widely as to the spelling of a large number of words. Vulgar spelling is, of course, infinitely more fluctuating. If we turn to an older language, such as Latin, for examples, we have scores of such duplicate forms as *adfero* and *affero*, *adlatum* and *allatum*, &c., &c. *Nicknames* constitute another variation of form of the same word. The English language is particularly rich in nicknames that differ widely from the original, *e.g.*, Dick or Dickon for Richard; Harry, Hal, Hank, for Henry; Robin and Bob for Robert; Jennie, Jeannie, Jane, for Johanna, &c., &c. The German furnishes *Hinz* for *Heinrich* and *Kunz* for *Conrad*, and in the southern dialects *Seppi* for *Joseph*, *Nazerl* for *Ignatius*, and a host of others. To these may be added varieties of surnames, *e.g.*, *Robinson*, *Robertson*, *Robison*, *Robeson* and *Robson*; *Boyce* and *Boys*, &c. In point of pronunciation and accentuation, usage is equally fluctuating. So we still hesitate between *either* and *either*, and within a short time great variations occur. Similarly accent varies in a short time, and in individual usage. *Bálcony*† seemed barbarous a few decades ago; and with regard to another word, I may say (almost) with Ingoldsby:

> "Re-*main*-der some style it; while others revile it
> As bad, and say *re*-mainder—'tisn't worth while, it
> Would seem, to dispute, when we know the result immaterial—I accent, myself, the penultimate."

The variations of pronunciation, both of vowels and consonants, in different dialects of the same language, are too familiar to require illustration. The South German and the Saxon are notoriously incapable of distinguishing *p* from *b*, or *t* from *d*; the Alsatian makes his *b*, when between two vowels, into a *v*, and says *aver* for *aber*; as the Spaniard makes his *d* into *dh*, or even *l* (*Madrid* pronounced *Madridh*, or *Madril*, whence *Madrileño*, "a citizen of Madrid"); and the Cockney scatters his *h*'s about most recklessly.

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* *Cf.* Geiger, Urspr. d. Spr. p. 78, *et seqq.*

† Max Müller, Lectures, &c., First Series, p. 36.

Precisely similar results may be obtained from an examination of the component parts of words, the formative affixes; results which may be arranged under similar categories, viz.: various affixes with the same meaning, various meanings of the same affix, and various forms of the same affix. Under the first head, we have the affixes *-dom, -hood* or *-head, -ric*, Germ. *-thum* (Norse *-domr*), *-heit*, or *-keit, -reich*, all identical, or nearly so, in meaning, when considered as affixes merely, and without reference to their derivation; as to the second, the prefix *dis-*, for instance, cannot be said to have precisely the same significance in *dis-cover, dis-tend, dis-hearten*, nor the suffix *-dom* in *wis-dom* and *king-dom*; and the series of Teutonic suffixes above mentioned will furnish with abundant illustrations under the third category. Thus *-head* and *-hood* are mere arbitrary variations of the same suffix, which is in German *-heit*: we say child-*hood*, but God-*head*; the Eng. child-*hood* corresponds to Germ. kind-*heit*, and Norse, barn-*domr*; the Eng. wis-*dom* to Germ. Weis-*heit* (Weis-*thum* has a different meaning); Eng. king-*dom*=Germ. König-*reich*; bishop-*ric*=Bis-*thum*; and so on, *ad infinitum*.

Such, then, is the material, the outward form of language, even as spoken by the most highly civilized nations, and fixed, as far as language can be fixed, by the diffusion of the written and printed word. The great characteristic of articulate speech, as we know and use it, is infinite variability of meaning and of form, so that, on the one hand, the same word may, in course of time, be at the opposite poles of signification (*e.g. kuanos*="blue," or "black;" *candidus*="white"); and, on the other, words identical in meaning and derivation are as far apart as possible in form (*e.g.* Fr. *larme*, and Eng. *tear*). The ruder and more uncultivated the language, the more fluctuating its forms and the meanings attached to them; and most fluctuating and unstable of all the speech of the primitive language-makers.

How, then, is this infinite variability and fluctuation, this "confusion of everything with everything else," as Geiger calls it, consistent with our definition of language, as a means of *intelligible* communication between man and man? What power was it that brought order out of this chaos? The answer has been hinted at already: this agent is *habit*, or *usage*. The case cannot be better stated than in the words of Geiger:*

* *Op. cit.*, p. 58.

"In the development of particular meanings, a great number of external circumstances have a share; in general, however, LINGUISTIC USAGE (*Sprachgebrauch*) may be regarded as the combining cause of the particular meaning attached to a word. Linguistic usage is *the habit of using a word in a particular sense.*"

Both the significance and the form of a word are first changed by habit, then fixed by usage. These changes may, in fact, be defined as *differentiation by the usage of the majority in a majority of cases of application.* The habit of using a word alone keeps it in existence; lose the habit, and you lose the word.

These variations, however, must not be regarded as the result of *conscious* change on the part of the language-makers, for all *habit* is *unconscious.* Primitive language, the creature of unconscious habit, is incapable of metaphorical application. When a word became the arbitrary sign of an action, object or idea, its original meaning and derivation was lost sight of, and ceased to be present to the mind of the speaker. The meanings of words change in a regular succession as determined by habit and usage, "the last link of the series having no clear connection with the first."* We have seen that the Gr. *damar*, "wife," is connected with *damao*, "to tame;" yet the idea of taming (or of binding, which is the root meaning) was of course never present to a Greek when he used the word; nor did he think of *penthos*, "grief," when he spoke of his *pentheros*, "father-in-law." So it is only by a conscious effort of thought that we connect *wedlock* with bolts and locks. Of course the fundamental idea contained in the root was the reason of its *original* application in the particular sense; but once *habitually* used in this sense, consciousness ceased, and the fundamental meaning was completely forgotten.

Having determined then that primitive man often indicated the same idea or object by different names, and widely different and even contradictory ideas by the same name, let us inquire why and how he as a general thing indicated similar objects by similar names. This inquiry is, in fact, identical with the vexed question as to the capacity of the primitive language-makers to form general ideas, and with that of the priority of general or particular names. Prof. Max Müller is one of the chief upholders of the priority of general ideas, and of primitive man's capacity for forming them. His argument may be best stated in his own language, as follows: "Man," he says,†

* *Op. cit.*, p. 58.

† Lectures on Science of Language, Second Series, p. 64.

could not name a tree . . . or any object . . . without discovering first some general quality that seemed at the time most characteristic of the object to be named." To this we answer that such abstraction is totally incompatible, not only with the intellectual capacity of primitive man, but with intelligibility, which was postulated as an attribute essential to constitute language a means of communication between man and man. "We have only to state the proposition," says Professor Sayce,* very truly, "to see how absurd it is. . . . There is no common bond of intelligibility between such universal ideas. . . . These abstract ideas must either be the last result of reflection, the universals arrived at after a long course of education, or else must be of the vaguest and most unmeaning character. In the first case, we are ascribing to the barbarian the mind of the civilized man; in the second case, any language at all would be out of the question. Two persons could not talk together in vague generalities, more especially when their conversation would be mostly confined to the bare necessities of life."

Man, to be intelligible to his fellow-man, must have named objects, not from a *general*, but from a *particular*, quality. For his name was first applied to an *individual* tree or other object, in which some *particular* quality struck him as its most prominent characteristic; and it was then applied to all individuals which bore a *general resemblance* to the first individual tree or other object named, though the difference might be wide indeed, and the *particular* quality which was the cause of the original name entirely absent. Thus general names, as used in primitive speech, arose from confusion, from inability to distinguish differences or failure to notice them, not from any miraculous power of abstraction and generalization, a power utterly wanting in the savage, *i.e.* in the primitive man of the present day. So a child will call a butterfly a bird, as it was originally called a fly, on account of the *particular* quality of flying common to both; and a leech a fish, because both swim; and most people call a whale a fish, because they are ignorant of the difference. So the South Sea Islanders called the horse a "man-carrying pig," according to the Rev. William Ellis, "the hog being the quadruped with which they were most familiar, and the name serving in their limited vocabulary as the generic designation for every other four-footed beast."† Now,

* *Op. cit.*, p. 220.
† Life of W. Ellis, p. 36.

surely there is no *general* resemblance between a pig and a horse; the name was given, on the contrary, from the *particular resemblance* of four-footedness, to which was added the *particular difference* "man-carrying." I have no access to any Polynesian vocabulary, but I very much doubt whether these savages had a word to indicate the abstract word "quadruped;" and it should be particularly observed that they did not call the horse a man-carrying *quadruped*, but a "man-carrying *pig*." The Oxford professor himself* quotes a similar story of the naming of the dog by other savages in the same way from the pig. *This, I suppose, he would attribute to a general resemblance;* and he goes on to say: "It would, however, very soon be felt as an inconvenience not to be able to distinguish between a dog and a pig. . . . How could that be effected?" The answer is contained in the instance given above, viz.: that a *particular resemblance* caused both animals to be at first designated by the same name; and when it was desired to distinguish them from each other, a *particular difference* was used to mark the distinction.

Indeed, all the phenomena of savage languages go to prove the incapacity of the savage to form abstract ideas. As Professor Sayce well says:† "In fact, the notion is absolutely contradicted by what we observe among modern savages. Here the individual objects have names enough, while general terms are very rare. The Mohicans have words for cutting various objects, but none to signify cutting simply; and the Society Islanders can talk of a dog's tail, a sheep's tail, or a man's tail, but not of tail itself. 'The dialect of the Zulus is rich in nouns denoting different objects of the same genus, according to some variety of colour, redundancy or deficiency of members, or some other peculiarity,' such as 'red cow,' 'white cow,' 'brown cow.'"

Again, Professor Max Müller says:‡ "All naming is classification, bringing the individual under the general; and whatever we know, whether empirically or scientifically, we know it only by means of our general ideas."

To this I reply that we acquire our general ideas of objects by the cumulative process of making the acquaintance of many different individuals, and of the *particular* attributes common to all of them. "It is the *particular*," says Geiger,§ "not the *individual*, that is the

* Life of W. Ellis, p. 311.
† Principles of Comparative Philology, p. 221.
‡ Lectures on Science of Language, Second Series, p. 885.
§ Op. cit., p. 107.

opposite of the general. Only the individual has a real existence, but each individual combines within itself the particular and the general. The *general* is only what is common to several individuals" (and is therefore synthetic by nature, and of later growth), "the *particular* is what distinguishes individuals."

What has hitherto been said may be summed up in the following statements:—

I. (*a*) That the grounds on which the possibility of the evolution of articulate speech from the inarticulate cries of the lower animals has been advocated are insufficient and untenable.

(*b*) That our inquiries as to primitive language should commence with primitive man, *i.e*, with the first men of whose existence as men we have positive evidence.

II. (*a*) That the earliest human beings of whose existence we have such evidence were tool-makers and tool-users, and that their tools were of the same kind as those used by savage races now in existence, *i.e.*, by the primitive man of the present day.

(*b*) That all tool-makers and tool-users known to us are capable of articulate speech, and actually use it; and that therefore

(*c*) The earliest human beings of whose existence we have evidence were capable of using, and probably did use, articulate speech.

III. That the phenomena of language, as spoken at the present day, and as it has been spoken within the period of which we have historical evidence, furnish us with data amply sufficient to enable us to draw, by a process of inductive reasoning, the following conclusions as to the nature of primitive words:

1°. That the most prominent general characteristic of all language is its infinite variability and constant fluctuation, and that in two respects, viz.:

(I.) In respect to content or significance.

(*a*) The same sounds were used to name different objects; and, *vice versa*,

(*b*) The same ideas were named by different sounds; and therefore

(*c*) Primitive names were infinitely variable in meaning.

(II.) In respect to form the variability was equally great.

2°. That in respect both to meaning and form, the determinative cause of the preferential use of a particular meaning, or form, was individual habit developed into general usage, which caused similar objects, in course of time, to be indicated, as a rule, by similar sounds, in the same community, and gave greater stability, and therefore greater intelligibility, to language.

3°. That the variation of meaning, the application of the same names to different objects or ideas, could only take place when the idea which was the primary cause of the use of the particular name had been entirely forgotten, and had become a mere arbitrary outward sign.

4°. That primitive language, in order to be an *intelligible* means of communication between man and man, must have dealt only in concrete or individual names and in particular ideas, and that abstract names and general ideas were the result of a subsequent process of comparison between the different individuals, with regard to a number of *particular* attributes common to many, which caused the general resemblance to be perceived.

Surely there is nothing miraculous in the direct invention of a vehicle of communication, an engine of thought, so unstable, so variable, so fluctuating as this, and yet so easily fixed by means so natural and unconscious as habit and usage, and at the same time so perfectly answering the purpose for which it was created or invented.

We have, however, considered language only in one aspect—with regard to the isolated word and its content. Now Professor Sayce, in his very ingenious and interesting work on the "Principles of Comparative Philology," has lately pointed out, with great force and clearness, that language consists not only of words but of sentences. The word bears the same relation to the sentence that letters do to words. A letter is nothing by itself, nor can a word express thought, except as a member of a sentence. The interjection can express emotion, not thought; and to this the imperative of the verb is akin in usage, though not in origin.

We have, therefore, as yet only completed half the task proposed; we have described the nature of primitive words as abstract and isolated things, incapable of conveying thought. We have still to

consider the nature of primitive words in relation to each other; in other words, the nature of primitive grammar.

With regard also to the other task which we set ourselves, namely, to prove that the direct invention of language was a thing within the capacity of the lowest savage, or, in other words, of primitive man, one-half still remains to be done. We have attempted to show that *general* names could *not* be primarily intelligible; we have still to show how *individual* names could be made so. In other words, we have to determine the sources *of primitive language.*

As, however, this paper has already greatly exceeded the limits originally proposed, these subjects must be left for future discussion.

LEAVES THEY HAVE TOUCHED.

BY HENRY SCADDING, D.D.

(*Continued from page 160.*)

FURTHER SUPPLEMENT.

As a further supplement to the collection of brief inedited auto graph documents laid by me from time to time before the Canadian Institute, I desire to add the following, which will close the series.

I. In the Canadian subdivision I insert (1) a royal warrant bearing the sign-manual of George III., authorizing the payment of a sum of money for the purchase of hemp-seed to be sent to the Province of Quebec, in 1789.

"GEORGE R.—Our will and pleasure is that by virtue of our general letters of Privy Seal, bearing date the 5th day of November, 1760, you do issue and pay, or cause to be issued and paid, out of our Treasury, or any Revenue in the receipt of the Exchequer applicable to the uses of our Civil Government, unto Alexander Davison, Esq., or his assigns, the sum of one hundred and fifty-two pounds, eighteen shillings and tenpence, without account, for the purposes following, that is to say: To reimburse him the charges attending the purchasing of 200 bushels of hemp-seed to be sent to Quebec to be distributed among the inhabitants of the different parts of that Province, £137 8*s.* 10*d.*: To pay the fees and charges attending the receipt thereof, £15 10*s.*: (together) £152 18*s.* 10*d.* And for so doing this shall be your Warrant. Given at our Court of St. James's, this 30th day of July, 1789, in the Twenty-ninth year of our Reign. To the Commissioner of our Treasury. By His Majesty's command: W. PITT. GRAHAM. ED. J. ELIOT." (A document bearing the signature of the younger Pitt has been given before.) (2), A letter written by Captain Bateman, commander of a sloop-of-war stationed at Halifax during the winter of 1760, in which the cold of the season is referred to, and the probable sufferings of brother-officers up the river, at Quebec. It is addressed to Richard Kee, Esq., in Savage

Garden, Tower Hill. "I have no news at present," the writer says, "or you might depend on having it; only I am heaving down, with expectation to go with the squadron early in the spring to Quebec. It is extream cold here: my pen and ink is ice. How poor Mackerly finds it at Quebec I shall hear in about May. Our squadron is in good health at present. Not the least sign of having Post. I shall be glad to have all the news you can furnish me with by the first ships, and to know if you can receive my pay: or the *Neptune*, if you'll mention it to Captain Hentwell: anything that's in his power, he will be so kind as to do it, I know. By this same opportunity I have writ to Captain Jervis and my friend Denham. I am in great hopes if they should come here, they will bring what beer and wine with bottles they can for—Dear Sir, your most sincere friend and humble servant to command, NATH'L BATEMAN." (3) A document written and signed by Gen. Carleton at Quebec in 1774, addressed to Benjamin Rumsey, Esq., Ordnance Store-keeper. "Quebec, 24th Sept. 1774. Sir: You are hereby ordered and directed to issue out from his Majesty's Ordnance-Stores in this Garrison, to Mr. Wilkinson, Quarter Master to the 52nd Regiment of foot, the undermentioned, they being for the service of the said regiment; and for so doing, this shall be your sufficient justification: Flints, musquet: 1000: Flints, carbine: 200: Musquet ball-cartridges made up :9144. —GUY CARLETON." (4) A receipt signed by Geo. Pownall, Secretary and Registrar of the Province of Quebec, in 1786. "Quebec, 2nd May, 1786. Received from Henry Caldwell, Esq., Acting Receiver General for the Province of Quebec, the sum of thirty-nine pounds, fifteen shillings, sterling, being the amount of my account for disbursements and contingencies as Secretary and Register of the Province from 11th October to 10th April, 1786, pursuant to His Honor Lieut.-Governor Hope's warrant, dated the 1st May, 1786, for which I have signed three receipts all of this tenor and date.—GEO. POWNALL." (5) Captain Jean Baptiste Bouchette's "Account of Expenses incurred in getting Intelligence," &c., in 1778, with his receipt attached, dated Quebec, 2nd April, 1779. "1778, Nov. 25. To paid Post hire to Ustette and back to get information of a large ship reported to have been seen from thence, by order of Lieut.-Governor Cramahé, £2. 1779. March 1. To ditto to Kamouraska and back, to deliver the Commissions of the Captains of Militia, &c., £3. To paid ditto with ditto, for the villages and back settlements,

£1. March 10. To paid ditto on a second journey to get intelligence of seditious letters that had been distributed in the lower parts of the Province, £3 10*s*. March 10. To paid to two persons who assisted in getting him said letters, by order of Lieut.-Governor Cramahé, £3 10*s*. March 10. To paid sundry expenses during the above journeys, £3. Total, £16.—Quebec, 2nd April, 1779. Received from Thomas Dunn, Esq., Paymaster-General of the Marine Department, sixteen pounds, currency, in full of the above account.—J. B. BOUCHETTE." (6) A receipt in the handwriting of Mr. Dunn, for a gratuity to Firmain d'Aigre, a French Canadian volunteer, made prisoner on the occasion of Burgoyne's surrender. "J'ai reçu de Mons. Thomas Dunn, Ecuyer, par les mains de Mons. le lieutenant Gouverneur Cramahé la somme de quarante piastres d'Espagne pour mes frais et depense d'Halifax à Quebec, et recompense pour moi captivité, ayant été fait prisonnier avec l'armée du Général Burgoyne, étant pourlors voluntaire.—FIRMAIN D'AIGRE. á Quebeck, 29^{e} Mars, 1779. Branard, temoin." (7) Col. F. Smith's order for ammunition to be used in firing a salute on the departure of General Carleton from Quebec. It is addressed to the respective Officers of His Majesty's Ordnance, Quebec. "Gentlemen: You are hereby ordered and directed to issue from out of His Majesty's Ordnance stores in this Garrison, to Capt.-Lieut. Agar Weetman, the undermentioned particulars, the same being to salute His Excellency Brigadier-General Guy Carleton, at his departure from hence, and for so doing this shall be your justification: Corned powder: lbs: Twenty-two and a half. Flannel cartridges, 6-pounders, fifteen. Tin tubes, 6-pounders, nineteen. Port-fires, two. Slow-match, lb: one.—F. SMITH, Lt.-Col." (8) A letter written by the Right Hon. Henry Dundas, when Secretary at War, in 1794. It relates indeed in no way to Canadian affairs; but I insert it here as an authentic relic of one whose name has been recorded again and again on the map of Canada. It was in honour of this Henry Dundas, that the flourishing Town of Dundas, the County of Dundas, and the original "grand trunk" highway, cut out through the forest from Detroit to the confluence of the Ottawa and the St. Lawrence, denominated on the early maps throughout its whole length, DUNDAS STREET, received their respective names. The letter referred to is addressed to the Governor of the Island of Jersey, Gen. Hall, during the troublous times of the Revolution in France. It appears that the island had been made a convenience of by persons

engaged in the manufacture and circulation of forged assignats. The Secretary-at-War thus addresses the Governor, from the Horse Guards, 26th October, 1794. "Sir: Some unpleasant occurrences which have lately happened on that part of the coast of Brittany on which persons sent from Jersey have been landed, with a view of establishing a communication with the Royalists in the interior of France, render it absolutely necessary that you should not permit or authorize any person whatever to embark from Jersey with a design of proceeding to France, and particularly to that part of the coast which I have described, unless you shall hereafter receive from me directions contrary to those of this dispatch, to which in the present state of affairs I must request you will pay immediate and particular attention. One reason in particular which induces me to urge this precaution is, that I have reason to believe an intercourse has lately been established between Jersey and the coast for the sale and distribution of forged Assignats. The parties concerned in this speculation will of course make every exertion to prevent its failure, and it will therefore be necessary that any person supposed to have taken a share in it should be carefully watched. * * * I am, etc.:—HENRY DUNDAS." This signature is all the more interesting, as a few years later it became merged and lost in that of MELVILLE, Mr. Dundas having been in 1802 created Viscount Melville. (For a transcript from a document wholly in the handwriting of Sir George Yonge, after whom the other great highway of Ontario, Yonge Street, was named, *vide supra.*)

To the literary relics connected with the United States, I add (1) a volume from the press of Dr. Franklin, the sheets of which may have been worked off by his own hand. It is a small German treatise, entitled "Einige zu dieser Zeit nicht unnütze Fragen," &c., dated at Philadelphia, 21st April, 1741. The imprint at the foot of the title-page reads as follows: "Gedruckt und zu haben bey B. FRANKLIN." (2) A book once the property of Washington Irving. It is a Spanish work—the Leon Prodigioso of Cosmo Gomez Texada de los Reyes, printed at Madrid in 1670, by Bernardino de Villa-Diego. On the first fly-leaf are the interesting words, in the handwriting of the former owner: W. IRVING, *Seville, May 16th, 1828.*

II. In the British division I insert now, (1) in the Court group, a letter which I copy from one written by William Henry, Duke of Gloucester, brother of George III. It is rather mysteriously worded,

and has reference to some royal gift of jewellery about to be presented to his niece, on the occasion of her marriage. Thus it reads: "Sir . I forgot to mention to you yesterday that I have been commissioned, very privately, to find out if the jewels that are to be seen at the jeweller's you employed to set the H. P.'s picture, are bespoken; which, though not believed or certainly expected, as a future present; yet the Family would avoid giving duplicates, if that was the case. All the letters from Windsor to-day speak highly in praises of the H. P.; and it is only wished he may be as well pleased. Yours, W. H." The note is dated April 18, 1797. "H. P." denotes "Hereditary Prince," *i. e.* of Wirtemberg, Stutgardt. He was married with great pomp May 17, 1797, at the Chapel Royal, St. James', to Charlotte Augusta Matilda, Princess Royal of Great Britain, the Archbishops of Canterbury and York both officiating. The Duke of Gloucester, the writer of the preceding note, was present. (See Annual Register 1797; Chronicle, p .29.) Among the letters from which I selected the above note, was one written nineteen years later by the princess then married. She was now Queen of Wirtemberg, but a widow; and she speaks of her great affliction and of the unpleasant state of her monetary affairs; she owes, she says, the King's heirs four thousand pounds, which sum she is anxious that her brother, the Prince Regent of England, should assist her to pay. One more addendum to this group of "Leaves They Have Touched," is Queen Charlotte's copy of "Advice from a Lady of Quality to her Children" —the presentation copy from the translator. This book is further interesting as coming from the press of Robert Raikes, Gloucester, the memorable philanthropist. The date is 1778. (2) I add to the general literary and scientific relics, a volume once the property of Narcissus Luttrell, and containing his autograph. It is entitled, "The Magazine of Honour, or a Treatise on the Several Degrees of Nobility of this Kingdom, with their Rights and Privileges:" collected by Master Bird; but enlarged by Sir John Doderidge. London, 1642. Lord Macaulay has many references to Luttrell's "Brief Historical Relation of State Affairs from September, 1678, to April 1714:" in six octavo volumes. Narcissus Luttrell's collection of fugitive pieces, poetical satires, squibs, &c., on national occurrences and events in high and low life, from 1640 to 1688, bound up in eight folio volumes, fetched at auction in London, in 1820, the sum of £781. (3) A letter written by the seventh Earl of Elgin, father of our Canadian Lord

Elgin, and the famous collector of the Elgin Marbles. It was written at Milan in 1791, where he was at the time in an official capacity, and it is addressed to Lord Auckland, Ambassador at Paris, apprising him of current events and rumours. We find ourselves at once breathing the diplomatic atmosphere. Several distinguished European personages are named. I transcribe from the original autograph: "My dear Lord: I was really mortified to learn from my servant, who left London on the 24th May, that your Lordship was not then in England, as that persuasion had prevented me sending you, as I otherwise most certainly should have done, some direct notion of the progress of my present negotiations. It were totally superfluous in me to trouble your Lordship with any details of what has now been so long in London; and I am very sorry to say that, as yet, nothing positive has been further done. The minute of a Treaty formed at Sistovo, and containing eighteen articles, threatens an unfortunate delay and many unpleasant discussions. The Emperor has it in his power to prevent them. I don't think myself far wrong in my belief, that He wishes to do so. But we well know, that is not all that's requisite for its being done. At this moment He is in possession of answers from England and Berlin, on my communications from Florence. I delivered them to Him on Sunday. But unfortunately His decision is suspended, or rather his reply is suspended, till the arrival of a messenger, who is announced from Vienna. I am not sanguine in my expectations from the dispatches he may bring. The more so, as he has been detained by some proposals, or intelligence brought to Vienna, by Ct. Buhler, a confidential man with Potemkin. I have no other but general grounds, for auguring ill. But you'll allow, they are not favorable. When I adverted to the ratification of your Convention, I received for answer, *Cela s'arrangera*, and that the Archduchess was on her way with D. d'Albert to the Netherlands, where they were to receive the oath of allegiance. You may depend on my obeying the further instructions I have received on that head. But from what I can learn here, your neighbourhood is becoming a very interesting scene in other views. We are told here that the Ct. d'Artois is drawing nearer to Brusselles. All the French are following Him from Italy. The Prince Lambescq arrived here on Sunday, and proceeds towards the Rhine to-morrow. I have to acquaint you, on the authority of a French person of distinction, that we mean to take all the West India Islands; that fifty sail of

line were never intended for the Baltick; and that, beyond a doubt, no first-rate can pass the Sound. This intelligence I got last night. However absurd, there are persons still more absurd by giving credit to such reports; and what's more astonishing, the effect of that belief is sensibly felt. I did not require fresh instances to convince me of your friendship. But I should be sorry to delay expressing my best thanks to your Lordship for the very kind manner in which, I understand, you have mentioned me in some letters lately written to England. Believe me to be, my dear Lord, most grateful for the obligations you confer on me; and with the utmost regard and esteem, your very faithful servant, ELGIN. I am just told that P. Lambescq has entered the Austrian service with the rank he held in the French army." The person spoken of in the postscript is a Charles Eugène de Loraine, Prince de Lambescq, a relative of Marie Antoinette, and Commander of the Royal German Regiment, with which force he charged the mob assembled at the Tuileries in 1789. The Count d'Artois was afterwards Louis XVIII. (4) A letter of William Hone's, transcribed from the original. Most people have consulted Hone's "Every Day Book," Hone's "Year Book," Hone's "Table Book," each of them filled with descriptions of old customs, old buildings, and the rural phenomena of England. Of the "Every Day Book," Charles Lamb took occasion thus to address its compiler:—

> "Dan Phœbus loves your book: trust me, friend Hone;
> The title only errs, he bids me say;
> For while such art, wit, reading, there are shewn,
> He swears 'tis not a *book of every day*."

My relic of this writer reads thus: "My Dear Sir,—From the time I came here until after the rain yesterday I was no better. I can make no effort with my pen, and very little orally, without pain. Yet your kind pencilling demanded more than apparent indifference. Can you stage yourself hither? Yours ever, W. HONE." It is addressed to Frederic Malcolm, Esq., from "Hampstead, at Mr. Hook's, Mount Vernon, Holly Bush Hill, 12th June, 1838." Hone died in 1842, æt. sixty-three. He was in his younger days a bold political pamphleteer, and was once tried for seditious libel, but acquitted. From being an erratic, unpractical revolutionist, he subsided at length into the literary antiquarian, and quiet law-abiding citizen.

(5) A volume, once the property of Leigh Hunt, another writer remarkable for a chequered literary and political career. He and his brother, during the Regency, established the *Examiner* newspaper; and three times they were prosecuted for their strictures on the government. On the third occasion, they were imprisoned for two years, and fined £500 each. This sentence caused Leigh Hunt to become very popular. In 1847 he received a pension of £200 per annum, which he enjoyed until 1859, when he died at the age of seventy-five. But it was not chiefly as a journalist that he was distinguished, but rather as an elegant English essayist, poet, dramatist, novelist, and translator from the Italian. He was the personal friend of Coleridge, Lamb, Keats, Shelley, Proctor, Moore and Byron. It was probably during his sojourn with the last-named in Italy, in 1823, that Leigh Hunt provided himself with the volume which is in my collection, which, besides having his autograph signature on the title page, is full of MS. annotations and reference-memoranda written by himself. It is a beautiful copy of Dante's "Amori è Rime," printed at Mantua in 1823; *co' tipi Virgiliani di L. Caranenti.* Brief fragments, that need not be transcribed, from the hands of (6) Sir Charles Lyell, (7) Sir Roderick Murchison, (8) Thackeray, and (9) Miss C. M. Yonge, (10) Miss Mary Russell Mitford's copy of Scott's "Lay of the Last Minstrel," and (11) Mark Anthony Lower's copy of Bowditch's "Suffolk Surnames," with the fine signature of the former owner, and an autograph letter of the author himself, inserted. As associated with the name of Sir Walter Scott, I place here (12) a copy of Smith's Translation of "Longinus on the Sublime," printed in London in 1756. It has fairly written on the title-page, in a hand of the last century, "E Libris. James Sanson." The Rev. Mr. James Sanson, of Leadhills, Lanarkshire, the former owner of the book, was a zealous bibliomaniac, well-known to Sir Walter; and it is held by Mr. Sanson's immediate family connexions in Scotland and here, that the novelist had him chiefly in his eye when he drew the world-famous "Dominie Sampson," venturing in the surname rather near that of his original.

Thackeray's relic, above referred to, is the following note, in which a too forward literary neophyte receives a rather stern rebuff. "My dear Sir: I cannot do what you have set your mind upon. Though I am always inclined to oblige, I at the same time am unable to do that which is utterly out of my power. You must not, young Sir,

take advantage of my shaking hands with you at the Garrick Club a few weeks ago, nor must you trouble me with any more letters on the subject upon which you have 'set your mind.' Besides, you should have stated your views to the publishers—decidedly not to me.—Yours truly, W. M. THACKERAY."

To the Shakspearean group, I add volumes once the property of several distinguished Shakspearean commentators or editors, as shewing inscriptions from the hands of each of their former owners: (1) Joseph Ritson's copy of "Miscellaneous Pieces relating to the Chinese," collected by Thomas Percy, afterwards Bishop of Dromore. In his "Observations on the Ancient English Minstrels," Ritson coarsely criticised Percy's "Reliques;" but Ritson coarsely criticised everybody. Sir Walter Scott says of Ritson that he was "a man of acute observation, profound research, and great labour. These valuable attributes were unhappily combined with an eager irritability of temper which induced him to treat antiquarian trifles with the same seriousness which men of the world reserve for matters of importance." (Ritson died mad.) (2) Isaac Reed's copy of "Ozell's Translation of the Lutrin of Boileau." Reed edited Shakspeare twice: first in ten, and secondly in twenty-one volumes. At his death, in 1807, the sale of his library occupied thirty-nine days. (3) Alexander Dyce's copy of his own "Translation of Quintus Smyrnæus's continuation of the Iliad"—a presentation copy from himself "to his friend J. J. Eyton." Besides Shakspeare, Mr. Dyce edited the plays of the early English dramatists Peele, Greene and Webster. (4) Robert Chambers' copy of J. Payne Collier's edition of the "Notes and Emendations to the text of Shakspeare's Plays, from early manuscript corrections in a copy of the folio, 1632." Besides the autograph of R. CHAMBERS, in this volume, there is at the end a MS. note from the same hand on the word "flote," in scene 2, act 1, of the *Tempest*, corrected to "float" in the "Emendations," with the change of the preceding "all" into "are," making the passage read thus:

> "They all have met again,
> And all upon the Mediterranean float."

The editor of the "Emendations" remarks on this: "'Float' in fact is a verb, used by everybody, and not a substantive, used by no other English writer." To this R. Chambers in his MS. note rejoins: "'Flote' is used as a noun for 'fleet' in a letter of King James VI.,

October, 1589. See Documents relative to reception of the King, &c. Edinburgh, 1822." Robert Chambers' enlightened regard for the great dramatist is shown by the room given him in the "Book of Days," the *Journal* (especially in the Tercentenary year), and the "Cyclopædia of English Literature;" and by an edition of the plays adapted to family reading. The stir made a few years since by Robert Chambers' "Vestiges of Creation" was a mild prelude to the widespread commotion raised, at a later time, by the same theories more explicitly unfolded. To the Shakspearean group of relics I finally add a note transcribed from the autograph of Mr. J. Payne Collier himself, on the subject of the received form of Shakspeare's name. It is known that some persons from time to time suffer from a craze for a change—an improvement—in the usual orthography of the poet's name. As was to be expected, Mr. Collier practically pronounces against them. "As to the spelling of the name of Shakespeare," he says in the MS. from which I copy, "I have never considered it a matter of any importance; but I have never put it on paper, either in print or in manuscript, but in this form—SHAKESPEARE. He seems to have spelt it in various ways, and nobody in his lifetime cared much how any name was spelt, as long as it sounded much in the same way. I have seen it, of old, as Shaksper, Shaxper, Shackspere, Shaxespere, Shaxspeare and Shackspeere, and in other fanciful modes, for there was then no uniformity or rule. I am so busy just now with my edition of his Plays, of which twenty-four are in type (only 50 copies 4to to subscribers), that I really have not time to enter more at large into the subject. I care much more about the accuracy of a single word of his text, however small, than about the mere orthography of his name." In 1842–44, Mr. Collier published an edition of Shakspeare in eight volumes 8vo; and in 1848, a work entitled "Shakespeare's Library," being a collection of the ancient romances, novels, legends, poems, and histories used by Shakspeare as the foundation of his dramas, printed in full. His "History of English Dramatic Poetry," in three volumes 8vo, published in 1831, is another standard work.

I augment the general European or Continental group (1) by a volume from the library of Ferdinand Philip, Duke of Orleans, eldest son of Louis Philippe, King of the French. It is an English work, entitled "A Dissertation on Parties, in several letters addressed to Caleb D'Anvers, Esq., and dedicated to Sir Robert Walpole; the

seventh edition. London, R. Francklin, 1749." Caleb D'Anvers is a fictitious personage. The frontispiece is a curious composition; it shews Liberty prostrate, and weeping: an exasperated hydra between two opposing groups of men armed in various ways (some of them with *pens* only), and clamorous; above all in the air, Sir Robert Walpole, *à la Jove*, supported by Plutus, blind Fortune, and Subtlety, while a winged Messenger descends towards the crowd below, extending in one hand a purse and reserving in the other a large mitre. The volume is stamped within thus: "Bibliothèque de S. A. R. Mgr. le Duc d' Orleans." Within the oval border bearing this inscription are the initials "F. P. O.," surmounted by a French ducal coronet. It thus appears that the Duke of Orleans indicated is the son of Louis Philippe, so entitled, accidentally killed in Paris in 1842, the father of the present Count of Paris. By virtue of his evident sympathy with European civilization, I place here (2) an autograph letter of the King of Siam, reigning in 1850. It is in English, and is addressed to John Jarvis, Esq. He writes for a gold pen, to replace one that had been broken and rendered useless in the carriage; and he asks to have a mathematical instrument sent to him from Singapore. "Dear Sir," he says, "I have tried to use your golden pen in writing, and observed that its platinical point on one side has longly broken off; there is still remaining the point of platinum, but on the other side, which is longer than the other, so that the pen is of no use. I trust you will procure other, and send one from Chingapore. Allow me to ask for something of my purpose; can one of the small Ismouth compass (which is small as to be convenient to be carried by pocket, and which has the staying line and the arch or whole circle divided into 90 degrees on a square quarter, or into 360 degrees around whole circle, and has a hole for looking on observation of parallax of many thing at the way of road o. bank of river, &c.) be procurable at Singapore or other place from your attention? Of which wanted article or instrument I shall be glad to pay for value which you would say of. Believe me your friend." [I regret that I do not accurately decipher the signature, nor the place of writing.] The following is added: "P. S.—Your pen was accompanied in the envelope."

III. I supplement the two groups representing the two ancient Universities of England, by adding (1) to the Oxford one, unimportant autograph fragments, which need not be transcribed, of (*a*) Dr.

Temple, the present Bishop of Exeter and late Master of Rugby: (*b*) Dr. Longley, Bishop of Ripon, afterwards, successively, Archbishop of York and Canterbury: (*c*) Sir George Cornewall Lewis, formerly of Christ Church, author of many classical, political and philological works: (*d*) John Henry Newman. I add (*e*) a relic of a distinguished Christ-Churchman of the last generation, Robert Nares: a small volume consisting of several classical pieces bound together. On the back of the first title is stamped the cipher of the former owner; and a list of the contents of the book follows in his handwriting. The first item is "Poemata, Auctore Oxon. nuper Alumno, 1769," to which is appended this query, "At quo?" Mr. Nares was the author of the well-known "Glossary" of Elizabethan English. After these relics I place (*f*) an autograph letter of John Wesley, some time Fellow of Lincoln. It is addressed to Mr. W. Churchey, Brecon, and is dated August 8, 1789. It announces that he has collected for Mr. Churchey one hundred guineas from subscribers to a publication which that gentleman was about to put forth. Thus it reads: "My dear Brother: I came round by London from Leeds to settle my affairs here, and to set out for Bristol this evening by the Mail Coach. On Tuesday morning I purpose, God willing, to set out thence for the West. What remains of the month of August I hope to spend there. September is dedicated to Bristol. I suppose you will stray over thither. As to Henry Floyd's writings, from what I can find, they are vanished away. I never had them, and I cannot find who had. The 'Essay on Man' is wonderfully improved since I saw it many years ago. It is your masterpiece, and therefore fit to close the volume. But this will take more time than I imagined. I have procured One Hundred Guineas for you, and hope to procure Fifty more. —Your affectionate Brother, J. WESLEY." I find in Tyerman's "Life and Times of John Wesley" (iii. 579), that "Walter Churchey was an enthusiastic Welshman; a lawyer with a large family, and a slender purse; a good, earnest, conceited old Methodist, who, unfortunately for his wife and children, had more delight in writing poetry than he had employment in preparing briefs. * * * In 1786 Churchey wished," Mr. Tyerman informs us, "to enrich the world with his poetical productions; and, among others, consulted Wesley and the poet Cowper. The latter, in reply, remarked: 'I find your versification smooth, your language correct and forcible, especially in your translation of the *Art of Pr* *g*. But you ask me would I advise

you to publish? I would advise every man to publish whose subjects are well chosen, whose sentiments are just, and who can afford to be a loser, if that should happen, by his publication.'"

I extract the following equally shrewd passage from a letter of Wesley's to the same Churchey, given in Tyerman, also having reference to the canvass for the sale of the proposed poems. "As you are not a stripling," Wesley says, "I wonder you have not yet learnt the difference between promise and performance. I allow, at least, five-and-twenty per cent.; and from this conviction, I say to each of my subscribers, what indeed *you* cannot say so decently to *yours*—'Down with your money.'"

(*g*) A letter of Canning's will not here be out of place, for he too was an Oxfordman. It has reference to the affairs of a pensioner, who has had some difficulty in receiving his allowance. I transcribe from the original, wholly in Canning's hand. It is dated at South Hill, near Bracknell, Berks, October 22, 1805, and is addressed to J. Smith, Esq., Chelsea Hospital. It reads as follows: "Sir: A poor out-pensioner of Kilmainham Hospital, who resides in my neighbourhood, has been accustomed to apply to me to pay him his half-year's pension as it became due, giving me his receipt for the same; and till this year I have found no difficulty in recovering the amount by application through my agent, at the Hospital near Dublin. This year the enclosed receipt for two payments advanced to Simon Hobson (that is the man's name) has been returned to me, with notice that I am to apply to you for repayment, for that by a new regulation all English pensioners belonging to Kilmainham are to be paid at Chelsea. I shall be obliged to you if you will remit to me the amount of the enclosed receipts, and if you will have the goodness at the same time to let me know, for the information of the poor man, whether Hobson is in future to address his half-yearly affidavit to Chelsea and to what officer there, instead of, as heretofore, to the Registrar of Kilmainham. I have the honour to be, &c., GEO. CANNING."

(2) To the Cambridge group I add (*a*) a third autograph relic, of the Rev. Charles Simeon, a note addressed by him apparently to his publisher. "I have sent all the remainder of the books," he says, "of which I desire your acceptance. I have enclosed 50 of The Evang. and Phar. Righ. compared, and 50 of The Fresh Cautions: 2nd edition. Pray put by the remainder of the first edition; and if without incon-

venience you can exchange those which Mr. Hatchard has, I will be much obliged to you. I am, &c., C. SIMEON, K. C. [King's College], Sept. 26, 1810." (*b*) A note from the hand of Professor Samuel Lee, a man of great note in the University in 1833, highly skilled, and in the first instance self-taught, in the Oriental languages; Professor, first, of Arabic, and then, Regius Professor of Hebrew in the University, author of a Hebrew, Chaldaic and English Lexicon, and many other learned productions. The note in question has reference apparently to an engraved illustration of a Biblical work: "I return the proof of the Plan of the Temple herewith," he says. "I like it much; it is a great improvement upon the drawing. As to the steps of which the Engraver inquires, they must be no more than seven in number. They will therefore occupy much less space than they do now. * * * In the Candlestick there should be seven branches; *i.e.* six, with the stem or trunk of it. No measure indeed is given, but a true representation of it is to be found on the Arch of Titus at Rome. Yours very truly, SAM'L LEE." (*c*) A brief and unimportant fragment in the handwriting of Connop Thirlwall, the associate of Julius Hare in the translation of Neibuhr's "Rome;" both formerly Fellows of Trinity College in Cambridge. It bears his signature, however, in the disguised form of C. ST. DAVIDS. After his appointment as Bishop of St. David's he perfectly mastered the Welsh language. Of his "History of Greece," Grote says: "Having studied, of course, the same evidence as Dr. Thirlwall, I am better enabled than others to bear testimony to the learning, the sagacity, and the candour which pervades his excellent work." On Thirlwall's monument in Westminster Abbey the words "SCHOLAR, HISTORIAN, THEOLOGIAN," inscribed after his name, sum up his claims to the regards of his fellow countrymen. (*d*) I subjoin here a note from the hand of the missionary Wolff, who though not a Cambridgeman, was, in his day, a well-known figure and character there. The little document is curious as mentioning "Lady Georgiana," his wife; the rest of it relates to the sale of his "Journals." It is addressed to Mr. Collins, Upper Sackville Street, Dublin, November 16, 1846. "My dear Mr. Collins!" it begins, "Lady Georgiana wrote to me that you were kind enough to send some money. Pray do not forget to send the two books of the names of the subscribers, and also any copies of the *Journal* remaining. I have no fear of not disposing of every one of them in England. I make you responsible for my subscription book.

Pray send me also my *Bokhara Journal.* I shall be happy to be enabled to be of use to you; for you have had a great deal of trouble with them. Yours affectionately, JOSEPH WOLFF." The maiden name of Lady Georgiana, was Walpole. She was a daughter of the second Earl of Orford. Somewhat eccentric herself, she became enamoured of the Rabbi's son, Joseph Wolff, whose exterior was not beautiful, nor by any means usually kept in trim order. The union proved happy. She accompanied her husband in his missionary excursions among the Jews and Mahommedans. In 1843 he was sent by the British Government to Bokhara, to ascertain the fate of Colonel Stoddart and Captain Conolly. This is one of the works referred to in the note. His missionary travels, he himself proclaimed in one of his books, surpassed those of St. Paul. "I, Joseph Wolff," he says, "also am an Israelite of the seed of Abraham, of the tribe of Levi, and I have preached the Gospel not only from Jerusalem round about Illyricum, but also from the Thames to the Oxus and the Ganges, and the New World." He was admitted to deacon's orders in the "New World," by Bishop Doane, of New Jersey. He in after years had the living of Isle-Brewers in Somersetshire, where he died in 1862.

SYNOPSIS OF THE FLORA OF THE VALLEY OF THE ST. LAWRENCE AND GREAT LAKES,

WITH DESCRIPTIONS OF THE RARER PLANTS.

BY JOHN MACOUN, M.A., *Botanist to the Geological Survey.*

(*Continued from page 435.*)

R. rotundifolium, Michx.

Indigenous. Rocky banks of rivers. Cape Rouge River (Brunet). Not very common at River du Loup (Thomas). Nonpareil (Maclagan). Common at Prescott (Billings).

R. lacustre, Poir.

Indigenous. Abundant in Cedar Swamps. New Brunswick (Fowler). Quebec and Point Levi (Brunet). River du Loup (Thomas). River Rouge (D'Urban). Abundant in swamps throughout Ontario, and extends by Lake Superior and the Dawson Route to Lake Winnipeg, thence through the wooded country to the Fraser in British Columbia (Macoun). West coast of Newfoundland (Dr. Bell). Labrador (Butler).

R. prostratum, L'Her.

Indigenous. Cold damp woods and rocks. New Brunswick (Dr. Fowler). Lotbinière (Brunet). Common on rocks, River Rouge (D'Urban). Very common at River du Loup (Thomas). Rocks west of Brockville and Chelsea, C. E. (Billings). Abundant on Laurentian rocks in the Counties of Addington, Hastings and Peterboro'. Shore of Lake Huron; Kaministiquia River and Thunder Bay; Dawson Route; on the slopes of Deer Mountains near Slave Lake (Macoun). Montreal and Kingston (Maclagan). Labrador (Butler). West coast of Newfoundland; Owen Sound and Gore Bay (Dr. Bell).

R. floridum, L.

Indigenous. Common in swamps and wet woods throughout the valley of the St. Lawrence and west to the Saskatchewan (Macoun).

R. rubrum, L.

Indigenous. Swamps and wet woods. New Brunswick (Mathews). Vicinity of Quebec, St. Joachim and Cape Tourmente (Brunet). Abundant around clearings, River Rouge (D'Urban). Very common at River du Loup (Thomas). Common at London (Saunders). Swamps, Niagara District (Maclagan). West coast of Newfoundland; Gore Bay and Hilton, Lake Huron (Dr. Bell). Cool damp woods, Central Canada, Owen Sound and Lake Huron, shore of Bruce Peninsula; common around Lake Superior and along the Dawson Route, and westward by the wooded country to Peace River and Upper British Columbia (Macoun). North to the mouth of the Mackenzie (Richardson).

PARNASSIA, Tourn. Grass of Parnassus.

P. parviflora, DC.

Indigenous. Wet rocky shores of lakes and rivers. Borders of the River St. Anne and River Jacques Cartier (Brunet). General around Lake Superior, also at Red Bay, Lake Huron; at Fort Edmonton on the Saskatchewan, and at the Canon on Peace River (Macoun). Labrador (Butler). Sandy banks of rivers in the Rocky Mountains (Drummond).

P. palustris, L.

Indigenous. Wet clay banks. Island of Anticosti (Brunet). Under the bank at Fort Francis, Dawson Route; Big Lake, west of Saskatchewan; west of the Arthabasca; shore of Little Slave Lake (Macoun). Saskatchewan Valley (Bourgeau).

P. Caroliniana, Michx.

Indigenous. Crevices of rocks along rivers. Vicinity of Quebec; Isle of Orleans (Brunet). Banks of the rocky Saugeen, Durham (Logie). Sandwich (Maclagan). Two miles south of London (Saunders). Crevices of rocks, Niagara Falls; Presqu' isle Point, Lake Ontario; Pott's Mill Dam, Brighton, Northumberland County; Red Bay, shore of Lake Huron (Macoun). McLeod's Harbour, Cockburn Island (Dr. Bell).

SAXIFRAGA, L. Saxifrage.

S. oppositifolia, L.

Indigenous. Moist rocks. Island of Anticosti (Goldie). Labrador (Butler). Cariboo Mountains (Macoun). Rocky Mountains (Bourgeau). Newfoundland and to the shores of the Arctic Sea and to Kotzebue Sound (Torr. & Gray).

S. aizoides, L.

Indigenous. Wet rocks and borders of streams. Newfoundland, Labrador, Greenland and the Island of Anticosti, and to the Arctic Sea (Torr. & Gray). Alpine Rivulets in the Rocky Mountains (Bourgeau). Labrador (Butler). Newfoundland (Dr. Bell).

S. tricuspidata, Retz.

Indigenous. Rocks along lakes and streams. North shore of Lake Superior (Agassiz). Rocks at the Peace River Canon; and on rocks at Stewart's Lake, Upper British Columbia (Macoun). Rocky Mountains (Bourgeau). Arctic and Sub-Arctic America; Hudson's Bay and Lake Winnipeg (Hooker).

S. caespitosa, L.

Indigenous. Perennial, caespitose; leaves glandular-pubescent, 3-5 cleft, the upper linear and entire, segments broadly linear, obtuse; flowering stems with a few scattered leaves, glandular 1-4 flowered; calyx-tube adherent to the ovary; petals white, obovate, 3-nerved, twice the length of the calyx.—*Hook. Fl. Bor.-Am. 1 p. 244.* On sandy places. Fortean Bay, Labrador (Butler). Arctic America from Greenland to Behring Strait. Vancouver Island (Macoun).

S. Aizoon, Jacq.

Indigenous. Moist rocks. Upper Falls on the River du Loup (Dr. Thomas). North shore of Lake Superior (Agassiz). Rocks four miles north of Michipi-

coten; also opposite Michipicoten Island, Lake Superior (Macoun). North shore of Lake Superior (Prof. Ellis).

S. stellaris, L.

Indigenous. *Leaves rosulate*, or a little scattered, obovate-cuneiform, almost sessile, dentate-serrate at the apex; scape corymbose at the summit, calyx free, reflexed; petals spreading, lanceolate, all attenuate into a claw.—*Pursh. Fl. 1 p. 310. Hook. Fl. Bor.-Am. 1 p. 250.* Canada (Pursh.) Labrador and Greenland (Torr. & Gray).

S. nivalis, L.

Indigenous. Perennial; leaves all radical, obovate or spatulate, attenuate into a petiole, unequally crenate-dentate; scape capitately or subcorymbosely several or many flowered, the half-adherent calyx erect, shorter than the oblong obtuse subunguiculate white petals; capsules purple, divergent.—*S. Watson in King's Explorations on the 40th parallel.* Canada (Pursh). Labrador, Melville Island, Arctic America and Greenland (Torrey & Gray).

S. rivularis, L.

Indigenous. The root usually granulate; plant glabrous or pubescent, stems weak, ascending 3-5-flowered; radical leaves somewhat reniform, crenately lobed, with the petioles dilated at the base; the cauline ones lanceolate, nearly entire; lobes of the calyx ovate, broad, as long as the tube or at length shorter; petals ovate, scarcely longer than the calyx; stigmas depressed-globose; capsule thick, much exceeding the calyx, crowned with the very short divergent styles; seeds minutely longitudinally rugose. Labrador, White Mountains and Rocky Mountains of Colorado. From Greenland to Behring Strait (Torrey & Gray). Cariboo Mountains, Vancouver Island (Macoun).

S. Virginiensis, Michx.

Indigenous. Exposed rocks. Cape Tourmente, Quebec (Brunet). Montreal, Kingston, Queenstown, Niagara Falls (Maclagan). River du Loup (Dr. Thomas). Common near London (Saunders). Top of the Mountain, near Hamilton (Logie). Brockville and Prescott, abundant (Billings). Rivers Moira and Trent, and the Rice Lake Plains; Pie and Michipicoten Islands, Lake Superior; New Portage, Dawson Route (Macoun). North-east coast of Lake Huron (Prof. Bell). Saskatchewan Plains (Bourgeau). Yale, British Columbia (Macoun).

S. Pennsylvanica, L.

Indigenous. Bogs. Canada and the Northern States (Torrey & Gray).

S. Sibirica, L.

Indigenous. Stem filiform, ascending, weak; radical leaves reniform, palmately 7-lobed, petiolate, a little hairy, the lobes ovate; those of the stem sessile; peduncles elongated, naked; segments of the calyx linear-ovate, striate, glabrous; petals cuneiform obovate; styles shorter than the ovary.—*Linn. Spec. (Ed. 2), p. 577. Sternb. reo. Saxifr. t. 25. Hook. & Arn. Bot. Beechey, p. 124.* Labrador and Newfoundland (Pursh.)

HEUCHERA, L. Alum-root.

H. villosa, Michx.

Indigenous. Rocks. Upper Canada (Douglas). Canada (Goldie). We suspect that this plant has been confounded with the *Tiarella cordifolia*.

H. Americana, L. Common Alum-root.

Indigenous. Rocky woodlands. Malden, Ontario. (Dr. Maclagan).

H. hispida, Pursh.

Indigenous. Rocky ground. Western end of Lake Shebandowan, within sixty miles of Lake Superior, and consequently in the valley of that lake. Westward from this point through the valleys of the Saskatchewan and Peace Rivers to the Rocky Mountains (Macoun).

MITELLA, Tourn. Mitre-wort. Bishop's Cap.

M. diphylla, L.

Indigenous. Hillsides in rich woods. Vicinity of Quebec and Cemetery of St. Charles (Brunet). River du Loup (Dr. Thomas). St. Valentin, Smith's Falls, Kingston, Chippawa and Malden (Maclagan). Common near Prescott (Billings). Common in Central Canada (Macoun). Common in Western Ontario (Logie, Ellis, Saunders, Gibson).

M. nuda, L.

Indigenous. Cedar swamps and moist woods in moss. Very common throughout Ontario and Quebec. New Brunswick (Mathews). River Rouge (D'Urban). Hillsides, Fortean Bay, Labrador (Butler). Manitoulin Islands (Dr. Bell). From Lake Superior, through the valleys of the Saskatchewan and Peace Rivers, to Quesnelle on the Fraser, in Upper British Columbia (Macoun).

TIARELLA, L. False Mitre-wort.

T. cordifolia, L.

Indigenous. Rich rocky woods. Very common throughout Ontario and Quebec. New Brunswick (Dr. Fowler).

CHRYSOSPLENIUM, Tourn. Golden Saxifrage.

C. Americanum, Schwein.

Indigenous. Cold wet places. Common throughout Ontario and Quebec. New Brunswick (Dr. Fowler).

CRASSULACEÆ.

PENTHORUM, Gronov. Ditch Stone-crop.

P. sedoides, L.

Indigenous. Open wet places. Lotbinière, Quebec (Brunet). River du Loup (Dr. Thomas). Everywhere (Maclagan). Common in Ontario, Hamilton, London, Owen Sound, Goderich, &c.

SEDUM, Tourn. Stone-crop.

S. acre, L. Mossy Stone-crop.

Introduced from Europe. Escaped to rocky banks and roadsides. Vicinity of Prescott and Brockville (Billings). New Brunswick (Dr. Fowler). On of a rocky hill at Picton Harbour, Prince Edward County (Macoun). Niag Falls (G. W. Clinton).

S. ternatum, Michx.

Indigenous. Rocky woods. Rocky banks of streams, Upper Canada (Torr. & Gray).

S. Telephium, L. Live-for-ever.

Introduced. *Borders of fences, banks, &c.* Escaped from cultivation in some places. Central Canada (Macoun). New Brunswick (Mathews).

S. Rhodiola, DC. Rose-Root.

Indigenous. Cliffs and crevices of rocks. Labrador (Brunet). Newfoundland (Torrey & Gray). Greenland to Behring Straits. Saskatchewan Plains (Bourgeau). Dunvegan, Peace River (Macoun).

HAMAMELACEÆ.

HAMAMELIS, L. Witch-Hazel.

H. Virginica, L.

Indigenous. *Damp woods.* New Brunswick (Dr. Fowler). Point Levi; Isle of Orleans (Brunet). Common near Prescott (Billings). Scarce in Central Canada (Macoun). Hamilton (Logie). London (Saunders). Kettle Point, Lake Huron (Gibson). Isle aux Noix, Wolfe Island, Chippawa and Malden (Maclagan). Toronto (Prof. Ellis).

HALORAGEÆ.

MYRIOPHYLLUM, Vaill. Water-milfoil.

M. spicatum, L.

Indigenous. Ponds, slow streams and margins of lakes. New Brunswick (Dr. Fowler). Lake Temiscouata, Montreal (Maclagan). St. Lawrence River, common (Billings). Bay of Quinté, Trent and Moira Rivers (Macoun). North shore of Lake Superior (Agassiz). Sandy Bay, Lake Huron (Dr. Bell). Georgian Bay, Lake Huron; Rat Creek, west of Portage Laprairie, in brackish lakes, to Edmonton on the Saskatchewan (Macoun). Great Bear Lake (Richardson). West coast of Newfoundland (Dr. Bell).

M. verticillatum, L.

Indigenous. In marshes along the Bay of Quinté (Macoun). Burlington Bay, Lake Ontario (Logie).

M. heterophyllum, L.

Indigenous. Lakes and rivers. River Trent, Heely Falls; North River above Round Lake; mouth of the Sydenham River, Owen Sound (Macoun). Niagara Falls (Maclagan). Vicinity of Hamilton (Logie).

M. ambiguum, Nutt. Var.

Indigenous. Ponds and ditches. New Brunswick (Dr. Fowler).

M. tenellum, Bigelow.

Indigenous. Borders of ponds and mouths of rivers. New Brunswick (Dr. Fowler). Saguenay River, Quebec (A. T. Drummond). Abundant at the mouth of the River Buck, Stanhope Township, Peterborough County, Ont. (Macoun). Newfoundland (La Pylaie).

PROSERPINACA, L. Mermaid-weed.

P. palustris, L.

Indigenous. Wet swamps. Island of Montreal (Maclagan). Banks of the Nation River, Eastern Ontario (Billings). Marshes along Lakes Isaac and Sky, Bruce Peninsula, Lake Huron; also Fishing Islands, Lake Huron (Macoun).

HIPPURIS, L. Mare's Tail.

H. vulgaris, L.

Indigenous. Ponds and springs. Lotbinière, Malbaie, Labrador (Brunet). New Brunswick (Dr. Fowler). Lake Temiscouata, Quebec (Maclagan). Banks of the St. Lawrence, Eastern Ontario (Billings). Scarce in Central Canada; abundant on the Sydenham River, Owen Sound; Pic and Current Rivers, Lake Superior; Fort Edmonton on the Saskatchewan (Macoun). Gore Bay and Vermont Harbour, Lake Huron (Dr. Bell). Labrador, Greenland, Sub-Arctic America (Torr. & Gray). Little Slave Lake, Lake Arthabasca, and throughout the north-west to the Fraser in British Columbia (Macoun).

ONAGRACEÆ.

CIRCAEA, Tourn. Enchanter's Nightshade.

C. Lutetiana, L.

Indigenous. Rich woods. Common throughout Ontario and Quebec. New Brunswick (Mathews). Island of Orleans (Dr. Thomas).

C. alpina, L.

Indigenous. Deep woods. Common throughout Ontario and Quebec. New Brunswick (Mathews). West coast of Newfoundland (Dr. Bell). Kaministiquia River, Dawson Route, Arthabasca River, Peace River and Rocky Mountains (Macoun).

GAURA, L.

G. biennis L.

Indigenous. Dry banks. Moffatt's Island, Montreal; Malden, Ontario (Maclagan).

EPILOBIUM, L. Willow-Herb.

E. angustifolium, L. Great Willow-Herb.

Indigenous. Low grounds and newly-cleared lands. Common throughout Ontario and Quebec. Common, New Brunswick (Mathews). West coast of Newfoundland; Islands in Lake Huron (Dr. Bell). Cariboo Bay, Labrador (Butler). From Lake Superior westward to Quesnelle on the Fraser in Upper British Columbia (Macoun).

E. angustifolium, L. Var. canescens.

Indigenous. Marmora Village, Hastings County; Owen Sound, very rare? Cariboo, British Columbia (Macoun).

E. alpinum, L. Var. majus, Wahl.

Indigenous. Rocky ground and mountainous regions. Canada (Mrs. Percival). Sault Montmorency, Quebec; South coast of Labrador (Brunet). Deer Mountains, near Little Slave Lake (Macoun). Rocky Mountains, lat. 52° N. (Bourgeau). Upper British Columbia (Macoun).

E. palustre, L. Var. lineare, Gray.

Indigenous. Bogs. Nicolet, Montreal, Niagara Falls (Maclagan). In swamps in Eastern Ontario (Billings). Marshes and swamps, common, Central Canada (Macoun). Hamilton (Logie). London (Saunders). East coast of Lake Huron (Gibson). North shore of Lake Superior (Agassiz). New Brunswick (Dr. Fowler). Swamps, Labrador (Butler). Dawson Route, Loon Portage; Edmonton on the Saskatchewan; the Arthabasca; Little Slave Lake (Macoun). Plains of the Saskatchewan (Bourgeau). Rocky Mountains, and west to the Fraser at Fort George (Macoun).

E. molle, Torrey.

Indigenous. Bogs. Sphagnous marshes, Saint Croix (Brunet). Nicolet (Maclagan). Cedar swamp at the foot of the Oak Hills, Sidney, Hastings *County (Macoun). Lake Medad, Ont. (Logie).*

E. tetragonum, L.

Indigenous. Rocky ground. Vicinity of Quebec and Tadoussac (Brunet). Canada (Hooker). Canada to lat. 64° (Torrey & Gray). Saskatchewan Plains (Bourgeau). On Peace River, through the Rocky Mountains to McLeod's Lake, and down the Fraser to Vancouver Island (Macoun).

E. coloratum, Muhl.

Indigenous. Wet places. Common throughout Ontario and Quebec. New Brunswick (Dr. Fowler). Kaministiquia River, Lake Superior; Fort Edmonton on the Saskatchewan; shore of Little Slave Lake; Dunvegan on the Peace River, and westward to Upper British Columbia (Macoun). Saskatchewan Plains (Bourgeau). Cockburn Islands and Bruce Mines, Lake Huron; west coast of Newfoundland (Dr. Bell).

E. paniculatum, Nutt.

Indigenous. Glabrous or glandular-pubescent above; stem erect, slender, terete, dichotomous above; leaves narrowly linear, obscurely serrulate, acute; attenuate at the base, mostly alternate and fascicled; flowers few, terminating the spreading filiform and almost leafless branches; calyx tube infundibuliform; petals obcordate, nearly twice exceeding the calyx lobes; capsules short, acute at each end, straight or little curved, erect or spreading. Stems 3'-3° high; flowers 1-4" long, light rose-colour; capsules ½-1' in length; sometimes glabrous throughout. On newly cleared land at Oxendon, Colpoy's Bay, Georgian Bay, Lake Huron, abundant (Macoun).

E. latifolium, L.

Indigenous. Stem ascending, often branched, 9'-18' high, glabrous or very minutely puberulent; leaves ovate or ovate-lanceolate, sessile, entire or nearly so, rather thick and rigid, 1'-1½' long, the veins not apparent; flowers axillary and terminal, on short pedicels; style somewhat erect, glabrous, shorter than the stamens. Amour Bay, south coast of Labrador (Butler). West coast of Labrador (Dr. Bell).

ŒNOTHERA, L. Evening Primrose.

Œ. biennis, L. Var. muricata, Gray.

Indigenous. Fields and waste places. Gravel bars around Lake Superior (Macoun). East coast of Lake Huron (*Gibson*). Vicinity of Hamilton (Logie). Montreal Island (Dr. Holmes). Gravel bars of the Manitoulin Islands, Lake Huron; west coast of Newfoundland (Dr. Bell). Dawson Route; Fort Edmonton on the Saskatchewan and Fort Assinaboine on the Arthabasca (Macoun). Saskatchewan Plains (Bourgeau).

Œ. biennis, L. Var. grandiflora, Gray.

Apparently introduced. Cultivated grounds and waste places. Common throughout Ontario and Quebec. New Brunswick (Mathews). Lake Superior (Prof. Bell). On sandy shores, east coast of Lake Superior (Macoun).

Œ. biennis, L. Var. parviflora, Gray.

Indigenous. Open places in woods. Frequent in Central Canada (Macoun).

Œ. fruticosa, L. Sundrops.

Indigenous. Open places. Island of Montreal (Mr. Goldie).

Œ. chrysantha, Michx.

Indigenous. Banks, &c. Vicinity of Quebec and at the Quarantine Station (Brunet). New Brunswick (*Mathews*). St. Helen's Island, Quebec; Chippawa, Ont. (Maclagan). Twenty miles up the Kaministiquia River, Lake Superior (Macoun). Niagara Falls (John Carey). Hudson's Bay (Michaux). Dawson Route, near Lake Shebandowan (*Macoun*).

Œ. pumila, L.

Indigenous. Dry fields. Common near Quebec (Brunet). Beven's Lake, River Rouge (D'Urban). New Brunswick (*Dr. Fowler*). Island of Orleans and Ancient Lorette (*Dr. Thomas*). Nicolet (Dr. Maclagan). Counties of Addington and Victoria, Central Canada (Macoun). North coast of Lake Superior (Prof. Bell). Vicinity of Hamilton (Logie). Island of Montreal (Dr. Holmes). Mississagui Island, Lake Huron (Dr. Bell).

LUDWIGIA, L. False Loosestrife.

L. palustris, Ell.

Indigenous. Ditches and dried beds of ponds. Conway's Creek, and elsewhere in swamps, common (Billings). Nicolet and Malden (Maclagan). Ditches and ponds abundant in Central Canada and at Owen Sound (Macoun). Very common at London (Saunders). Saskatchewan River (Torr. & Gray).

L. alternifolia, L.

Indigenous. Swamps, especially near the coast. In swamps, Canada (Torr. & Gray).

MELASTOMACEÆ.

RHEXIA, L. Deer-grass.

R. Virginica, L.

Indigenous. Sandy swamps very rare. Shores of Muskoka Lake.

LYTHRACEÆ.

LYTHRUM, L. Loosestrife.

L. alatum, Pursh.

Indigenous. Wet places. Malden (Maclagan).

L. Salicaria, L.

Indigenous. Wet meadows, Canada (Torr. & Gray). Moist meadows near the Quarantine Station, Quebec (Brunet).

NESÆA, Juss. Swamp Loosestrife.

N. verticillata, K.B.K.

Indigenous. Muddy margins of lakes, rivers and ponds. Bank of the St. Lawrence, near Brockville; banks of the Rideau, near Ottawa (Billings). Bay of Quinté, at Belleville; Wellington Beach, Lake Ontario; River Trent, and many lakes and streams in North Hastings; Cameron's Lake at Fenelon Falls, Peterboro' County (Macoun). Burlington Beach, near the Water Works, and in the "Old Desjardin Canal," Burlington Heights (Logie). Montreal, Chippawa and Malden (Maclagan).

CUCURBITACEÆ.

SICYOS, L. One-seeded Cucumber.

S. angulatus, L.

Doubtfully indigenous. River banks and weed yards, and running over fences. Near M. Ross's house, Montreal (Brunet). St. John's, Quebec (Maclagan). Waste heaps and around dwellings, Belleville (Macoun). Vicinity of Hamilton (Logie).

ECHINOCYSTIS, Torr. & Gray. Wild Balsam Apple.

E. lobata, Torr. & Gray.

A very doubtful native. Rich soil along rivers, and climbing over fences and bushes around dwellings. New Brunswick (Fowler). Saint Laurent and Lotbinière (Brunet). Cayuga (Maclagan). Belleville, Hastings County, and Seymour, Northumberland County; also at Fort Francis, Dawson Route (Macoun). From the Saskatchewan River (Torr. & Gray).

UMBELLIFERÆ.

HYDROCOTYLE, Tourn. Water Penny-wort.

H. Americana, L.

Indigenous. Damp grassy places along streams or in woods. New Brunswick (C. F. Mathews). Saint Croix, common; border of the River Blanche in Somerset (Brunet). Moist woods, common (Billings). Grassy damp places three miles east of Belleville; Seymour, Northumberland County; Crevices of wet rocks, Sydenham Falls, Owen Sound (Macoun). Ancaster (Logie). Hilton, Cockburn Island, Lake Huron (Dr. Bell).

SANICULA, Tourn. Black Snake-root.

S. Canadensis, L.

Indigenous. Rich low woods. Woods west of Belleville, rare (Macoun). Woods west of Hamilton (Logie). Rich woods, common, London (Saunders). Malden (Maclagan).

S. Marilandica, L.

Indigenous. Woods and copses common. Newfoundland (Torr. & Gray). New Brunswick (Fowler). Abundant in Quebec (Brunet, Thomas, D'Urban). Very common in Ontario (Billings, Macoun, Logie, Saunders and Gibson). Kaministiquia River and Dawson Route; Fort Edmonton on the Saskatchewan; Fort Assinaboine on the Arthabasca; and in woods west of Little Slave Lake (Macoun).

DAUCUS, Tourn. Carrot.

D. Carota, L.

Introduced. By roadsides, and spontaneous in old fields and gardens. New Brunswick (Fowler). Wastes around Grand Trunk Railway Gravel Pit at Prescott (Billings). Along the Grand Trunk Railway and in gardens, Belleville (Macoun). Found at Galt by Miss Crooks (Logie). Montreal (Maclagan). Owen Sound (Dr. Bell).

HERACLEUM, L. Cow-Parsnip.

H. lanatum, Michx.

Indigenous. Moist rich ground. Common throughout Ontario and Quebec. Labrador (Brunet). New Brunswick (Dr. Fowler). West coast of Newfoundland (Dr. Bell). Manitoulin Islands, Lake Huron (Dr. Bell). Very common on the Kaministiquia River and Thunder Bay, Lake Superior; near Lake of the Woods, Dawson Route; south-west branch of the Peace River, west of the Rocky Mountains (Macoun). Saskatchewan Plains (Bourgeau). Sitcha (Bougard). Vancouver Island (Macoun).

PASTINACA, Tourn. Parsnip.

P. sativa, L. Common Parsnip.

Introduced from Europe. Fields, waste places and roadsides. New Brunswick (Mathews). Quebec (Brunet). Common in Central Canada; Owen Sound; Fort Francis, Rainy River (Macoun). Common in Eastern Ontario (Billings). Niagara and Malden (Maclagan). County Huron, Ont. (Gibson).

ARCHEMORA, DC. Cowbane.

A. rigida, DC.

Indigenous. Sandy swamps. Malden, Ontario (Maclagan).

ARCHANGELICA, Hoffm.

A. officinalis, Hoffm.

Indigenous. In Labrador, according to Torrey & Gray. In waste places and along fences in Central Canada. Evidently introduced.

A. atropurpurea, Hoffm. The Great Angelica.

Indigenous. Low river banks. Common in Ontario and Quebec. West coast of Newfoundland (Dr. Bell). New Brunswick (Dr. Fowler). Isle of Orleans, St. Lambert, Lotbinière (Brunet). North shore of Lake Superior (Agassiz). Kaministiquia River, Lake Superior, and Michipicoten Island (Macoun). Ravines, south coast of Labrador (Butler).

A. Gmelini, DC.

Indigenous. Rocky ground. In Upper Canada, according to Pursh.

CONIOSELINUM, Fischer. Hemlock-Parsley.

C. Canadense, Torrey & Gray.

Indigenous. Swamps, &c. Lotbinière and Tadoussac (Brunet). New Brunswick (Dr. Fowler). Lake Temiscouata (Maclagan). Sea shore, River du Loup (Dr. Thomas). Mouth of the River St. Lawrence (Michaux). West coast of Newfoundland (Dr. Bell).

LIGUSTICUM, L. Lovage.

L. Scoticum, L. Scotch Lovage.

Indigenous. Salt marshes. River du Loup; Tadoussac (Brunet). Labrador, Caribou Bay (Butler). West coast of Newfoundland (Dr. Bell). New Brunswick (G. F. Mathews).

L. actaeifolium, Michx.

Indigenous.

THASPIUM, Nutt. Meadow-Parsnip.

T. barbinode, Nutt.

Indigenous. River banks. Rare, London (Saunders). Chippawa and Detroit River (Maclagan).

T. aureum, Nutt.

Indigenous. Dry hills and river banks. Common throughout Ontario and Quebec. Isle of Orleans (Brunet). New Brunswick (G. F. Mathews).

T. aureum, Nutt. Var. apterum, Gray.

Indigenous. Dry hills and river banks. Vicinity of Belleville (Macoun). Nuns' Island, Montreal (Dr. Holmes).

T. trifoliatum, Gray. Var. apterum, Gray.

Indigenous. Dry soil and banks of rivers. In Canada, according to Torrey & Gray. Fort Garry to Edmonton, and west by Little Slave Lake and Peace River to the Rocky Mountains (Macoun). Saskatchewan Plains (Bourgeau).

MONTHLY METEOROLOGICAL REGISTER, AT THE MAGNETICAL OBSERVATORY, TORONTO, ONTARIO—MARCH, 1877.

Latitude—43° 39′4 *North. Longitude*—5*h.* 17*m.* 33*s. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of Mean above Normal.	Tension of Vapour.				Humidity of Air.				Direction of Wind.				Velocity of the Wind.					Rain in Inches	Snow in Inches
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M.	2 P.M.	10 P.M.	MEAN		6 A.M.	2 P.M.	10 P.M.	M'N.	6 A.M.	2 P.M.	10 P.M.	M'N.	6 A.M.	2 P.M.	10 P.M.	Res'l-tant.	6 A.M.	2 P.M.	10 P.M.	Res'l-tant.	MEAN		
					°	°	°	°													°							
1	29.802	29.755	29.559	29.6927	24.5	39.2	34.4	33.38	+ 7.78	.101	.123	.155	.126	76	54	79	66	W	S	E	S 10 E	5.0	5.2	8.7	1.95	4.69	...	...
2	.164	28.816	.043	.0042	34.2	42.7	36.6	37.62	+11.82	.185	.242	.154	.193	94	88	71	84	E	S	W	S 17 W	13.5	16.0	21.0	3.44	13.46	.460	0.3
3	.390	29.384	.330	.3637	30.1	38.0	33.3	33.73	+ 7.72	.114	.186	.170	.156	68	81	89	79	W	S W	S W	S 56 W	8.4	14.0	1.4	6.02	10.95	...	0.9
4	.380	.590	.710	.6817	20.0	26.0	24 0	22.67	— 3.69	—	—	—	—	—	—	—	—	N W	W	S W	S 88 W	14.0	22.0	16.0	10.49	13.47	...	0.7
5	.703	.639	.758	.7093	10.4	26.1	13.8	17.10	— 9.42	.063	.083	.072	.076	92	58	89	82	N	W	N W	S 89 W	2.0	23.0	7.0	9.23	10.93	...	0.3
6	.829	.668	.393	.6147	3.8	22.1	29.7	19.86	— 6.92	.046	.083	.162	.101	89	70	97	86	N W	S W	S W	S 41 W	2.8	17.0	23.0	10.26	12.32	...	1.5
7	.609	.849	.762	.7518	18.5	21.8	20.0	20.12	— 6.88	.064	.068	.081	.071	64	56	74	64	N W	W	N E	N 13 W	22.2	3.8	6.8	3.50	12.08	...	0.3
8	.415	.194	28.886	.1305	26.5	30.1	31.9	28.62	+ 1.32	.141	.157	.180	.153	98	93	100	97	E	N	N E	N 53 E	18.5	10.0	5.9	10.83	12.63	.510	3.5
9	28.728	.103	29.603	.1587	20.0	20.7	14.5	17.55	—10.00	.093	.086	.079	.080	87	76	94	83	N W	W	W	N 64 W	15.5	23.0	12.2	15.51	17.39	.160	0.5
10	29.709	.827	.884	.8190	8.8	18.2	14.3	14.22	—13.65	.050	.068	.069	.061	78	68	80	72	W	S W	W	S 68 W	10.0	14.6	6.0	10.74	11.01	...	...
11	.910	.880	.884	.8918	12.0	31.6	31.0	25.33	— 2.82	—	—	—	—	—	—	—	—	W	S W	S W	S 60 W	8.2	9.3	2.6	5.96	6.13	...	0.2
12	.886	.798	.740	.8017	23.6	30.1	27.2	26.58	— 1.88	.119	.150	.118	.125	93	89	79	86	N E	E	N E	N 48 E	7.6	7.2	8.0	6.79	7.11	...	2.9
13	.838	.906	.780	.8160	19.4	27.9	27.9	25.10	— 3.67	.088	.103	.103	.099	83	66	66	71	N	S E	S E	N 71 E	5.5	7.8	11.0	6.23	8.98	...	0.1
14	.409	.241	.558	.4097	32.2	33.8	19.6	27.35	— 1.73	.162	.190	.079	.126	89	98	74	80	S E	W	N W	S 85 W	11.5	19.0	20.0	7.18	15.27	...	1.0
15	.618	.541	.574	.5763	18.2	25.0	21.0	21.12	— 8.30	.088	.083	.076	.083	89	61	66	74	W	W	W	W	7.6	16.0	9.0	12.43	12.73	...	...
16	.616	.528	.660	.6137	8.4	23.6	10.6	14.45	—15.30	.049	.078	.042	.060	78	61	58	69	N W	W	N W	N 54 W	4.0	8.2	18.5	7.16	8.90	...	s
17	.867	.944	.904	.9097	0.7	10.9	6.3	6.47	—23.62	.041	.047	.045	.044	92	65	78	77	N	N W	N W	N 7 W	12.8	5.4	7.0	5.87	6.75	...	s
18	.840	.790	.830	.8117	6.0	20.0	10.0	12.50	—17.91	—	—	—	—	—	—	—	—	N	S W	W	N 61 W	2.0	5.0	4.4	3.73	4.50	...	0.2
19	.757	.613	.701	.6860	4.0	22.3	12.6	13.82	—16.95	.045	.073	.068	.065	87	59	89	80	N	S E	S E	N 10 E	3.8	3.0	4.0	1.61	4.10	...	0.1
20	.808	.761	.554	.6847	7.8	26.1	27.5	21.67	— 9.46	.051	.096	.112	.089	85	68	74	75	W	S W	N E	S 17 W	3.4	11.5	10.8	2.89	7.11	...	s
21	.265	.350	.458	.3603	27.6	31.9	30.4	30.42	— 1.05	.143	.158	.146	.152	96	87	86	89	N E	W	S W	N 43 W	8.0	9.0	6.0	2.17	9.29	...	7.0
22	.541	.544	.480	.5227	30.8	36.9	32.9	33.77	+ 1.93	.166	.184	.168	.172	90	84	90	89	S W	S	E	S 18 W	6.0	12.0	5.6	5.62	7.83	...	...
23	.411	.546	.684	.5635	33.7	32.6	23.2	29.70	— 2.48	.163	.129	.083	.127	95	68	66	76	N E	N W	N W	N 27 W	0.7	13.5	13.0	9.54	10.12	...	...
24	.790	.876	.839	.8453	23.6	32.2	31.1	28.62	— 3.95	.105	.126	.153	.127	83	68	87	80	N W	E	E	N 39 E	9.0	9.5	16.0	7.18	10.92	...	...
25	.750	.610	.530	.6200	31.0	39.5	39.0	36.58	+ 3.64	—	—	—	—	—	—	—	—	E	N E	E	N 61 E	13.0	13.5	9.0	10.70	11.25	.020	...
26	.439	.329	.216	.3160	37.1	36.2	35.5	36.50	+ 3.20	.198	.201	.193	.200	89	94	93	92	N E	N E	N W	N 38 E	11.0	13.5	13.0	10.13	12.15	1.220	...
27	.200	.259	.354	.2738	33.3	33.3	30.8	31.76	— 1.93	.170	.153	.127	.142	89	80	74	79	N W	N W	N W	N 42 W	14.0	26.5	26.0	21.09	21.23	.040	0.2
28	.335	.300	.449	.3663	23.2	24.6	28.2	24.83	— 9.22	.089	.107	.100	.096	72	81	65	71	N W	N W	N W	N 41 W	35.0	43.0	26.0	34.07	34.21	...	s
29	.528	.605	.771	.6505	19.4	31.9	34.0	29.27	— 5.18	.073	.074	.080	.074	69	42	39	47	N W	N W	N W	N 40 W	30.0	36.5	23.5	30.23	30.31	...	...
30	.950	.650	.950	.9500	29.0	45.0	34.0	36.33	+ 1.51	—	—	—	—	—	—	—	—	N W	N W	W	N 36 W	13.0	11.5	1.2	8.90	9.56	...	...
31	.886	.795	.697	.7828	34.0	37.1	37.1	36.25	+ 1.07	.167	.156	.198	.176	87	70	89	82	E	N E	E	N 76 E	6.4	8.5	10.0	7.79	8.17	.040	0.2
	29.5926	29.5804	29.5935	29.5896	21.01	29.59	25.93	25.59	— 4.38	.107	.123	.116	.114	85	73	79	78	...	...	...	...	10.46	14.13	13.37	...	11.79	2.450	19.9

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR MARCH, 1877.

NOTE.—The monthly means of the Barometer and Temperature include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely, at 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer.....29.960 at 8 a.m. on 30th. } Monthly range
Lowest Barometer.....28.728 at 6 a.m. on 9th. } 1.232.

Self-registering Ther.
- Maximum temperature ..... 45°1 on 30th. } Monthly range
- Minimum temperature ..... —0°6 on 17th. } 45°7.
- Mean maximum temperature ..... 32°99. } Mean daily range
- Mean minimum temperature ..... 17°91. } 15°08.
- Greatest daily range.....29°3 from a.m. to p.m. of 6th.
- Least daily range.....—0°6 from a.m. to p.m. of 17th.

Warmest day.....2nd; mean temperature .....37°62 } Difference=31°15.
Coldest day.....17th; mean temperature ..... 6°47 }
Maximum Radiation
- Solar ..... 120°0 on 13th. } Monthly range
- Terrestrial ..... —8°0 on 6th. } 128°0.

Aurora observed on 9th.
Possible to see Aurora on 15 nights; impossible on 16 nights.
Raining on 7 days; depth, 2.450 inches; duration of fall, 53.1 hours.
Snowing on 21 days; depth, 19.9 inches; duration of fall, 90.7 hours.
Mean of cloudiness, 0.72.

WIND.

Resultant direction N. 49° W.; resultant velocity 5.26 miles.
Mean velocity 11.79 miles per hour.
Maximum velocity 43.0 miles, from 2 to 3 p.m. of 28th.
Most windy day 28th; mean velocity 34.21 miles per hour.
Least windy day 19th; mean velocity 4.10 miles per hour.
Most windy hour 2 p.m.; mean velocity 14.13 miles per hour.
Least windy hour 6 a.m.; mean velocity 10.46 miles per hour.

Solar halos on 1st, 5th, 7th, 10th, 13th, 19th, 20th and 21st.
Lunar halos on 27th and 28th.
Thunder on 2nd.
Wild geese on 27th.
Robins on 31st.

COMPARATIVE TABLE FOR MARCH.

YEAR.	TEMPERATURE. Mean.	Excess above average	Maximum.	Minimum.	Range.	RAIN. No. of days.	Inches.	SNOW. No. of days.	Inches.	WIND. Resultant. Direction.	Vel'y	Mean Velocity. Miles.
	°	°	°	°	°							
1849	33.5	+4.6	63.0	15.1	47.9	7	1.525	2	2.3	N 3 W	1.48	5.37
1850	29.8	+0.8	46.5	7.2	39.3	2	0.745	7	11.2	N 52 W	2.62	7.62
1851	32.4	+3.4	59.3	12.0	47.3	3	0.770	9	8.8	N 21 W	1.93	7.65
1852	27.7	—1.3	44.8	—7.4	52.2	8	3.080	12	19.5	N 8 W	0.71	5.81
1853	30.6	+1.6	56.3	0.0	56.3	6	1.080	8	7.1	N 58 W	2.60	5.96
1854	30.7	+1.7	55.1	7.4	47.7	9	2.425	3	2.8	N 53 W	3.39	8.03
1855	28.5	—0.5	49.4	—2.9	52.3	5	1.485	11	18.1	N 88 W	4.76	9.95
1856	23.1	—5.9	41.4	14.0	55.4	0	0.000	12	16.2	N 71 W	7.68	11.39
1857	27.8	—1.2	57.6	—5.5	63.1	4	0.335	15	11.3	N 63 W	6.63	10.84
1858	28.4	—0.6	55.4	—5.5	60.9	10	0.917	6	0.2	N 58 W	5.45	8.56
1859	36.3	+7.3	54.2	9.8	44.4	15	4.054	8	1.0	N 64 W	1.96	10.39
1860	34.5	+5.5	67.0	12.8	54.2	5	0.882	11	2.4	N 64 W	7.61	12.41
1861	26.9	—2.1	47.4	—5.2	52.6	8	2.125	14	7.1	N 54 W	4.33	10.56
1862	28.8	—0.2	43.2	8.0	35.2	8	2.560	11	18.5	N 12 W	2.50	9.38
1863	25.8	—3.2	42.2	—4.0	46.2	4	0.687	17	11.4	N 27 W	2.62	9.27
1864	29.1	+0.1	50.2	3.0	47.2	9	1.620	12	3.7	N 53 W	2.29	8.41
1865	33.6	+4.6	55.6	—3.5	59.1	10	3.050	12	18.9	N 61 W	2.16	8.80
1866	27.6	—1.4	45.8	7.5	38.3	8	1.915	18	7.2	N 73 W	6.84	11.51
1867	26.6	—2.4	46.8	3.0	43.8	6	0.617	14	33.4	N 34 W	2.12	8.52
1868	31.3	+2.3	59.0	—15.6	74.6	7	2.600	5	4.2	N 21 W	2.12	8.58
1869	23.1	—5.9	46.8	—5.4	52.2	3	0.985	9	15.0	N 53 W	2.86	8.02
1870	26.3	—2.7	44.0	5.2	38.8	2	0.755	18	62.4	N 18 E	4.73	10.13
1871	34.7	+5.7	58.5	17.0	41.5	8	2.782	12	13.0	N 31 W	2.59	8.31
1872	19.9	—9.1	46.4	—10.8	57.2	2	0.700	14	16.3	N 66 W	5.36	10.48
1873	26.6	—2.4	45.0	—6.0	51.0	5	1.755	15	25.2	N 61 W	5.91	11.47
1874	28.7	—0.3	57.0	5.5	51.5	10	1.390	10	2.6	N 65 W	7.47	13.24
1875	24.1	—4.9	51.5	—1.5	53.0	3	0.930	11	30.0	N 23 W	2.80	9.40
1876	26.0	—3.0	50.5	—2.9	53.4	6	1.250	14	44.1	N 29 W	3.43	12.04
1877	25.6	—3.4	45.1	—0.6	45.7	7	2.450	21	19.9	N 49 W	5.26	11.79
Res'lts to 1876.	29.05	...	51.07	0.83	50.24	6.05	1.560	10.38	13.90	N 51 W	3.43	9.24
Excess for '77.	3.46	...	5.97	1.43	4.54	+ 0.95	0.890	+ 10.62	+ 6.00	...	...	+ 2.55

MONTHLY METEOROLOGICAL REGISTER, AT THE MAGNETICAL OBSERVATORY, TORONTO, ONTARIO—APRIL, 1877.

Latitude—43° 39′ 4″ *North. Longitude*—5*h.* 17*m.* 33*s. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barometer cor. to 32°.				Temp. of the Air.				Excess of Mean above Normal	Tension of Vapour.				Humidity of Air.				Direction of Wind.				Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M.	2 P.M.	10 PM	MEAN		6 A.M.	2 P.M.	10 P.M.	M'N.	6 A.M.	2 P.M.	10 P.M.	M'N.	6 A.M.	2 P.M.	10 P.M.	Res'l-tant.	6 A.M.	2 P.M.	10 P.M.	Res'l-tant.	MEAN.		
					°	°	°	°																			
1	29.620	29.440	29.480	29.5117	36.0	51.0	48.0	45.33	+ 9.76	—	—	—	—	—	—	—	—	E	E	S W	N 85 E	6.5	9.8	10.0	5.65	9.12	.020	...
2	.731	.899	30.007	.8930	32.9	30.4	22.5	27.70	— 8.25	.132	.102	.097	.108	70	60	81	71	N W	N W	N W	N 37 W	16.0	16.0	14.0	13.87	14.79	...	...
3	30.033	.954	29.802	.9183	18.9	29.3	27.5	26.43	— 9.93	.079	.066	.108	.086	76	39	71	60	N E	E	E	N 65 E	8.5	10.7	10.2	7.41	10.07	...	...
4	29.650	.512	.394	.5007	30.8	41.6	39.8	37.67	+ 0.93	.149	.148	.188	.161	86	55	76	72	E	E	E	N 83 E	12.0	12.0	11.0	10.91	11.14	R	...
5	.291	.329	.430	.3557	36.6	39.8	34.4	37.23	+ 0.10	.196	.179	.166	.181	90	73	83	81	E	W	W	S 35 W	8.0	9.5	17.2	2.49	8.41	.250	...
6	.505	.537	.649	.5623	32.0	47.7	34.4	38.30	+ 0.80	.156	.132	.114	.135	86	39	58	60	W	N W	N W	N 64 W	12.5	17.0	4.9	13.40	13.53	...	...
7	.735	.752	.716	.7405	28.6	42.0	35.1	36.37	— 1.53	.102	.076	.107	.110	65	28	62	52	N	N	N	N 16 W	9.5	12.5	10.5	7.56	8.55	...	...
8	.710	.620	.620	.6467	30.0	40.0	39.0	36.33	— 1.95	—	—	—	—	—	—	—	—	N E	E	N E	N 66 E	8.0	12.0	12.0	8.65	9.15	...	...
9	.585	.654	.671	.6360	36.9	47.7	43.4	42.65	+ 3.95	.168	.186	.160	.160	72	56	54	59	E	E	N E	N 63 E	17.0	15.5	8.0	14.64	15.04	...	...
10	.724	.752	.700	.7288	39.1	51.9	45.2	46.37	+ 7.33	.138	.140	.147	.141	57	36	48	45	N E	S E	N	N 40 E	10.0	9.0	12.5	6.48	10.63	...	...
11	.722	.671	.679	.6916	41.6	55.3	42.0	47.67	+ 7.65	.139	.213	.197	.177	53	49	74	54	N	N	N W	N 16 W	12.0	15.0	10.5	13.41	13.75	...	...
12	.708	.760	.858	.7727	37.1	42.7	34.4	38.75	— 1.05	.143	.125	.135	.136	64	45	69	58	N	S E	N E	N 35 E	12.0	14.0	6.6	6.27	10.63	...	...
13	.859	.823	.742	.8025	35.1	44.6	38.0	40.15	— 0.03	.093	.085	.109	.100	48	28	47	40	N E	N E	N E	N 65 E	10.0	15.5	6.0	10.11	10.06	...	...
14	.740	.726	.694	.7270	35.8	52.1	43.4	44.72	+ 4.15	.138	.186	.159	.157	66	48	56	53	N	S	N W	N 10 E	6.8	9.0	7.4	0.61	7.21	...	...
15	.730	.690	.670	.6917	37.0	59.0	42.0	47.00	+ 6.06	—	—	—	—	—	—	—	—	N W	S	S E	S 45 W	7.0	11.0	1.6	0.79	5.79	...	...
16	.626	.560	.523	.5640	36.2	44.1	43.8	42.98	+ 1.67	.151	.205	.191	.186	71	71	67	67	N E	E	N E	N 78 E	4.4	6.5	7.0	3.64	4.75	.030	...
17	.589	.611	.607	.6068	42.7	57.5	47.7	50.43	+ 8.73	.188	.236	.233	.223	68	50	70	61	N	S	N E	N 51 E	8.0	9.2	4.2	2.01	6.29	...	...
18	.567	.519	.417	.4933	44.5	45.9	44.6	44.68	+ 2.63	.209	.209	.256	.236	71	67	98	80	N E	E	E	N 70 E	11.0	13.5	17.0	13.59	13.83	.335	...
19	.324	.155	.181	.2142	42.0	42.5	40.9	41.40	— 1.03	.243	.254	.220	.239	90	93	86	91	N E	N E	N	N 53 E	23.0	22.0	11.5	17.39	18.10	.800	...
20	.195	.315	.450	.3320	39.1	46.3	42.3	43.53	+ 0.72	.181	.195	.202	.189	75	62	75	67	N	N W	N W	N 1 W	14.0	15.0	11.3	13.03	14.02	...	...
21	.580	.704	.810	.7138	44.5	57.8	50.3	50.50	+ 7.32	.173	.151	.160	.150	58	32	44	42	N W	N W	N W	N 29 W	17.5	21.5	2.6	14.94	15.32	...	...
22	30.000	.960	.960	.9733	46.0	64.0	46.0	52.33	+ 9.27	—	—	—	—	—	—	—	—	N	S	N	N 55 W	10.0	6.5	3.0	1.78	5.93	...	...
23	29.958	.878	.749	.8572	40.5	66.5	45.9	52.73	+ 8.78	.208	.250	.209	.217	82	38	67	57	S	S	S E	S 5 W	0.5	8.2	2.2	3.16	4.08	...	...
24	.620	.633	.718	.6563	42.0	58.7	44.5	50.77	+ 6.47	.224	.263	.190	.209	84	53	65	66	S E	N W	N W	N 32 W	0.2	12.0	16.0	8.02	8.79	.020	...
25	.795	.750	.772	.7752	37.3	54.6	43.2	44.78	+ 0.12	.137	.213	.128	.157	61	50	45	52	N W	S W	N	N 50 W	13.5	11.0	10.0	5.32	8.06	...	...
26	.799	.742	.702	.7408	36.2	55.7	49.5	49.23	+ 4.23	.159	.178	.190	.192	74	40	53	56	N	S	N	S 66 W	4.5	8.0	6.5	0.42	5.55	...	...
27	.704	.649	.589	.6412	44.5	52.8	49.2	49.40	+ 3.98	.144	.177	.194	.166	49	44	54	46	N	E	N E	N 56 E	12.4	12.0	15.0	9.60	11.26	...	...
28	.469	.349	.205	.3268	42.7	42.7	43.0	42.80	— 3.37	.197	.234	.265	.232	71	85	96	85	E	E	N E	N 70 E	16.0	19.0	11.0	17.88	17.90	.796	...
29	.260	.370	.410	.3567	42.3	56.0	46.0	48.13	+ 2.01	—	—	—	—	—	—	—	—	S	S W	S W	S 35 W	3.8	14.0	7.5	6.05	6.90	.020	...
30	.469	.469	.513	.4807	43.0	43.0	40.3	41.93	— 4.55	.219	.201	.190	.198	79	72	75	74	S W	S W	S W	S 42 W	7.0	9.0	9.0	7.31	7.71	R	...
	29.6433	29.6238	29.6239	29.6308	37.72	48.77	41.54	43.26	+ 2.17	.162	.176	.173	.170	71	52	66	62	.....	.....	.....	.....	10.05	12.53	9.21	.....	10.25	2.271	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR APRIL, 1877.

NOTE.—The monthly means of the Barometer and Temperature include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely, at 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M. and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer.....30,058 at 8 a.m. on 3rd } Monthly range=
Lowest Barometer .....29.155 at 2 p.m. on 19th } 0.903.

Self-registering Ther.
- Maximum temperature .....67°2 on 23rd } Monthly range=
- Minimum temperature .....18°7 on 3rd } 48°5
- Mean maximum temperature .....51°83 } Mean daily range=
- Mean minimum temperature .....35°15 } 16°68
- Greatest daily range.....28°2 from a.m. to p.m. of 23rd.
- Least daily range ..... 4°7 from a.m. to p.m. of 18th.

Warmest day ..... 22nd; mean temperature 52°83 } Difference=26°40.
Coldest day ..... 3rd; mean temperature 26°43 }

Maximum { Solar .....123°0 on 23rd } Monthly range=
Radiation { Terrestrial..... 11°5 on 3rd } 111°5.

Aurora observed on 2 nights, viz., 7th and 14th

Possible to see Aurora on 19 nights; impossible on 11 nights.

Raining on 9 days; depth, 2.271 inches; duration of fall, 54.3 hours.

Mean of Cloudiness, 0.45.

WIND.

Resultant direction, N. 28° E.; Resultant Velocity, 4.37 miles.

Mean Velocity, 10.25 miles per hour.

Maximum Velocity, 26.0 miles, from 9 to 10 a.m. of 21st.

Most Windy day, 19th; Mean Velocity, 18.10 miles per hour.

Least Windy day, 26th; Mean Velocity, 5.55 miles per hour.

Most Windy hour, 11 a.m.; Mean Velocity, 12.85 miles per hour.

Least Windy hour, 9 p.m.; Mean Velocity, 8.13 miles per hour.

Solar halos on 3rd, 4th, and 27th.

Fog on 16th and 29th.

Thunder on 24th and 28th. Lightning on 28th.

Butterflies seen on 12th.

Frogs croaking, 21st.

Swallows seen on 30th.

COMPARATIVE TABLE FOR APRIL.

YEAR.	TEMPERATURE. Mean.	Excess above Average.	Maximum.	Minimum.	Range.	RAIN. No. of days.	Inches.	SNOW. No. of days.	Inches	WIND. Resultant. Direction.	Velocity.	Mean Velocity.
	°	°	°	°	°							
1849	39.0	— 1.6	72.0	15.5	56.5	10	2.655	2	1.7	N 43 W	3.14	7.50
1850	37.9	— 2.7	65.7	18.0	47.7	7	1.720	2	1.1	N 50 E	1.12	7.64
1851	41.3	+ 0.7	59.3	25.8	33.5	11	2.295	3	1.2	N 14 E	2.52	8.07
1852	38.2	— 2.4	53.8	20.0	33.8	6	1.990	4	9.4	N 23 E	2.44	6.68
1853	41.9	+ 1.3	65.7	25.0	40.7	10	2.625	1	1.0	N 12 W	1.95	5.20
1854	41.0	+ 0.4	64.5	20.2	44.3	12	2.685	4	2.7	N 50 E	2.57	6.81
1855	42.4	+ 1.8	69.4	10.7	58.7	8	2.030	3	1.6	N 36 W	3.99	7.57
1856	42.3	+ 1.7	72.2	14.2	58.0	13	2.780	3	0.1	N 29 E	1.64	6.05
1857	35.3	— 5.3	52.0	5.9	46.1	10	1.755	4	12.9	N 60 W	4.15	10.24
1858	41.6	+ 0.9	65.2	21.8	43.4	13	1.642	2	0.1	N 14 W	1.64	9.57
1859	39.5	— 1.1	64.8	22.6	42.2	9	2.527	8	1.2	N 36 W	2.33	10.79
1860	39.5	— 1.1	61.8	19.5	42.3	11	1.282	5	0.3	N 37 W	4.10	10.39
1861	42.0	+ 1.4	67.0	23.8	43.2	12	1.619	4	6.9	N 37 E	2.31	8.90
1862	39.6	— 1.0	68.0	14.5	53.5	10	2.235	4	0.2	N 50 E	2.48	9.77
1863	42.0	+ 1.4	69.0	8.6	60.4	8	2.210	4	1.6	N 14 E	3.76	9.20
1864	40.9	+ 0.3	59.4	28.1	31.3	16	3.633	3	3.5	N 41 E	3.39	7.77
1865	43.1	+ 2.5	62.5	23.0	39.5	17	3.972	6	2.0	N 84 W	2.11	8.39
1866	43.9	+ 3.3	71.0	28.5	42.5	7	1.675	2	Insp.	N 42 W	3.34	7.95
1867	39.5	— 1.1	65.5	25.4	40.1	12	2.147	5	7.2	N 51 W	2.68	7.89
1868	38.0	— 2.6	64.0	9.2	54.8	7	0.990	10	5.3	N 63 W	2.43	9.24
1869	40.1	— 0.5	72.2	16.6	55.6	9	2.065	6	0.5	N 59 W	4.03	8.91
1870	44.6	+ 4.0	67.0	29.6	37.4	9	2.145	2	0.1	N 40 E	3.55	7.03
1871	43.0	+ 2.4	72.8	26.4	46.4	17	3.318	2	1.3	N 48 W	1.86	8.85
1872	40.5	— 0.1	70.0	22.7	47.3	9	0.910	5	0.7	N 68 W	3.84	9.12
1873	38.6	— 2.0	61.2	24.4	36.8	13	3.975	3	Insp.	N 18 E	2.89	9.05
1874	34.2	— 6.4	60.8	9.5	51.3	4	1.240	7	11.0	N 39 W	4.09	9.64
1875	36.4	— 4.2	62.2	10.0	52.2	10	1.230	8	2.7	N 37 W	3.71	10.16
1876	38.2	— 2.4	57.2	17.0	40.2	3	1.805	3	0.3	N 69 W	4.11	9.89
1877	43.3	+ 2.7	67.2	18.7	48.5	19	2.271	0	0.0	N 28 E	4.37	10.25
Results to 1876.	40.63	.....	64.86	19.16	45.70	9.97	2.411	3.84	2.44	N 24 W	2.21	8.33
Excess for 1877	+ 2.63	.....	+ 2.34	— 0.46	+ 2.80	0.97	0.140	3.84	2.44	...	...	+ 1.87

MONTHLY METEOROLOGICAL REGISTER, AT THE MAGNETICAL OBSERVATORY, TORONTO, ONTARIO—MAY, 1877.

Latitude—43° 39′4 *North.* *Longitude*—5h. 17m. 83s. *West.* *Elevation above Lake Ontario, 108 feet.*

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of Mean above aver'ge	Tension of Vapour.				Humidity of Air.				Direction of Wind.				Velocity of Wind.				Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M.	2 P.M.	10 PM	MEAN		6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.	M'N.	6 A.M.	2 P.M.	10 P.M.	Res'l-tant.	6 A.M.	2 P.M.	10 P.M	Res'l-tant.	MEAN		
	°				°	°	°		°																		
1	29.502	29.483	29.580	29.5227	38.0	42.9	35.1	38.68	— 8.27	.186	.199	.142	.168	81	71	68	71	W	S W	N W	N 73° W	3.5	5.6	5.2	5.33	6.92	R	...
2	.610	.599	.618	.6102	33.7	45.6	35.8	39.43	— 7.75	.153	.142	.148	.136	78	44	70	57	N W	N W	N W	N 48 W	13.2	20.0	5.0	12.38	12.61	...	...
3	.558	.382	.355	.4232	36.9	56.4	47.2	46.80	— 0.75	.134	.111	.165	.149	60	24	50	49	W	W	N W	N 78 W	3.0	20.0	13.0	8.54	10.43	R	...
4	.433	.447	.549	.4865	36.2	53.1	37.1	42.72	— 5.18	.176	.115	.139	.141	82	29	62	65	W	N W	N	N 52 W	9.5	13.8	2.0	7.89	9.07	.005	...
5	.631	.675	.631	.6497	30.5	49.2	44.1	45.18	— 3.08	.127	.160	.141	.156	55	47	49	51	N E	E	N E	N 71 E	5.8	13.0	7.5	7.10	8.78	...	...
6	.660	.650	.645	.6550	42.0	57.0	40.0	47.50	— 1.12	—	—	—	—	—	—	—	—	N E	S E	W	N 83 E	8.0	10.5	1.5	4.21	7.44	...	...
7	.647	.556	.533	.5710	43.0	54.4	43.4	48.17	— 0.82	.130	.143	.150	.143	46	32	54	43	N E	S E	N E	N 88 E	4.8	11.0	8.0	6.67	8.08	...	...
8	.531	.506	.603	.5122	42.0	53.9	48.1	49.18	— 0.15	.197	.222	.228	.212	73	53	67	61	N E	S E	N W	N 60 E	7.8	12.0	12.0	4.90	8.87	...	...
9	.545	.537	.597	.5623	43.0	47.7	46.3	46.03	— 2.75	.201	.204	.263	.228	72	61	83	71	N	S	N W	N 65 E	8.0	6.4	3.8	2.50	6.25	.005	...
10	.645	.700	.788	.7195	44.5	46.3	44.1	46.00	— 4.05	.218	.218	.224	.220	74	69	77	71	N	S E	S E	N 36 E	13.0	4.8	2.6	2.28	6.67	...	...
11	.873	.893	.946	.9102	43.0	52.4	47.0	49.22	+ 1.18	.229	.247	.232	.238	82	62	72	68	S E	S	S W	S 2 E	0.5	6.0	3.0	2.69	3.13	...	...
12	.990	.964	.945	.9668	44.1	61.0	46.6	52.28	+ 1.57	.242	.263	.205	.230	84	48	64	60	N W	S	W	S 39 W	2.2	9.0	3.0	3.22	4.75	...	...
13	.990	.940	.920	.9467	42.0	64.0	53.0	55.17	+ 4.09	—	—	—	—	—	—	—	—	N	S	N W	S 22 W	1.6	6.0	6.4	1.14	4.62	...	...
14	.980	.914	.867	.9102	44.5	68.6	57.1	58.48	+ 7.05	.200	.233	.231	.224	68	33	49	47	N	S	N	S 48 W	0.8	8.0	5.6	2.25	6.54	...	...
15	.855	.776	.666	.7602	49.2	65.4	52.1	57.62	+ 5.83	.209	.325	.373	.317	57	52	96	67	N W	N W	S	S 86 W	2.0	9.0	3.0	2.07	4.14	.080	...
16	.621	.490	.518	.5302	51.0	69.7	61.1	60.63	+ 8.40	.366	.544	.491	.460	98	75	91	87	N W	S	W	S 47 W	1.0	8.0	1.5	4.04	5.90	R	...
17	.563	.562	.546	.5540	57.8	62.2	57.5	59.72	+ 7.22	.426	.544	.441	.471	89	97	93	91	S W	S	S E	S 41 W	2.0	2.7	1.6	1.99	2.42	.488	...
18	.544	.553	.651	.5857	57.8	81.5	66.1	69.65	+16.83	.437	.489	.412	.433	91	45	64	63	S	N W	N W	N 82 W	3.8	28.0	7.5	10.09	11.21	...	...
19	.694	.641	.587	.6330	63.2	72.3	62.7	67.13	+13.97	.413	.475	.470	.461	70	59	83	70	N W	S W	N W	N 81 W	5.8	5.5	2.6	2.30	4.72	...	...
20	.550	.480	.420	.4750	69.0	71.0	62.0	64.00	+10.49	—	—	—	—	—	—	—	—	N E	E	N E	N 82 E	0.8	7.5	5.6	4.31	5.40	...	...
21	.844	.263	.268	.2798	57.1	69.5	55.9	59.45	+ 5.58	.435	.526	.432	.444	93	73	96	87	N E	S E	N E	N 77 E	3.6	7.0	3.6	4.23	5.09	.050	...
22	.199	.309	.462	.3340	53.0	56.8	54.6	54.25	+ 0.05	.383	.356	.233	.324	95	77	54	76	S	N	N W	N 2 E	3.4	10.2	12.0	5.02	7.38	.610	...
23	.591	.532	.603	.5757	44.1	49.9	39.8	43.58	—10.97	.141	.139	.179	.161	48	39	73	58	N	N W	N W	N 32 W	13.0	26.0	11.0	16.32	16.60	...	...
24	.612	.641	.663	.6457	40.5	49.9	41.8	44.85	—10.05	.187	.205	.214	.206	74	56	81	69	N W	N W	W	N 35 W	21.0	20.0	2.4	15.63	15.90	...	...
25	.668	.648	.694	.6723	46.5	54.4	54.0	52.82	— 2.42	.255	.267	.241	.254	81	63	57	64	N W	N W	N W	N 28 W	8.5	6.5	14.5	11.09	11.17	.110	...
26	.709	.698	.731	.7108	52.1	65.8	59.6	60.00	+ 4.43	.256	.285	.252	.249	66	45	49	49	N	N W	N	N 24 W	10.0	10.5	11.5	10.01	10.06	...	...
27	.760	.800	.820	.8067	58.0	68.0	54.0	59.83	+ 3.94	—	—	—	—	—	—	—	—	N	S E	S	S 71 E	2.3	5.5	3.0	0.50	5.45	...	...
28	.895	.860	.826	.8603	51.7	69.7	60.7	62.08	+ 5.87	.323	.315	.310	.302	85	44	58	56	S	S	W	S 20 W	0.5	10.0	4.0	3.93	5.27	...	...
29	.867	.805	.710	.7895	54.2	72.3	54.2	61.42	+ 4.87	.335	.342	.357	.347	80	43	84	66	W	S E	S E	S 1 E	1.2	7.8	1.8	2.68	4.22	...	...
30	.719	.636	.592	.6405	54.4	72.6	62.2	63.63	+ 6.77	.339	.442	.379	.376	79	55	67	64	E	S	W	S 3 E	1.6	7.3	3.5	3.25	4.17	...	...
31	.643	.648	.654	.6537	58.2	78.0	59.6	66.08	+ 8.92	.360	.468	.401	.398	74	48	78	64	W	S E	S W	S 2 W	2.2	8.5	2.0	2.91	3.87	...	...
	29.6592	29.6319	29.6415	29.6438	47.67	60.71	51.06	53.94	+ 1.85	.262	.296	.276	.276	75	53	70	64					5.31	10.52	5.47	...	7.29	1.348	...

NOTE.—The monthly means of the Barometer and Temperature include Sunday observations The daily means, excepting those that relate to the wind, are derived from six observations daily, namely, at 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer.....30.010 at 8 a.m. on 12th. } Monthly range
Lowest Barometer.....29.196 at 8 a.m. on 22nd. } 0.814.

Self-registering Ther.
- Maximum temperature.....83.9 on 18th. } Monthly range
- Minimum temperature.....29.7 on 5th. } 54°2.
- Mean maximum temperature.....63.55 } Mean Daily range
- Mean minimum temperature.....43.21 } 20°34.
- Greatest daily range .....31.4 from a.m. to p.m. on 18th.
- Least daily range .....12.0 from a.m. to p.m. on 10th.

Warmest day .....18th; mean temperature.....69.65 } Difference=31°07.
Coldest day ..... 1st; mean temperature.....38.58 }

Maximum Radiation { Solar .....134.5 on 18th. } Monthly range 116 5
Terrestrial .....—18.0 on 2nd. }

Aurora observed on 3 nights, viz., 2nd, 4th, and 28th.
Possible to see Aurora on 21 nights; impossible on 10 nights.
Raining on 10 days; depth, 1.348 inches; duration of fall, 24.5 hours.
Mean of cloudiness, 0.50.

WIND.

Resultant direction, N. 40° W.; resultant velocity, 2.26 miles.
Mean velocity, 7.29 miles per hour.
Maximum velocity, 28.0 miles per hour, from 2 to 3 p.m. of 18th.
Most windy day, 23rd; mean velocity, 16.60 miles per hour.
Least windy day, 17th; mean velocity, 2.42 miles per hour.
Most windy hour, noon; mean velocity, 10.95 miles per hour.
Least windy hour, 9 p.m.; mean velocity, 4.71 miles per hour.

Hoar frost on 2nd, 3rd, 4th, 5th, and 7th. Thin ice on 23rd and 24th.
Solar halos on 8th, 11th, 15th, 18th, 19th, and 28th. Lunar halo on 19th.
Dew on 12th, 13th, 15th, 16th, and 18th. Fog on 16th and 17th.
Lightning on 17th. Thunder on 17th and 21st. Rainbow on 22nd.
1st May, first trip City of Toronto; 5th, maples in flower; 15th, plum trees in flower; 16th, Baltimore birds and humming birds.

COMPARATIVE TABLE FOR MAY.

YEAR.	TEMPERATURE. Mean.	Excess above Average.	Maximum.	Minimum.	Range.	RAIN. No. of days.	RAIN. Inches.	SNOW. No. of days.	SNOW. Inches.	WIND. Resultant. Direction.	Resultant. Velocity.	Mean Velocity.
	°		°	°	°					°		
1849	48.0	— 3.7	72.2	27.9	44.3	16	5.118	0	0.0	N 51 E	1.97	5.33
1850	47.6	— 4.1	77.8	27.5	50.3	7	0.545	1	s	N 64 W	2.05	6.32
1851	51.3	— 0.4	73.3	28.0	45.3	12	2.950	1	0.5	N 32 W	1.59	6.34
1852	51.4	— 0.3	73.3	32.0	41.3	7	1.125	1	s	N 2 W	0.99	4.00
1853	50.9	— 0.8	78.4	32.2	46.2	17	4.420	1	s	E	0.83	5.16
1854	52.2	+ 0.5	71.4	25.2	46.2	11	4.630	0	0.0	N 1 W	0.40	5.38
1855	53.1	+ 1.4	77.5	33.0	44.5	6	2.568	2	0.9	N 4 E	2.76	5.93
1856	50.5	— 1.2	82.2	31.2	51.0	14	4.580	1	s	N 23 W	3.99	9.81
1857	48.9	— 2.8	74.8	26.0	48.8	15	4.145	1	s	N 42 E	1.14	8.13
1858	48.9	— 2.8	69.8	31.0	38.8	17	6.367	0	0	N 72 E	3.33	9.30
1859	55.2	+ 3.5	79.6	39.5	40.1	11	3.410	0	0	N 26 E	1.59	5.70
1860	55.6	+ 3.8	74.5	32.5	42.0	16	1.815	0	0	N 47 W	2.66	7.17
1861	47.5	— 4.2	73.0	28.0	45.0	12	3.380	1	0.5	N 52 W	3.60	9.17
1862	52.2	+ 0.5	78.5	32.4	46.1	8	1.427	0	0.0	N 56 W	2.80	7.87
1863	54.3	+ 2.6	79.0	36.4	42.6	14	3.363	1	0.1	N 56 E	0.41	5.89
1864	54.8	+ 3.1	79.0	32.2	46.8	18	4.070	0	0.0	N 7 W	1.86	5.64
1865	52.3	+ 0.6	79.0	30.0	49.0	11	4.005	0	0.0	N 3 W	1.65	5.48
1866	48.3	— 3.4	73.4	33.4	40.0	13	2.820	0	0.0	N 46 W	4.49	9.26
1867	46.5	— 5.2	65.0	24.6	40.4	18	3.220	1	s	N 51 W	3.55	8.40
1868	51.8	+ 0.1	73.0	33.2	39.8	16	7.670	0	0.0	N 38 E	3.16	6.87
1869	50.8	— 0.9	74.2	31.4	42.8	16	2.805	1	s	N 20 W	2.38	6.55
1870	56.3	+ 4.6	81.2	38.8	42.4	10	1.150	0	0.0	N 23 E	1.09	5.48
1871	54.2	+ 2.5	85.0	32.4	52.6	7	2.302	0	0.0	N 23 W	2.53	7.70
1872	51.9	+ 0.2	78.8	32.0	46.8	14	1.934	0	0.0	N 52 W	2.25	6.49
1873	51.9	+ 0.2	76.4	30.0	46.4	13	2.205	0	0.0	N 26 E	2.69	8.58
1874	52.6	+ 0.8	86.0	25.3	60.7	8	1.492	0	0.0	N 49 W	2.64	8.45
1875	52.3	+ 0.6	79.2	27.0	52.2	14	2.980	2	3.1	N 46 W	3.84	10.07
1876	51.5	— 0.2	81.9	30.4	51.5	13	3.230	0	0.0	N 22 W	1.41	8.36
1877	53.9	— 2.2	85.9	29.7	54.2	10	1.348	0	0.0	N 40 W	2.26	7.29
Results to 1876	51.66	.....	76.69	30.34	45.85	11.95	3.134	0.37	0.15	N 17 W	1.60	7.04
Excess for 1877	+ 2.26	.....	+ 7.21	— 1.14	+ 8.35	— 1.95	— 1.786	— 0.37	— 0.15	...	...	+ 0.25

PROSPECTUS

OF THE

ENCYCLOPÆDIA BRITANNICA,

NINTH EDITION.

Edited by THOMAS SPENCER BAYNES, LL.D., Professor of Logic, Rhetoric, and Metaphysics, in the University of St. Andrews.

IN submitting to the Public the PROSPECTUS of a New Edition of the ENCYCLOPÆDIA BRITANNICA, it is almost needless to explain that during the interval which has elapsed since the publication of the Eighth Edition, great advances have been made in every department of knowledge, and particularly in the Arts and Sciences. It has accordingly been found necessary to adopt a scheme of very extensive alteration in the preparation of the NINTH EDITION, amounting virtually to a reconstruction of the entire work. Thus, while the general character of the ENCYCLOPÆDIA will remain substantially unchanged, the whole of the matter retained from the last Edition will be subjected to thorough revision, and the necessary additions (estimated at considerably more than half the whole work) provided for from the best sources. The utmost care will be taken in selecting headings and deciding on methods of treatment, so as to embody the greatest amount of general information in the most accessible form. The more important topics will be dealt with systematically and at length, and particular attention will be given to all subjects of general and popular interest. The object aimed at is the production of a work which shall possess the highest character and value as a Book of Reference adapted in all respects to the circumstances and requirements of the time.

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It is now upwards of a century since the ENCYCLOPÆDIA BRITANNICA made its first appearance. The FIRST Edition, in Three volumes quarto, published in 1771, was little more than a Dictionary of Arts and Sciences; the SECOND (1778-1783), in Ten volumes, introduced the branches of Biography and History. The THIRD Edition (1797) extended to Eighteen volumes, to which a supplement of Two volumes was added. The FOURTH (1810), in Twenty volumes, was reproduced in a Fifth and Sixth with little alteration; and a very important addition was made, between the years 1815 and 1824, in a Supplement of Six volumes. The two subsequent Editions, the SEVENTH (1830-1842) and the EIGHTH (1852-1860), each in Twenty-one volumes, were in every respect greatly superior to their predecessors, and adequately supplied the demand for general information at the time of their publication.

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Volumes I. to VI. are now ready.

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