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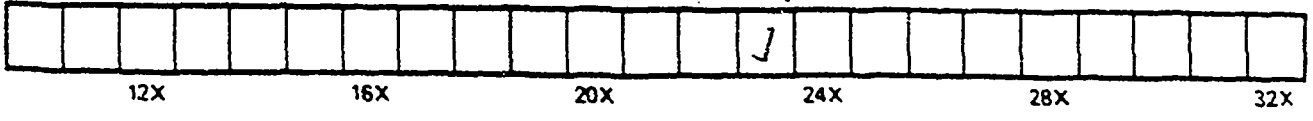

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THE CANADIAN JOURNAL.

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BRAIN-WEIGHT AND SIZE IN RELATION TO RELATIVE CAPACITY OF RACES.

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

Read before the American Association for the Advancement of Science, at Buffalo, N.Y. 25th August, 1876.

Consistently with the recognition of the brain as the organ of intellectual activity, it seems not unnatural to assume for man, as the rational animal, a very distinctive cerebral development. One of the most distinguished of living naturalists, Professor Owen, has even made this organ the basis of a system of classification, by means of which he separates man into a sub-class distinct from all other mammalia. But while a comparison between man and the anthropoid apes, as the animals most nearly approximating to him in physical structure, lends confirmation to the idea not only that a well developed brain is essential to natural activity, but that there is a close relation between the development of the brain and the manifestation of intellectual power: the distinctive features in the human brain, as compared with those of the anthropomorpha, prove to be greatly less than had been assumed under imperfect knowledge. The substantial difference is in volume. "No one, I presume," says Darwin, "doubts that the large size of the brain in man, relatively to his body, in comparison to that of the gorilla or orang, is closely connected with his higher mental powers;" * and it might not unfairly be reasoned from analogy, that the same test distinguishes the intellectual

* "The Descent of Man," Part I., chap. iv.

man from the stolid, and the civilised man from the savage. A careful study of the subject, however, shows some remarkable deviations from such a scale of progression. In this Mr. Darwin would recognize an analogy to greatly more ample proofs of inequality between the organic source of power and the manifestations of mental energy; as, for example, in the ant, with its cerebral ganglia not so large as the quarter of a small pin's head, displaying instincts and apparent affections of wonderful intensity and compass. Viewed in this aspect, "the brain of an ant is one of the most marvellous atoms of matter in the world, perhaps more marvellous than the brain of man." Here, however, we look on elements of contrast rather than analogy; and seek in vain in this direction for any appreciable test of the soundness of the popular belief in the size of the brain as a measure of intellectual power. It is otherwise when we turn to the anthropomorpha. There, alike in the scientific and in the popular creed, very special and exceptional affinities to man are admitted; and the more careful study of their anatomical structure tends to increase the recognized points of analogy.

Mr. Lockhart Clarke, in a contribution to Dr. Maudsley's work on the Physiology and Pathology of Mind, gives a minute description of the concentric layers of nervous substance which combine to form the convolutions of the human brain, and of the forms and disposition of the various nerve-cells of which its vesicular structure consists. Comparing the human brain with those of other animals, he says: "Between the cells of the convolutions in man and those of the ape tribe I could not perceive any difference whatever; but they certainly differ in some respects from those of the larger mammalia—from those, for instance, of the ox, sheep, or cat."* Apart from the difference in volume (55 to 115 cub. in.), the only distinctive features, according to Professor Huxley, between the brain of the anthropomorpha and that of man, are "the filling up of the occipito-temporal fissure; the greater complexity and less symmetry of the other sulci and gyri; the less excavation of the orbital face of the frontal lobe; and the larger size of the cerebral hemispheres, as compared with the cerebellum and the cerebral nerves."

The brain of the orang is the one which seems most nearly to approximate to that of man. In volume it is about twenty-six or twenty-seven cubic inches; or about half the minimum size of a

* "Insanity and its Treatment," by G. F. Blandford, M.D., p. 10.

normal human brain. The frontal height is greater than in that of other anthropomorpha; the frontal lobe is in all respects larger as compared with the occipital lobe; and certain folds of brain-substance, styled "bridging convulsions," which in the human brain are interposed between the parietal and occipital lobes, also occur, though greatly reduced, in the brain of the orang; while they appear to be wholly wanting in the chimpanzee, the gibbon, and other apes which superficially present a greater resemblance to man. Referring to the convolutions of the central cerebral lobe, Huschke says: "With their formation in the ape, the brain enters the last stage of development until it arrives at its perfection in man;" and the higher class of brains may be arranged between the extremes of poorly and richly convoluted examples.

But it must not be overlooked that, apart from structural differences, relative, and not absolute mass and weight of brain has to be considered, otherwise the elephant and the whale would take the foremost place. "The brain of the porpoise," Professor Huxley remarks,* "is quite wonderful for its mass, and for the development of the cerebral convolutions;" but it is the centre of a nervous system of corresponding capacity, while as compared with the size of the animal, the brain is not relatively large. Vogt states the weight of the human body to be to the brain, on an average, as 36 to 1; whereas in the most intelligent animals the difference is rarely less than 100 to 1.

Assuming the existence of some uniform relation between the size of the brain and the development of the intellectual faculties, along with whatever is recognized as most closely analogous to them in the lower animals, it might be anticipated that we should find not only a graduated development of brain in the anthropomorpha as they approximate in resemblance to man; but, still more, that the progressive stages from the lowest savage condition to that of the most civilized nations should be traceable in a comparative size and weight of brain. Dr. Carl Vogt, after discussing certain minor and doubtful exceptions, thus proceeds: "We find that there is an almost regular series in the cranial capacity of such nations and races as, since historic times, have taken no part in civilization. Australians, Hottentots, and Polynesians, nations in the lowest state of barbarism, commence the series; and no one can deny that the place they

* "Mr. Darwin's Critics: Critiques and Addresses."

occupy in relation to cranial capacity and cerebral weight corresponds with the degree of their intellectual capacity and civilization."* But the position thus confidently assigned to the Polynesians receives no confirmation from the evidence supplied by the measurements of Dr. J. B. Davis, in his *Thesaurus Craniorum;* and a careful study of the subject reveals other remarkable deviations from such a scale of progression, not only in individuals but in races. To these exceptional deviations, with their bearing on the comparative capacity of races, the following remarks are chiefly directed. The largest and heaviest brains do indeed appear, for the most part, to pertain to the nations highest in civilization, and to the most intelligent of their number. But this cannot be asserted as a uniform law, either in relation to races or individuals. The more carefully the requisite evidence is accumulated, the less does it appear that the volume of brain, or the cubic contents of the skull, supply any uniform gauge of intellectual capacity. In the researches which have thus far been instituted into the characteristics of the human brain among the lowest races, the development is in many respects remarkable; and, as was to be expected, no organic differences between diverse races of men have been traced.

Professor C. Luigi Calori has published the results of a careful examination of the brain of a Negro of Guinea. It presented the marked excess of length over breadth so characteristic of the Negro cranium; but in other respects it corresponded generally to the fully developed European brain. The distribution of the white and gray substances was the same; the cerebral convolutions were collected into an equal number of lobes; and the only special difference was that the convolutions were a little less frequently folded, and the separating sulci somewhat less marked than in the average European brain. But even in this respect the complication was great. The actual weight of the brain, according to Professor Calori, was 1,260 grammes, equivalent to 44·4 cubic inches. The complexity of convolution, and consequent extension of superficies of the encephalon, appears to be an essential element in the development of the brain as the organ of highest mental capacity; and to the cerebrum, apparently, the true functions of intellectual activity pertain. Professor Wagner undertook the measurement of the convex surface of the frontal lobe in a series of brains. The heaviest, as a rule, had also the greatest

* Vogt, "Lectures on Man." Lect. III

development of surface. But the two elements were not in uniform ratio. Some of the lighter brains presented a much greater degree of convolution and consequent extent of convex superficies than others which ranked above them in weight. It is thus apparent that in estimating the comparative characteristics of brains, various elements are necessary for an exhaustive comparison. Besides the functional differences of the cerebrum, cerebellum, and pons varolii, they have different specific gravities, so that brains of equal weight may differ widely in quality. Dr. Peacock, taking distilled water as 1000, gives the values of the subdivisions of the brain thus: cerebrum, 1034; cerebellum, 1041; pons varolii, 1040. Again, Dr. Sankey states the mean specific gravity of the gray matter of the brain in either sex as 1·0346, and of the white matter as 1·0412. The variations from these results, as given by Bastian, Thurnam, and others, are trifling. But it is significant to note that recent researches shew that where greater specific gravity of brain occurs in the insane, it appears to be limited to the gray matter.* Professor Goodsir maintained that symmetry of brain has more to do with the higher faculties than bulk or form. It is, at any rate, apparent that two brains of equal weight may differ widely in quality.

Nevertheless, the popular estimate embodied in such expressions as "a good head," "a long-headed fellow," and "a poor head," like many other popular inductions, has truth for its basis. Up to a certain stage the growth of the brain determines the capacity of the skull. Then it seems as though more complex convolutions accompanied the packing of the elaborated cerebral mass within the fixed limits of its osseous chamber.

A comparison of races, based on minute investigation of an adequate number of brains of fair typical examples, may be expected to yield important results; but in the absence of such direct evidence, the chief data available for this purpose are derived from measurements of the internal capacity of their skulls. Among English observers who have devoted themselves to this class of observations, the foremost place is due to Dr. J. Barnard Davis, who, in 1867, summed up the results of his extensive researches in a contribution to the Royal Society, entitled, "Contributions towards determining the weight of the brain in different races of man."† Inferior as such

* "Journal of Mental Science," Vol. XII., p. 23.

† "Philosophical Transactions," Vol. CLVIII., p. 505.

evidence must necessarily be, if compared with the examination of the brain itself, nevertheless the number of skulls of the different races gauged unquestionably furnishes some highly valuable data for ethnical comparison. The evidence, moreover, is obtained from a source in some respects less variable than the encephalon; and will always constitute a corrective element in estimating results based on direct examinations of the brain. Dr. Davis, indeed, claims "that the examination of a large series of skulls in ascertaining their capacities and deducing from those capacities the average volume of the brain, affords in some respects more available data for determining this relative volume for any particular race than the weighing of the brain itself." The defect is, that its most important results are necessarily based on the assumption of a uniform density of brain; whereas some notable ethnical differences, hereafter referred to, may prove to be due to the fact that certain races derive their special characteristics from a prevailing diversity in this very respect.

But the extensive observations of Dr. Davis, as of Dr. Morton, have a special value from the fact that each furnishes results based on a uniform system of observation; for the diverse methods and materials employed by different observers in gauging the human skull have greatly detracted from their practical value. In a communication by the late Professor Jeffreys Wyman to the Boston Natural History Society,* he presented the results of a series of measurements of the internal capacity of the same skull with pease, beans, rice, flax-seed, shot, and coarse and fine sand. From repeated experiments he arrived at the conclusion that the apparent capacity varied according to the different substances used, so that the same skull measured respectively, with pease 1193 centimetres, with shot 1201·8, with rice 1220·2, and with fine sand 1313 centimetres. Professor Wyman was led to the conclusion that, for exactness, small shot, as employed latterly by Dr. Morton, is preferable to sand, were it not for its weight, which, in the case of old and fragile skulls, is apt to be destructive to them. With a view to avoid the latter evil, Dr. J. B. Davis has used fine Calais sand of 1·425 specific gravity. The diversity in apparent volume, consequent on the employment of different substances in gauging the internal capacity of the skull, necessarily detracts from the value of comparative results of Morton, Davis, and others. But the elaborate measurements of their great collections

* "Proceedings of the Boston Natural History Society," Vol. XL.

of human crania furnish reliable series of data, each uniform in system, and sufficiently minute to satisfy many requirements of comparative craniometry.

Without assuming an invariable correspondence in cubical capacity and brain-weight, there is a sufficient approximation in the cubical capacity of the skull and the average weight of the encephalon to render the deductions derived from gauging the capacities of skulls of different races an important addition to this department of comparative ethnology. For minute cerebral comparisons, however, it is apparent that much more is required; and the special functions assigned to the various organs within the cranium have to be kept in view. Of these the medulla oblongata, in direct contact with the spinal cord, is now recognized as the centre of the vital actions in breathing and swallowing; and is believed also to be the direct source of the muscular action employed in speech. Next to it are the sensory ganglia, arranged in pairs along the base of the brain. To the cerebellum, which the phrenologist sets apart as the source of the emotions and passions embraced in his terminology of amativeness, philoprogenitiveness, &c., physiologists now assign the function of conveying to the mind the conditions of tension and relaxation of the muscles, and so controlling their voluntary action. But above all those is the cerebrum, or brain-proper, consisting of two large lobes of nervous substance, which in man are so large that, when viewed vertically, they cover and conceal the cerebellum. To this organ is specially assigned emotion, volition, and ratiocination. It is the assumed seat of the mind; and, in a truer sense than the skull,

"The dome of thought, the palace of the soul;"

if indeed it be not, to one class of reasoners, the mind itself. Certain it is that no acute disease can affect it without a corresponding disorder of the functions of mind; and with this organ much below the average size, intellectual weakness may always be predicated. But at the same time, it is significant to note that the human brain, stinted in its full proportions, and reduced to a seeming equality with the anthropomorpha, exhibits no corresponding capacities or instincts in lieu of the higher mental qualities. Microcephaly is the invariable index, not of mere limited intelligence and mental capacity, but of actual mental imbecility. If the augmentation of the brain of the anthropomorpha from 55 to 115 cubic inches be all that is requisite for the transformation of the irrational ape into the reasoning man,

it would seem to be in no degree illogical to look for the accompaniment of the inversion of the process by an approximation, in some instances, to certain capacities and functions of the ape. But there are no indications of this. In some examples of microcephaly, the so-called animal propensities do indeed manifest themselves to excess; but there is no reproduction of the animal nature, instincts, or capacities, analogous to the scale of cerebral development of the orang or chimpanzee. A microcephalous idiot, who died at the age of twenty-two, in St. Bartholomew's Hospital, London, had a brain weighing only 13·125 oz., or 372 grammes. In describing this case, Professor Owen remarks: "Here nature may be said to have performed for us the experiment of arresting the development of the brain almost exactly at the size which it attains in the chimpanzee, and where the intellectual faculties were scarcely more developed. Yet no anatomist would hesitate in at once referring the cranium to the human species." And so is it with the encephalon. The brain of the chimpanzee is a healthy, well-developed organ, adequate to the amplest requirements of the animal; whereas the microcephalous human brain is inadequate for any efficient, continuous cerebral activity: not merely limited in its range of powers. Much, however, may yet be learned from a careful attention to the imperfect manifestations of activity in certain directions, in cases of microcephalic idiocy, and noting the predominant tendency in each case, with a view to subsequent examination of the brain. By this means it may be found possible to refer certain forms of mental activity to special variations in the structure of the organ, or to distinct members of the encephalon.

Dr Laennec recently exhibited to the Anthropological Society of Paris a microcephalous idiot of the male sex, aged fourteen years. "This child is entirely unconscious of his own actions, and his intellectual operations are very few in number, and very rudimentary. His language consists of two syllables, *oui* and *la*, and he takes an evident pleasure in pronouncing them. He takes no heed in what direction he walks. He would step off a precipice, or into a fire." Attention was specially directed to the idiot's hands: "The thumbs are atrophied, and cannot be opposed to the other fingers. The palms of the hands have the transverse creases, but not the diagonal —the result of the atrophy of the thumbs. Hence the hand resembles that of the chimpanzee. The dentition too is defective. Though

fourteen years of age, the child has only twelve teeth." Here it is curious to note the analogies in physical structure to the lower anthropomorph in other organs besides the brain, for it only renders more striking the absence of any corresponding aptitudes.

Dr. J. Barnard Davis, in his interesting monograph on "Synostotic Crania among Aboriginal Races of Man," produces some remarkable illustrations of the effect of premature ossification of the sutures of the skull in arresting the full development of the brain, and so rendering it unequal to the due performance of its functions. "I have," he says, "the cranium of a convict who was executed on Norfolk Island, which I owe to the kindness of Admiral H. M. Denham. This man was executed there when that beautiful isle was appropriated to the reception of the most dangerous and irreclaimable convicts from the other penal settlements. It is a microcephalic skull, rather dolichocephalic, of a man apparently about forty years of age. It exhibits a perfect ossification of the sagittal and of the greater portion of the lambdoidal sutures. The coronal suture is partially obliterated at the sides in the temporal regions, and can only be distinguished by faint traces in all its middle parts. In this case there has not been any compensatory development of moment in other directions. The calvarium is not abridged in its length, which is 7·1 inches, equal to 179 millimetres; probably it is a little elongated. It is, however, very narrow, being only 4·8 inches, or 122 m.m. at its widest part, between the temporal bones. So that the result is a very small, dwarfed, almost cylindrical calvarium. The internal capacity is only 59 ounces of sand,* which is equal to 71·4 cubic inches, or 1169 cubic centimetres." Here is a skull considerably below the lowest mean of the crania of any race in Morton's enlarged tables, or in the more comprehensive ones furnished in Dr. Davis's "Thesaurus Craniorum." Another skull nearly approximating to it is that of a Cole, one of the savage tribes of Nagpore, in Central India, who are said to go entirely naked. It is described in the supplement to the "Thesaurus Craniorum" as that of "Chara," a Cole farmer, aged fifty,

* The internal capacity of 59 oz. is given here from the "Thesaurus Craniorum," p. 40, in correction of that of 50 oz. stated in the memoir in "Transactions of the Dutch Society of Sciences," Haarlem, p. 21, which may be presumed to be a misprint. Dr. Davis adds, in the "Thesaurus Craniorum," "An early closure of the sutures has occasioned a stunted growth of the brain, especially of its convolutions, and thus prevented the development of those structures and faculties which might have given a different direction to his lower propensities;" and he justly adds his conviction that this was a case rather for timely treatment as a dangerous idiot, than for punishment as a criminal.

and its internal capacity is stated as 59·5 oz. av., equivalent to 71·7 cub. inches. The Coles appear to be small of stature. The heights of three of them, whose skulls are in the same collection, were respectively 5 ft. 5 in., 5 ft. 2 in., and 5 ft., and the average internal capacity of five male skulls is only 66·6. The small stature in this and others of the native races of Central India, has to be taken into account in estimating the relative size of the brain. But the Cole skulls are remarkable for their small size, being smaller even than the ordinary Hindoos of Bengal. Yet one of them, "Cootlo," whose skull is among those included in the above mean, commanded a band of insurgents in the Porahant rebellion of 1858, and made himself a terror to the district.

The microcephalism of races, as well as of individuals, of small stature, must not be confounded with the true microcephaly of a dwarfed or imperfectly developed brain, which is invariably accompanied with mental imbecility. The Mincopies of the Andaman Islands are spoken of by Professor Owen as "perhaps the most primitive, or lowest in the scale of civilization, of the human race."* Mr. G. E. Dobson, in describing his first visit to one of their "homes," says: "Although none of the tribe exceeded 64 inches in height, so that on first seeing them we thought the shed contained none but boys and girls, I was especially struck by the remarkable contrast between the size of the males and females."† Dr. J. B. Davis has given, in the supplement to "Thesaurus Craniorum," the dimensions of a male Mincopie skeleton in his collection. The age he assumes to have been about thirty-five. The internal capacity of the skull is 62 oz. (Calais sand), equivalent to 75·5 cubic inches, and the entire height of the skeleton is 58·7 inches. It belongs, says Dr. Davis, to a pigmy race, is small in all its dimensions, and is particularly small in the dimensions of the pelvis. Of their skulls, moreover, he adds, "it is somewhat difficult to determine the sex with confidence. They are all small (but this is a character of the race), they are delicate in development, and they have that fullness of the occipital region, and smallness of the mastoid processes, which are marks of feminism."

Mr. Alfred R. Wallace connects the Mincopies with the Negritos and Semangs of the Malay peninsula, a dark woolly-haired race,

* "Report of British Association," 1861.
† "Journal Anthrop. Inst.," Vol. IV, p. 464.

dwarfs in stature. Dr. Davis says of the six Mincopie skulls in his collection, four male and two female, as well as of others which he has seen: "They are all remarkably and strikingly alike, not merely in size but in form also. They are all small, round, brachycephalic crania of beautiful form." Moreover, though classed as "lowest in the scale of civilization," the Mincopies betray no deficiency of intellect. The admirable photographs which illustrate Mr. Dobson's narrative show in the majority of them good frontal development. The brain is not, indeed, relatively small. Their canoes are made of the trunk of a tree, hollowed out; and Mr. Dobson remarks: "The construction of their peculiar arrows and fish spears with movable heads exhibits much ingenuity, and the use of no small reasoning power in adapting means to an end."

We are indeed too apt to apply our own artificial standards as the sole test of intellectual vigour; whereas it is probable that in the amount of acquired knowledge and acuteness of reasoning many savage races surpass the majority of the illiterate peasantry in the most civilized countries of Europe. Mr. Wallace, in viewing the subject in one special light, remarks: "The brain of the lowest savages, and, as far as we yet know, of the prehistoric races, is little inferior in size to that of the higher types of man, and is immensely superior to that of the higher animals; while it is universally admitted that quantity of brain is one of the most important, and probably the most essential of the elements which determine mental power. Yet the mental requirements of savages, and the faculties actually exercised by them are very little above those of animals. The higher feelings of pure morality and refined emotion, and the power of abstract reasoning and ideal conception, are useless to them; are rarely, if ever, manifested; and have no important relations to their habits, wants, desires, and well-being. They possess a mental organ beyond their needs."*

Here, however, it may be well to guard against the confusion of two very distinct elements. The higher feelings of pure morality and refined emotion are not manifestations of intellectual vigour in the same sense as is the power of abstract reasoning and ideal conception. It is not rare to find an English or Scottish peasant with little intellectual culture or capacity for abstract reasoning, but with an acutely instinctive moral sense. On the other hand, among the criminal

* "Limits of Natural Selection, as Applied to Man."

class, it is by no means rare to find examples of wonderfully vigorous intellectual power applied to the planning and accomplishing of schemes which involve as much foresight and skill as many a triumph of diplomacy; but which at the same time seem to be nearly incompatible with any moral sense. Moreover, it is needless to say that intellectual vigour and high moral principle are by no means invariable concomitants in any class of society; nor can they be traced to a common source. Mr. Wallace recognizes that "a superior intelligence has guided the development of man in a definite direction, and for a special purpose;" and such guidance involves much more than the mere evolution of a higher animal organization. But, appreciating as he does the difficulties involved in any acceptance of a theory of evolution which assumes man to be the mere latest outgrowth of a development from lower forms of animal life, Mr. Wallace points out that "natural selection could only have endowed savage man with a brain a little superior to that of an ape, whereas he actually possesses one very little inferior to that of a philosopher."

Yet neither Mr. Wallace, nor Professor Huxley when controverting this argument, withholds a due recognition of the activity of the intellect of the savage. No one indeed can have much intercourse with savage races wholly dependent on their own resources, without recognizing that, within a certain range, their faculties are kept in constant activity. The savage hunter has not merely an intimate familiarity with all the capabilities and resources of many regions traversed by him in pursuit of his game; his geographical information includes much useful knowledge of the topography of ranges of country which he has never visited. I found, on one occasion, when exploring the Nepigon River, on Lake Superior, that my Chippewa guides, though fully five hundred miles from their own country, and visiting the region for the first time, were nevertheless on the look-out for a metamorphic rock underlying the sienite which abounds there; and they made their way by well-recognized landmarks to this favourite "pipe-stone rock." While moreover the Indian, like other savages, is devoid of much of what we style "useful knowledge," but which would be very useless to him, he is fully informed on many subjects embraced within the range of the natural sciences; and has a very practical knowledge of meteorology, zoology, botany, and much else which constitutes useful know-

ledge to him. He is familiar with the habits of animals, and the medicinal virtues of many plants; will find his way through the forest by noting the special side of the trunks on which certain lichens grow; and follow the tracks of his game, or discover the nests of birds, by indications which would escape the most observant naturalist. The Australian savage, stimulated apparently to an unwonted ingenuity by the privations of an arid climate, is the inventor of two wonderfully ingenious implements, the *wommera* or throwing stick, and the *bomerang*, which, when employed by the native expert, accomplish feats entirely beyond any efforts of European skill. Moreover, as Professor Huxley remarks, he "can make excellent baskets and nets, and neatly fitted and beautifully balanced spears; he learns to use these so as to be able to transfix a quartern loaf at sixty yards; and very often, as in the case of the American Indians, the language of a savage exhibits complexities which a well-trained European finds it difficult to master." Again he goes on to say: "Consider that every time a savage tracks his game he employs a minuteness of observation, and an accuracy of inductive and deductive reasoning which, applied to other matters, would assure some reputation to a man of science, and I think we need ask no further why he possesses such a fair supply of brains. In complexity and difficulty, I should say that the intellectual labour of a good hunter or warrior considerably exceeds that of an ordinary Englishman." Hence Professor Huxley is not prepared to admit that the American or Australian savage possesses in his brain a mental organ which he fails to turn to full account. But without entering on the questions of evolution and natural selection in all their comprehensive bearings, it is still apparent that the brain of the savage is an instrument of great capacity, employed within narrow limits.

In estimating the comparative size of the brain, it is seen to be necessary to discriminate between individuals or races of small stature and cases of true microcephaly. On the other hand, it is not to be overlooked that examples of idiocy are not rare where the head is of a fair average size, and where the mental imbecility is regarded as congenital. But in this as in other researches of the physiologist, he is limited in his observations mainly to the chance opportunities which offer for study; and not unfrequently the prejudices of affection arrest the hand of the student, and prevent a *post mortem* examination

in cases where science has much to hope for from freedom of investigation. Hence the data thus far accumulated in evidence of the actual structure, size and weight of the human brain fall far short of what is requisite for a solution of many questions in reference to the relations between cerebration and mental activity. From time to time men of science have sought by example, as well as by precept, to lessen such impediments to scientific research. Dr. Dalton left instructions for a *post mortem* examination, in order to test the peculiarity of his vision, which he had assumed to be due to a colouring of the vitreous humour; Jeremy Bentham bequeathed his body to his friend Dr. Southwood Smith, for the purposes of anatomical science; and the Will of Harriet Martineau, who died during the present year, contains this provision: "It is my desire, from an interest in the progress of scientific investigation, that my skull should be given to Henry George Atkinson, of Upper Gloucester Place, London, and also my brain, if my death should take place within such distance of his then present abode as to enable him to have it for purposes of scientific investigation." The Will is dated March 10th, 1864; but by a codicil, dated October 5, 1871, this direction is revoked, with the explanation which follows in these words: "I wish to leave it on record that this alteration in my testamentary directions is not caused by any change of opinion as to the importance of scientific observation on such subjects, but is made in consequence merely of a change of circumstances in my individual case." The natural repugnance of surviving relatives to any mutilation of the body must always tend to throw impediments in the way of such researches; though it may be anticipated that, with the increasing diffusion of knowledge, such obstacles to its pursuit will be diminished. Thus far, however, notwithstanding the persevering labours of Welcker, Bergmann, Parchappe, Broca, Boyd, Skae, Owen, Thurnam, and other physiologists, their observations have been necessarily limited almost exclusively to certain exceptional sources of evidence, embracing to a large extent only the pauper and the insane classes; and in the case of the latter especially, the functional disorder or chronic disease of the organ under consideration renders it peculiarly desirable that such results should be brought, as far as possible, into comparison with a corresponding number of observations on healthy brains of a class fairly representing the social and intellectual status of a civilized community.

The average brain-weight of the human adult, as determined by a numerous series of observations, ranges for man from 40 oz. to 52½ oz., and for woman from 35 oz. to 47½ oz. But some indications among ancient crania tend to suggest a doubt as to whether this difference in cerebral capacity was a uniformly marked sexual distinction among early races; due allowance being made for difference *in stature*. Dr. Thurnam made the race of the British Long Barrows a special subject of study; and Dr. Rolleston has followed up his researches with valuable results. Amongst other points, he notes that the males appeared to have averaged 5 feet 6 inches, and the females 4 feet 10 inches in height. But while the difference of stature between the male and the female exceeds what is observable in most modern races, the variation in the size and internal capacity of their skulls appears to be less than among civilized races. The like characteristics are noticeable in the larger race of Europe's palæotechnic era. Nothing is more striking in the discovery of those ancient remains of European man than the remarkable development of the skulls, and the good brain capacity of the race of the palæotechnic dawn, where man is proved, by his works of art and all the traces of his hearth and home, to have been still a rude hunter and cave-dweller. Whatever other changes, therefore, may have affected the brain as the organ of human thought and reasoning, it does not thus far appear that the average mass of brain has increased since the advent of European man. Important exceptions have indeed been noted. Professor Broca's observations on the cerebral capacity of the Parisian population at different periods, based on nearly 400 skulls derived from vaults and cemeteries of various dates from the 11th or 12th to the 19th century, appear to him to show a progressive cerebral development in that remarkable centre of European civilization.* But though the assumption is not inconsistent with other results of civilization, and is the necessary corollary of the postulate that intellectual activity tends to permanent development of brain; the fact that the crania presented a still greater diversity in type than in size reminds us of the intermixture of races on the banks of the Seine, and the consequent necessity for much more extended observations before so important a deduction can be received as an established truth.

Taking the average brain-weight of the human adult as already stated, all male brains falling much below 40 oz. or 1130 grammes,

* "Bull. de la Soc. d'Anthropologie de Paris." 1861, ii., p. 501; 1862, iii., p. 102.

and female brains below 35 oz. or 990 grammes, may be classed as *microcephalous;* and all above the maxima of the medium male and female brain, viz., 52½ oz. or 1480 grammes, and 47½ oz. or 1345 grammes, may be ranked as *megalocephalous*, or great brains.

Professor Welcker, who devoted special attention to the whole subject under review, assumes another and simpler test, when he says that skulls of more than 540 to 550 millemetres, or 21·26 to 21·65 inches in circumference—the weight of brain belonging to which is 1490 to 1560 grammes (52·5—55 oz. avoir.),—are to be regarded as exceptionally large. But while an excess of horizontal circumference may be accepted as indicating good cerebral capacity, it must not be overlooked that the adoption of it as the key to any definite or even approximate brain-weight ignores the important elements of variation involved in the difference between acrocephalic and platycephalic head-forms. The volume of brain in Scott, and probably in Shakespeare, appears to have depended more on its elevation than its horizontal expansion. The same was also the case with Byron. The intermastoid arch, measured across the vertex of the skull from the tip of one mastoid process to the other, furnishes an accurate gauge of this development. Of thirteen selected male English skulls in Dr. Davis's collection, the mean of this measurement is 15·1; and of thirty-nine male and female English skulls, it is only 14·4. Of the whole number of eighty-one English skulls described in the "Thesaurus Craniorum," three exceptionally large ones are—No. 123, that of an ancient British chief, of fully 6 ft. 2 in. in stature, from the Grimsthorpe Barrow, Yorkshire; No. 905, a calvarium of great magnitude, very brachycephalic, and with the elevation across the middle of the *parietals apparently exaggerated by compression in infancy, from* Hythe, Kent; and No. 1029, another male skull, remarkable alike for its size and weight, and with a peculiarity of conformation ascribed by Dr. Davis to synostosis of the coronal suture. The intermastoid arch in those exceptionally large skulls measures respectively 16·0, 16·2 and 16·9; whereas the same measurement derived from the cast of Scott's head taken after death, yields the extraordinary dimensions of 19 inches.* This last measurement is over the hairy scalp. But after making ample allowance for this, the vertical measurement of the skull and consequently of the brain is remarkable.

* I am indebted to Dr. J. A. Smith F.S.A., Scot., for this and other measurements of casts of The Bruce, Burns, Scott, &c., not accessible to me.

Full value has been assigned at all periods to the well-developed forehead. It is characteristic of man. The physiognomist and the phrenologist have each given significance to it in their respective systems; and it has received no less prominent recognition from the poets. A fully developed forehead is assumed as distinctive of the male skull. But Juliet, in "The Two Gentlemen of Verona," when depreciating her rival, exclaims, "Ay, but her forehead's low;" and the jealous Queen of Egypt, in "Antony and Cleopatra," is told of Octavia that "her forehead is as low as she would wish it." "The fair large front" of Milton's perfect man is the external index of an ample cerebrum: the organ to which the seat of consciousness, intelligence, and will is assigned. It is therefore consistent with this that a low, retreating forehead is popularly assumed to be the characteristic index of the savage, and of the unintellectual among civilized races. But the cerebral characteristics of both ancient and modern civilized races have still to be studied in detail; and the influence of race and sex on the form of the head and the mass and weight of the brain, involves some curious questions in relation to the oldest illustrations of the physical characteristics of man, and to the effect of civilization on the relative development of the sexes.

Early observations led Dr. Pruner-Bey and other ethnologists of France to recognize in certain ancient Gaulish skulls of a brachycephalic type the evidences of a primitive race, assumed to represent the inhabitants of France and of Central Europe during its reindeer period, and which appeared to be assigned with reasonable probability to a Mongol origin. But in the Cro-Magnon cavern, and in other caves more recently explored, the remains of a race of men have been brought to light markedly dolichocephalic, and no less striking in cranial capacity. Dr. Broca speaks of these ancient cave-dwellers of the valley of the Vezère as characterized by "sure signs of a powerful cerebral organization. The skulls are large. Their diameters, their curves, their capacity, attain, and even surpass, our medium skulls of the present day. The forehead is wide, by no means receding, but describing a fine curve. The amplitude of the frontal tuberosities denotes a large development of the anterior cerebral lobes, which are the seat of the most noble intellectual faculties." Alongside of the remains of this ancient race, and in the underlying deposits, lay those of the mammoth, cave-lion and bear, fossil horse, and reindeer. In neighbouring caves of the same valley, and especially

in that of La Madelaine, numerous specimens of primitive art have been found: tools and weapons of flint, carved lances and harpoons of bone; and ingenious engravings and carvings of the mammoth, reindeer, and of man himself, on pieces of horn and ivory tablets. The evidences of primitive skill and intellectual vigour are remarkable. Dr. Broca, after a review of their ingenious arts, says: "They had advanced to the very threshold of civilization;" and Dr. Pruner-Bey thus comments on their characteristics: "If we consider that its three individuals had a cranial capacity much superior to the average at the present day; that one of them was a female, and that female crania are generally below the average of male crania in size; and that nevertheless the cranial capacity of the Cro-Magnon woman surpasses the average capacity of *male* skulls of to-day, we are led to regard the great size of the brain as one of the more remarkable characters of the Cro-Magnon race. This cerebral volume seems to me even to exceed that with which at the present day a stature equal to that of our cave-folks would be associated: whilst the skulls from the Belgium caves are small, not only absolutely, but even relatively in the rather small stature of the inhabitants of those caves."*

The remarkable cranial capacity of the skulls thus seemingly pertaining to the most primitive of European races—the troglodytes of the mammoth and reindeer periods of Central Europe,—is the more significant from its bearing on the evidence of progressive cerebral development adduced by Dr. Broca from skulls recovered from ancient and modern cemeteries of Paris. It appears indeed to conflict with any theory of a progressive development from the Troglodyte of the post-glacial age to the civilized Frenchman of modern times. Mr. W. Boyd Dawkins has accordingly been at some pains in his "Cave Hunting," to show that the conclusions formed by previous observers as to the epoch of their burial are not supported by the facts of the case; and he sums up his review of the whole evidence by expressing a conviction that he "should feel inclined to assign the interments to the neolithic age, in which cave-burial was so common. The facts," he adds, "do not warrant the human skeletons being taken as proving the physique of the palæolithic hunters of the Dordogne, or as a basis for an inquiry into the ethnology of the palæolithic races." Mr. Boyd Dawkins also pronounces the same doubts in reference to the equally characteristic

* "Reliquiæ Aquitanicæ."

male skeleton found in a cave at Mentone, and to others obtained in the Lombrive and other caves. Nor was this caution without reason, for the remains of man differ from other animal remains found in such series of deposits as mark a succession of periods, in so far as they pertain to the only animal habitually given to the practice of interment; so that human skeletons found under such circumstances may have been artificially intruded long subsequent to the accumulation of the breccia in which they lay. Happily, however, any doubts as to the contemporaneity of the human remains with the other cave-relics has since been removed by the discovery of skeletons, similar in type, in other caverns in the same valley—and especially in that of Laugerie Basse,—in positions which seem to leave no room for questioning their being of the same age as the works of art found along with them.

Other examples of the ancient man of Europe show him in like manner endowed with a cerebral development far in advance of the rudest races of modern times. The skull found by Dr. Schmerling in the Engis Cave, near Liége, along with remains of six or seven human skeletons, was embedded in the same matrix with bones of the fossil elephant, rhinoceros, hyæna, and other extinct quadrupeds. It is a fairly proportioned, well developed dolichocephalic skull; and, like others of the seemingly most ancient human skulls yet found, has signally disappointed the expectations of those who count upon invariably finding a lower type the older the formation in which it occurs. "Assuredly," says Professor Huxley, "there is no mark of degradation about any part of its structure. 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." Even the famous Neanderthal skull, of doubtful geological antiquity, but pronounced to be "the most brutal of all human skulls," acquires its exceptional character chiefly from the abnormal development of the superciliary region.

It is a universally accepted fact that the size of the male head and the weight of the brain are greater than those of the female. The average weight of the male brain is found to exceed that of the female by about ten per cent.; or, as it is stated by Professor Welcker, the brain-weight of man is to that of woman as 100 : 90. But the difference of stature between the two sexes has to be taken

into account. The average, based on various series of observations to determine the mean stature for man and for woman, shows the latter to be about eight per cent. less than the former; or, as Dr. Thurnam has stated it more precisely:

RATIO OF STATURE AND BRAIN-WEIGHT IN THE TWO SEXES.

	Male.		Female.
Stature.....	100·	.....	92·
Weight of Brain.....	100·	.....	90·3

Here again, however, it becomes important to take into consideration other elements of difference besides weight; for, as Tennyson insists, "Woman is not undevelopt man, but diverse." The results of Wagner's observations on the superficial measurements of the convolutions of the brain point to the conclusion that in the female the lesser brain-weight may be compensated by a larger superficies. Ranked in the order of their relative weights in grammes, six average brains of men and women were found to stand thus:

1	Male	(*a*)	1340
2	"	(*b*)	1330
3	"	(*c*)	1273
4	Female	(*d*)	1254
5	"	(*e*)	1223
6	"	(*f*)	1185

But the same brains, when tested by the degrees of convolution of the frontal lobe, measured in squares of sixteen square millimetres, irrespective of the question of relative size, ranked as follows, advancing the female (*d*) from the fourth to the first place, and reducing the male (*c*) from the third to the sixth place:

1	Female	(*d*)	2498
2	Male	(*a*)	2451
3	Male	(*b*)	2309
4	Female	(*f*)	2300
5	Female	(*e*)	2272
6	Male	(*c*)	2117

But, as already indicated, some modern disclosures tend to raise the question whether the difference between the sexes, in so far as relative volume of brain is concerned, has not been increased as a result of civilization. The disparity in size between the Cro-Magnon male and female skeletons is quite as great as that of modern times, but the capacity of the female skull is relatively good.

Other observations, such as those of Professor Rolleston "On the People of the Long Barrow Period," seem to indicate a nearer

approximation in actual cranial capacity of the two sexes in prehistoric times than among modern civilized races. On the assumption that intellectual activity tends to permanent development of brain, it is consistent with the conditions of savage life that it should bring the mental energies of both sexes into nearly equal play. They have equally to encounter the struggle for existence, and have their faculties stimulated in a corresponding degree. As nations rise above the purely savage condition of the hunter stage, this relative co-operation of the sexes is subjected to great variations. The laws of Solon with reference to the right of sale of a daughter or sister, and the penalties for the violation of a free woman, show the position of the weaker sex among the Greeks at that early stage to have been a degrading one. But the change was great at a later stage; and much of our higher civilization is traceable to the early establishment of the European woman's rights, which Christianity subsequently tended to enlarge. The position of woman among the ancient Britons appears to have been one of perfect equality with man. Among the Arabians and other Mohammedan nations, including the modern Turks, the opposite is the case; and the whole tendency of the creed of the Koran, and the social life among Mohammedan nations, must be towards the intellectual atrophy of woman. Hence it is consistent with the diverse conditions of life that, in so far as cerebral development is the result of mental activity, a much closer approximation is to be looked for in the mass and weight of brain in the two sexes among savage races, than among nations where woman systematically occupies a condition of servile degradation, or of passive inertness.

Some interesting results of the actual brain-weights of Negroes and other typical representatives of inferior savage races have been published, including examples of both sexes; and although the observations are as yet too few for the deduction of any absolute or very comprehensive conclusions, they furnish a valuable contribution towards this department of ethnical comparison. In 1865, Dr. Peacock published the results of observations on the brains of four Negroes and two Negresses; and to those he subsequently added a seventh example.* Other examples are included in the following table. But I have excluded some extremes of variation, such as the two given by Mascagni, one of which weighed 1458 grammes, or

* "Mem. Anthropol. Soc. Lond.," Vol. I., p. 65.

51·5 oz. av., and the other only 738 grammes, or 26·1 oz. av. In addition to each actual brain-weights, Morton, Tiedemann, Davis, Wyman, and others, have gauged the skulls of Negroes, American Indians, Mincopies, Tasmanians, Australians, and other savage races, as well as those of many civilized and semi-civilized nations, and thereby contributed valuable data towards determining their relative cranial capacity. In his "Crania Ægyptiaca," Dr. Morton, when discussing the traces of a Negro element in the ancient Egyptian population, says: *"I have in my possession seventy-nine crania of* Negroes born in Africa, for which I am indebted to Drs. Goheen and McDowell, lately attached to the medical department of the colony of Liberia, in western Africa; and especially to Don Jose Rodriguez Cisneros, M.D., of Havana, in the island of Cuba. Of the whole number, fifty-eight are adult, or sixteen years of age and upwards, and give eighty-five cubic inches for the average size of the brain. The largest head measures ninety-nine cubic inches; the smallest but sixty-five. The latter, which is that of a middle-aged woman, is the smallest adult head that has hitherto come under my notice."*

TABLE I.

NEGRO BRAIN-WEIGHT.

	Race.	Authority.	Weight.
M	African, Mozambique	Peacock	43·80
M	"	"	45·80
M	" Buenos Ayres	"	44·00
M	" Congo	"	46·25
M	"	"	42·80
M	"	Sœmmering	45·40
M	"	Tiedemann	35·20
M	" Congo	C. Luigi Calori	44·40
M	"	Barkow	50·80
M	"	"	45·90
M	"	"	38·90
M	"	Sir A. Cooper	49·00
F	Hottentot Venus	Marshall	31·00
F	Bushwoman	"	30·75
F	"	"	31·50
F	"	"	31·00
F	"	Flower & Murie	38·00
F	African	Peacock	46·00
F	"	"	41·00

* "Crania Ægyptiaca," p. 21.

The influence of race on the volume, weight, disposition, and relative proportions of the different subdivisions of the human brain, and so of brain on the character of races, has thus far been very partially tested. But the diversities of race head-forms—brachycephalic, dolichocephalic, platycephalic, acrocephalic, &c.—are now well recognized, though their relation to cerebral development still requires much research for its elucidation. The ancient Roman forehead, as illustrated by classic busts, and confirmed by genuine Roman skulls, was low but broad, and the whole head was platycephalic. The Greek had a high forehead, and the works of the Greek sculptors show that this was regarded as typical. But contemporary with the classic races were the Macrocephali of the Euxine and the Caspian Seas, who, like many modern tribes of the New World, purposely aimed at depressing a naturally receding forehead, and thereby exaggerated the typical forehead characteristic of certain ancient barbaric races.

In the case of hybrids the interchange of physical and mental characteristics of the parents, including modifications of head-form, is a familiar fact. The English head-form appears to be an insular product of intermingled Briton, Teuton and Scandinavian elements, which has no continental analogue; and its sub-divisions, or sub-types, vary with the ethnical intermixture. The Scottish head appears to exceed the English in length, while the latter is higher. Where the Celtic element most predominates, the longer form of head is found; but even in the most Teutonic districts the difference between the prevailing head-form and that of the continental German is so marked that the latter finds it difficult to obtain an English-made hat which will fit his head.* Here the diversities of head-form are accompanied with no less marked differences of individual and national character.

Professor Welcker determined the average capacity of the German male skull as 1450 cubic centimetres, equivalent to 88 cubic inches, and representing an average brain-weight of 49 oz. Dr. Davis, by a similar process, assigns to the Germans, male and female, the larger mean brain-weight of 50·28 oz.; but by combining the means of both sexes, as derived from his own tables and those of Huschke and Wagner, we obtain a mean weight of German brain of 1314 grms., or 46·37 oz. The results of an extensive series of observations by

* *Vide* "Physical Characteristics of the Ancient and Modern Celt." *Canadian Journal*, Vol. VII., p. 369.

Dr. Broca, on the male French skull, yield a mean capacity of 1502 cubic centimetres, or 91 cubic in., representing an average brain-weight of 50·6 oz. Morton, taking his average from five English skulls, gives the great internal capacity of 96 cubic in.; while Dr. J. B. Davis arrives at a capacity of only 90·9 cubic in., from the examination of thirty-two skulls, male and female; and for the Scottish and Irish, each of 91·2 cubic in., from an examination of thirty-five skulls. But unfortunately the Davis collection, so rich in other respects, derived its chief English specimens from a phrenological collection; and, along with a few large skulls, contains "many small and poor English examples."* The average weight of the English brain may therefore, as Dr. Davis admits, be assumed to be higher than the mean determined by him. "Still a comparison with actually tested weights of brains shows that there cannot be any material error." The average brain-weight of twenty-one Englishmen, as given by him, is 50·28 oz., that of thirteen women is 43·13; and of the combined series, 47·50. The results determined by the same process in relation to the other nationalities of Europe are exhibited in detail in Dr. Davis's tables, printed in the "Philosophical Transactions."

Such averages are, at best, only approximations to true results; and when obtained, as in Morton's English race, from a very few examples, or in Dr. Davis's, from exceptional skulls, collected under peculiar circumstances or for a special purpose, they must be tested by other observations. According to Dr. Morton, for example, the mean internal capacity of the English head is 96 cubic in., while that of the Anglo-American is only 90 cubic in. Such a conclusion, if established as the result of comparison of a sufficiently large number of well authenticated skulls, would be of great importance in its bearing on the influence of change of climate, diet, habits, &c., as elements affecting varieties of the human race. But determined as it was in the Morton collection, from five English and seven Anglo-American specimens, it can be regarded as no more than a mere chance result. Ranged nearly in the order of mean internal capacity of skull, the following are the results arrived at, mainly by gauging the skulls in various collections available for such comparisons of different races of mankind. In presenting them here, I avail myself of Dr. Thurnam's researches, augmenting them with other data sub-

* "Thesaurus Craniorum;" App., p. 347.

sequently published, including results deduced from Dr. J. B. Davis's minute reports of his own extensive collections, and taking Tiedemann's capacity of 92·3 for the European skull as 100.

TABLE II.

RATIO OF CUBICAL CAPACITY OF SKULLS OF DIFFERENT RACES.

Race.	Authority.	Capacity.
European	Tiedemann	100·
Asiatic	Davis	94·3
African	"	93·
American	Tiedemann	95·
"	Davis	94·7
"	Morton	87·
Oceanic	Davis	96·9
Chinese	Davis	99·8
Mongol	Morton	94·
"	Tiedemann	93·
Hindoo	Davis	89·4
Malay	Tiedemann	89·
American Indian	Morton	91·
Esquimaux	Davis	98·8
Mexican	Morton	88·5
Peruvian	Wyman	81·2
"	Morton	81·2
Negro	Tiedemann	91·
"	Peacock	88·
Hottentot	Morton	86·
Javan	Davis	94·8
Tasmanian	"	88·
Australian	Morton	88·
"	Davis	87·9

The tables of Dr. Morton and Dr. Davis furnish materials for drawing comparisons between diverse nations of the great European family; but though they are of value as contributions to the required means for ethnical comparison, they fall far short of determining the average cranial capacity of the different nationalities. Whilst, for example, the tabular data in the "Thesaurus Craniorum" show a mean internal capacity of 94 cub. in. for the combined Teutonic family, the Finns yield the higher mean capacity of 96·3 cub. in. Again, Dr. Thurnam found that the results of the weighing of fifty-nine brains of patients at the Friends' Retreat near York, mostly persons of the middle class of society, yielded weights considerably above those which he subsequently obtained from testing those of pauper patients in Wilts and Somerset. But this has to be estimated along with

the undoubted ethnical differences which separate the population of Yorkshire from that of Somerset and Wiltshire. An interesting paper in the West Riding Asylum Reports gives the results of the determination of 716 brain-weights, rather more than half being males. The average is 48·149 oz. for the male, and 43·872 for the female brain; whereas the average weights of 267 male brains of a similar class of patients in the Wilts' County Asylum, as given by Dr. Thurnam, is 46·2 oz., and of 213 female brains, 41·0 oz. The results of the observations carried on by Dr. Boyd at St. Marylebone yield, from 680 male English brains, a mean weight of 47·1 oz., and from 744 female brains a mean weight of 42·3 oz.; whereas Dr. Peacock determined, from 183 cases in the Edinburgh Infirmary, the weight of the male Scottish brain to average 49·7, and that of the female brain to average 44·3 oz. Here the results are determined by so numerous a series that they might be accepted as altogether reliable, were it not that in the former case they are based to a large extent on a purely pauper class; whereas the patients of the Royal Infirmary of Edinburgh include respectable mechanics and others from many parts of Scotland, among whom education is common. It is not to be doubted, indeed, that a considerable difference in the form and size of the head, and no doubt also in brain-weight, is to be looked for amongst English, Scotch, Irish, German and French men and women, according to the county or province of which they are natives, and the class of society to which they belong.

The comparative ratio of the cubical capacity of the skull, or the average brain-weight, in so far as either is indicative of ethnical differences among members of the European family of nations, has thus to be determined by numerous examples; or dealt with in detail in reference to the different nationalities. Even in single provinces or counties, social position, and probably education, must be taken into account; so that a series of observations on hospital and pauper patients may be expected to fall below the general average; and fallacious comparisons between European peoples may be based on data, correct enough *per se*, but unjust when placed alongside of a different class of results. The great mass of evidence in reference to brain-weight has thus far been mainly derived, in the case of the sane, from one rank of life. A comparison of the results with those derived from the insane of various classes of society shows less dis-

crepancy than might have been anticipated. But there are certain cases of hydrocephalous and other abnormally enlarged brains which have to be rigorously excluded from any estimate of the size or weight of the brain, either as a race-test or as an index of comparative mental power.

Were it possible to select from among the great intellects of all ages an adequate series of representative men, and ascertain their brain-weights, or even the cubical capacity of their skulls, one important step would be gained towards the determination of the relation between size of brain and power of intellect. But we have little other data than such hints as the busts of Æschylus, Pericles, Socrates, Plato, Aristotle, and other leaders of thought may supply. Malcolm Canmore—Malcolm of the great head, as his name implied,—stands forth with marked individuality from out the shadowy roll of names which figure in early Scottish history. Charlemagne, we should fancy, merited a similar designation. But the portraits of his modern imperial successor, Charles V., show no such loftiness of forehead. Judging from the portraits and busts of Chaucer, Shakespeare, Milton, Cromwell, Napoleon, and Scott, their brains must have considerably exceeded the ordinary size. In the report of the *post mortem* examination of Scott, the physicians state that "the brain was not large." But this, no doubt, means relatively to the internal capacity of the skull in its then diseased condition. The intermastoid arch, as already noted, shows a remarkably exceptional magnitude of 19 inches, whereas the average of fifty-eight ancient and modern European skulls, as given in the "Thesaurus Craniorum," is only 14·60. The portraits of Wordsworth and Byron show an ample forehead; and the popular recognition of the "fair large front" of Milton's typical man as the index of superior intellect is an induction universally accepted. But, on the other hand, examples of intellectual greatness undoubtedly occur with the brain little, if at all, in excess of the average size. On the discovery of Dante's remains at Ravenna in 1865, the skull was pronounced to be ample, and exquisite in form. But its actual cubical capacity and estimated brain-weight fall considerably below those of the heaviest ascertained brain-weights of distinguished men. Again, looking at the casts of the skulls of Robert the Bruce and the poet Burns, the first impression is the comparatively small size of head, and the moderate frontal development in each. Mr. Robert Liston, the

eminent surgeon, remarked of the former: "The division of the cranium behind the meatus auditorius is large in proportion to that situated before it. The skull is also remarkably wide and capacious in that part, whereas the forehead is rather depressed."* Other characteristics so markedly indicate the elements of physical rather than intellectual vigour, that Mr. Liston expressly pointed out the analogy to "the heads of carnivorous animals." The Bruce was indeed pre-eminently distinguished for courage and deeds of personal prowess; but it was no less by statesmanlike qualities, calm, resolute perseverance, and wise prudence, that he achieved the independence of his country.

Mr. George Combe, the phrenologist, to whom the original cast of Burns' skull was first submitted, thus states the case in reference to the frontal development of the poet: "An unskilful observer looking at the forehead, might suppose it to be moderate in size; but when the dimensions of the anterior lobe, in both length and breadth, are attended to, the intellectual organs will be recognised to have been large. The anterior lobe projects so much that it gives an appearance of narrowness to the forehead which is not real."† The actual dimensions of the skull are, longitudinal diameter, 8 inches; parietal diameter, 5.95; and horizontal circumference, 22·25.

In the year 1865 the bones of Italy's greatest poet, Dante, were submitted to a minute examination under the direction of commissioners appointed by the Italian Government to verify the discovery; and careful measurements were taken of the skull. Dr. H. C. Barlow, describing it from personal observation, says: "The head was finely formed, and the cranium showed, by its ample and exquisite form, that it had held the brain of no ordinary man. It was the most intellectually developed head that I ever remember to have seen. The occipital region was prominently marked, but the frontal was also amply and broadly expanded, and the anterior part of the frontal bone had a vertical direction in relation to the bones of the face." (*Athenæum*, September 9, 1865). But however intellectually developed and exquisite in form the poet's skull may have appeared, the actual measurements fall short of the amplitude here assigned to it. The dimensions were as follows:—Internal capacity, determined by filling the calvarium with grains of rice, 3·1321 lb. avoird., or a

* "Archæologia Scotica," Vol. II., p. 450.

† "Phrenological Development of Robert Burns," by George Combe, p. 7.

little over 50 oz.; circumference, 52 cent. 5 mill.; occipito-frontal diameter, 31 cent. 7 mill.; transverse diameter, taken between the ears, 31 cent. 8 mill.; height, 14 cent. If the internal capacity is accepted without any correction, it would yield 57 oz., but if allowance be made, as in the actual weighing of the brain, for the abstraction of the dura mater and fluids, of say 8 per cent., this would reduce it to about 52·5, or nearly the same weight as that of the mathematician, Gauss. Professor Welcker deducts from 11·6 to 14 per cent., according to the size of the skull; Dr. J. B. Davis recommends a uniform deduction of 10 per cent. If we apply the latter rule, it will reduce the estimated weight of Dante's brain to 51·3 oz.*

Another interesting example of the skull of an Italian poet is that of Ugo Foscolo, a cast of which was taken on the transfer of his remains to the Church of Santa Croce at Florence. Though only fifty years old at the time of his death, the skull was marked by "the entire ossification of the coronal, sagittal, and lambdoidal sutures, and that atrophy of the outer table, manifested by a depression on each side in the posterior half of each parietal, leaving an elevated ridge in the middle, in the position of the sagittal, which is but rarely observed except in extremely advanced age."† Sir Henry Holland, who knew the poet intimately, describes him as resembling in temperament the painter Fuseli, "passionately eccentric in social life." Full of genius and original thought, as the writings of Foscolo show him to have been, he "was fiery and impulsive, almost to the verge of madness."‡ He died in England in obscurity and neglect; but a regenerated Italy recalled the memory of her lost poet, and transferred his remains to Santa Croce's consecrated soil. The estimated size of his brain is given as 1426 cub. cent., equivalent to 87 cub. in. internal capacity, which corresponds to a weight of brain

* The use of different standards of weights and measures, and of diverse materials for determining the capacity of the skull in different countries, greatly complicates the researches of the craniologist. Some pains have been taken here to bring the various weights and measurements to a common standard. In attempting to do so in reference to the weight of brain of Italy's great poet, the following process was adopted: It was ascertained by experiment that 912·5 grs. of rice, well shaken down, occupied the space of 1000 grs. of water. Hence 3·1321 lbs. rice=3·4324 water. Multiplying this by 1·04, the s.g. of brain, the result is the capacity of the skull, viz., 3·5697 lbs., or 57 oz., as given above. In this and other investigations embodied in the present paper, I have been indebted to the valuable co-operation of my friend and colleague, Prof. H. H. Croft.

† Dr. J. B. Davis, Supp. "Thesaurus Craniorum," p. 7.

‡ Sir H. Holland's "Recollections of Past Life," p. 254.

of 48·44 oz. The longitudinal diameter is 6·90; the parietal diameter 5·70; the intermastoid arch 15·0; and the horizontal circumference 520 m.m., or 20·5 in. The brain capacity of the poet was thus little more than the European mean deduced by Morton from the miscellaneous examples in his collection.

Dr. J. C. Gustav Lucae, in his "Zur Organischen Formenlehre," furnishes views and measurements of two other skulls of men of known intellectual capacity. One of these is Johan Jacob Wilhelm Heinse, the author of "Ardinghello," a work of high character in the elements of æsthetic criticism, though as a romance fit to rank with "Don Juan" in subjective significance and morality. He wrote another romance entitled "Hildegard;" in addition to numerous articles and translations of Petronius, Tasso, &c., which won for him the high commendation of Goethe, and the more guarded admiration of Wieland. His skull, as figured by Dr. Lucae, shows the frontal suture still open at the age of 53, at which he died. The internal capacity of the skull is stated as 41·4 oz., equivalent to 1173 grms., In this, as in other examples hereafter referred to, Dr. Lucae has gauged the capacity of the skull with peas, and gives the weight in "unzen." In the results deduced from them here the *unzen* are assumed to be Prussian ounces, the lb. of 12 oz. equal to 350·78348 *grms. Professor Croft has made a series of experiments for me with* a view to correct the error necessarily resulting from the fact that peas do not entirely fill the cavity. The results show that 82·5 grms. of ordinary sized peas occupy the space of 100 grms. of water. Deducting 10 per cent. for membranes and fluids, the estimated brain-weight of Heinse is 1379 grms. or 48·7 oz. av. The dimensions of the skull are given thus:

	Height.	Length.	Breadth.
Fore part	4·9	4.0	4·10
Middle part	4·10	3·11	5·3
Hind part	3·9	3·6	4·1

The other example produced by Dr. Lucae is that of Dr. Christian Heinrich Büngen, Professor of Anatomy in the University of

Marburg. In this skull the frontal suture is still more strongly defined at the age of 60 than in that of Heinse. The internal capacity of the skull is stated as 42·8 oz., equivalent to 1213 grms., which, dealt with as above stated, yields 1410 grms. or 49·8 oz. av. Other dimensions of the skull are given as follows:

	HEIGHT.	LENGTH.	BREADTH.
Fore part	4·8	4·1	4·20
Middle part	4·9	4·1	5·0
Hind part	3·7	3.10	4·1

Professor Welcker assigns a standard, which was accepted by Dr. Thurnam, thus: "Skulls of more than 540 to 550 millemetres in horizontal circumference (the weight of brain belonging to which is 1490 to 1560 grms., or 52·5–55 oz. avoirdupois), are to be regarded as exceptionally large. The designation of *kephalones*, proposed by Virchow, might commence from this point. Men with great mental endowments fall, for the most part, under the definition of kephalony. If we consider the relations of capacity, 1800 grms. (63·5 oz.) appears to be the greatest attainable weight of brain within a skull not pathologically enlarged." But the brain of Cuvier—the heaviest healthy brain yet recorded,—exceeded this. Its weight is stated by Wagner as 1861 grammes, or 65·8 oz.; but this M. Broca corrects to 1829·96 grammes. Even thus reduced it exceeds the limits assigned by Professor Welcker to the normal healthy brain. But a curious commentary upon this is furnished by the fact that the modern English skull which Dr. J. B. Davis selects as presenting the most striking analogy to the Neanderthal skull—"the most ape-like skull which Professor Huxley had ever beheld,"—though marked not only by the prominence of the superciliary ridges, but by great depression of the frontal region, appears to have a cubical capacity equivalent to that of Dr. Abercrombie, whose brain is only surpassed by that of Cuvier among the ascertained brain-weights of distinguished men.* Its capacity is 94 oz. of sand, or 113 cubic inches,

* "Memoirs of Anthrop. Soc., Lond.," Vol. I., p. 289. "Thesaurus Craniorum," p. 49.

equivalent—after making the requisite deduction for membranes and fluids,—to a brain-weight of 63 oz.

I have attempted in the following table to reduce to some common standard such imperfect glimpses as are recoverable of the cranial capacity of some distinguished men, of whose actual brain-weights no record exists:

TABLE III.

CRANIAL CAPACITY OF DISTINGUISHED MEN.

	Length.	Breadth.	Circumference	Estimated Brain-Weight.
Dante	....	....	....	51·3
Robert the Bruce	7·70	6·25	22·25	....
Burns	8·00	5·95	22·25	....
Scott (head)	9·	6·40	23·10	....
Heinse	....	5·30	....	48·7
Bürger	....	5·00	....	49·8
Ugo Foscolo	6·90	5·70	20·50	48·4

Some of the examples adduced in the above table appear to exhibit instances of mental endowment of high character, without the corresponding degree of cranial, and consequently cerebral development. The following table exhibits recorded examples of a series of actual brain-weights of distinguished men. It seems to lend confirmation to the idea that great manifestation of mental endowment is correlated, in the majority of observed cases, to a brain above the normal average in mass or weight. But even here intellect and brain-weight are not strictly in uniform ratio. Several of the following brain-weights, including that of Tiedemann, are furnished by Wagner, in the "Vorstudien des Menschlichen Gehirns;" but in an elaborate table of brain-weights given in the "Morphologie und physiologie des Menschlichen gehirns als Seelenorgan," the brain of Byron is classed above all except Cuvier; while Vogt gives the same place, by estimate, to Schiller's, as next in rank to that of the great naturalist among highly developed brains. Dr. Thurnam states his authorities for others, when producing them in his valuable contribution to the *Journal of Mental Science* "On the Weight of the Brain." For that of Webster he refers to "the unsatisfactory article on the brain of Daniel Webster, *Edin. Med. Surg. Journ.*, vol. lxxix., p. 355." Dr. J. C. Nott, in his "Comparative Anatomy

of Races" ("Types of Mankind," p. 453), says: "Dr. Wyman, in his post-mortem examination of the famed Daniel Webster, found the internal capacity of the cranium to be 122 cubic inches, and in a private letter to me, he says: 'The circumference was measured outside of the integuments before the scalp was removed, and may, perhaps, as there was much emaciation, be a little less than in health.' It was 23¾ inches in circumference; and the Doctor states that it is well-known there are several heads in Boston larger than Webster's. I have myself, in the last few weeks, measured half a dozen heads as large and larger." The circumference, it will be seen, exceeds the corresponding measurement of Scott's head, taken under similar circumstances. But the statement of 122 cubic inches as the internal capacity of Webster's skull seems open to question. If correct, instead of 53·5 oz. of brain-weight, as stated in the following table, it is the equivalent of a brain-weight of fully 65 oz., or one in excess even of that of Cuvier. The brain-weights of Goodsir, Simpson and Agassiz, are given in the following table from the reported autopsy in each case.

TABLE IV.

BRAIN-WEIGHTS OF DISTINGUISHED MEN.

			Age.	Oz.	Grms.
1	Cuvier	Naturalist	63	64·5	1830
2	Byron	Poet	36	63·5 ?	1799
3	Abercrombie	Philosopher, Physician	64	63·	1785
4	Schiller	Poet	46	63· ?	1785
5	Goodsir	Anatomist	53	57·55	1629
6	Spurzheim	Phrenologist, Physician	56	55·06	1559
7	Simpson	Physician, Archæologist	59	54·	1530
8	Dirichlet	Mathematician	54	53·6	1520
9	De Morny	Statesman	50	53·6	1520
10	Daniel Webster	Statesman	70	53·5	1516
11	Campbell	Lord Chancellor	80	53·5	1516
12	Agassiz	Naturalist	66	53·4	1512
13	Chalmers	Author, Preacher	67	53·	1502
14	Fuchs	Pathologist	52	52·9	1499
15	Gauss	Mathematician	78	52·6	1492
16	Dupuytren	Surgeon	58	50·7	1436
17	Whewell	Philosopher	71	49·	1390
18	Hermann	Philologist	51	47·9	1358
19	Tiedemann	Physiologist	80	44·2	1254
20	Hausmann	Mineralogist	77	43·2	1226

Dr. Thurnam, in producing fifteen of the above examples, remarks: "Altogether, they decidedly confirm the generally received view of the connection between size of brain and mental power and intelligence:" and he adds his conviction that if the examination of the brain in the upper ranks of society, and in men whose mental endowments are well known, were more generally available, further confirmation would be given to this conclusion. The converse, at least, is certain, that no great intelligence or unwonted mental power is possible with a brain much below the average in mass and weight. But there are unquestionable indications that a large, healthy brain may exist without the manifestation of great mental power; while brains *inferior both in size* and weight have been the *organs of unwonted* intelligence and mental activity.

In the "Philosophical Transactions" of 1861, Dr. Boyd published an elaborate series of researches illustrative of the weight of various organs of the human body, including the weights of 2,000 brains. Most of the healthy brains are those of patients in the St. Marylebone Infirmary, and have already been referred to as necessarily representing the indigent and uneducated classes of London. Here, therefore, if an unusually large brain is the index of intellectual power, every probability was against the occurrence of brains above the average size or weight. But the results by no means confirm this assumption. Among the patients in the Edinburgh Royal Infirmary, in like manner, though including the better class of artizans and others from country districts, we might still look for a confirmation of M. Broca's assumption, based on extensive observations of French crania, "that, other things being equal, whether as the result of education, or by hereditary transmission, the volume of the skull, and consequently of the brain, is greater in the higher than in the lower classes." But Dr. Peacock's tables include four brain-weights, three of them of a sailor, a printer, and a tailor, respectively, ranging from 61 to 62·75 oz.; and so surpassing all but two, or at the most three, of the heaviest ascertained brain-weights of distinguished men. Tried by the posthumous test of internal capacity, three skulls of nameless Frenchmen, derived from the common cemeteries of Paris, in like manner showed brains equalling in size that of Cuvier. The following are the maximum brain-weights among the St. Marylebone patients apparently unaffected by cerebral disease.

TABLE V.

MAXIMUM BRAIN-WEIGHTS—ST. MARYLEBONE.

Age.	Male.		Female.	
	Oz.	Grms.	Oz.	Grms.
7—14	57·25	1622	52·	1473
14—20	58·5	1658	52·	1473
20—30	57·	1615	55·25	1565
30—40	60·75	1721	53·	1502
40—50	60·	1700	52·5	1488
50—60	59·	1672	52·5	1488
60—70	59·5	1686	54·	1530
70—80	55·25	1565	49·5	1403
80—	53·75	1523	48·	1360
All Ages. 7—80	60·75	1721	55·25	1565

The stature, or relative size of body, has already been referred to as an element in testing the comparative male and female weight of brain; and it is one which ought not to be overlooked in estimating the comparative size and weight of the brains of distinguished men. From my own recollections of Dr. Chalmers, who was of moderate stature, his head appeared proportionally large. The same was noticeable in the cases of Lord Jeffrey, Lord Macaulay, Sir James Y. Simpson, and very markedly so in that of De Quincey. The philosopher Kant was also of small stature; and Dr. Thurnam refers to the observation of Carus that he had a head not absolutely large, though, in proportion to the small and puny body of that eminent thinker, it was of remarkable size. Among the large-brained artizans of the Marylebone Infirmary, on the contrary, the probabilities are in favour of a majority of them being men of full muscular development and ample stature. Nevertheless, with every allowance for this, it still remains probable, if not demonstrable, that from the same humble and unnoted class, examples of megalocephaly could be selected little short in cerebral mass, and apparently in brain-weight, of the group of men whose large brains are recognized as the concomitants of exceptionally great mental capacity and intellectual vigour. Unless, therefore, we are contented to accept the poet's dictum, "Their lot forbad,"* and assume that "chill penury repressed their noble rage, and

* Gray's "Elegy."

froze the genial current of the soul," it is manifest that other elements besides those of volume or weight are essential as cerebral indices of mental power. Dr. Thurnam, after noting examples that had come under his own notice of brain-weights above the medium—but which, as those of insane patients, may be assigned to other causes than healthy cerebral development,—adds: "The heaviest brain weighed *by me (62 oz., or 1760 grms.) was that of an uneducated butcher*, who was just able to read, and who died suddenly of epilepsy, combined with mania, after about a year's illness. The head was large, but well-formed; the brain of normal consistence; the *puncta vasculosa* numerous." In cases like this, of weighty brain with no corresponding manifestation of intellectual power, something else was wanting besides a less circumscribed sphere. The mere position of a humble artizan or labourer will not suffice to mar the capacity to "make by force his merit known," which pertains to the "divinely gifted man."

Arkwright, Franklin, Watt, Stephenson, and others of the like type of self-made men, are not rare. Among those large-brained artizans, scarcely one can have had a more limited sphere for the exercise of mental vigour than the poet Burns, the child of poverty and toil, who refers to his own early years as passed in "the unceasing moil of a galley-slave." In his case the very means essential to a healthy physical development were stinted at the most critical period of life. *His brother Gilbert says:* "We lived sparingly. For several years butcher's meat was a stranger to the house; while all exerted themselves to the utmost of their strength, and rather beyond it, in the labours of the farm. My brother, at the age of thirteen, assisted in thrashing the crop of corn, and at fifteen was the principal labourer on the farm." Such premature toil and privations left their permanent stamp on his frame. "Externally, the consequences appeared in a stoop of the shoulders, which never left him; but internally, in the more serious form of mental depression, attended by a nervous disorder which affected the movements of the heart." He had only exchanged the toil on his father's farm for equally unremitting labour on his own, when the finest of his poems were written; nor would it be inconsistent with all the facts to assume that the privations of his early life diminished his capacity for continuous mental activity; as it undoubtedly impaired his physical constitution. But, while the possession of a brain much above the average in size might have

seemed to account for his triumph over the depressing influences of his limited sphere, the fact that his brain appears to have been rather below than above the average size, points to some other requisite than mere cerebral mass as essential to intellectual vigour.

The brain is influenced in all its functions by the character and the amount of blood circulating through it, and promptly manifests the effects of any deleterious substance, such as alcohol or opium, introduced into its tissues. It depends, like other portions of the nervous system, on an adequate supply of nourishment. In both respects the brain of the Ayrshire poet was injuriously affected, in so far as we may infer from all the known circumstances of his life.

The human brain is large in proportion to the body in infancy and youth; and the opinions of leading anatomists and physiologists early in the present century favoured the idea that it attained its full size within a few years after birth. Professor Soemmering assumed this to take place so early as the third year. Sir William Hamilton explicitly stated his conclusion thus: "In man the encephalon reaches its full size about seven years of age;" and Tiedemann assigns the eighth year as that in which it attains its greatest development. But the more accurate and extended observations since carried on rather tend to the conclusion that the brain not only goes on increasing in size and weight to a much later period of life, but that, under exceptionally favouring circumstances, it may increase in weight long after the body has attained its maximum.

The largest average brain-weights, as determined by observations on the brains of upwards of two thousand men and women in different countries of Europe, have indeed been found in those not above twenty years of age; and from a nearly equal number of English examples, Dr. Boyd determines the period of greatest average weight to be the interval between fourteen and twenty years of age; but this includes cases in which death has ensued from undue or premature brain development.

Other evidence leaves no room for doubt that cases are not rare of the growth, or increased density of the brain up to middle age; while the observations of Professor Welcker indicate this process extended to a later period of life. The average brain-weights, as given by Boyd, Peacock, and Broca, from healthy or sane cases, along with those of Welcker, include the weights of forty-seven male brains from ten to twenty years of age, giving an average of

49·6 oz., or 1405 grms.; and of one hundred and twelve male brains from twenty to thirty years of age, giving an average of 48·9 oz., or 1384 grms.; and the results of a nearly equal number of female brains closely approximate. They embrace English, Scotch, German, and French, men and women. Dr. Welcker's results indicate the period of maximum brain-weight to be between 30-40, as shewn in the following table:

TABLE VI.

AVERAGE WEIGHT OF THE BRAIN AT DIFFERENT AGES.

	Male.		Female.	
	Oz. Av.	Grms.	Oz. Av.	Grms.
From 10—20	47·5	1346	43·1	1221
20—30	49·5	1404	44·1	1251
30—40	49·5	1404	44·8	1272
40—50	48·6	1379	43·5	1234
50—60	48·1	1365	43·5	1234
60—70	46·1	1306	42·8	1213

In the female examples, amounting to thirty-one between seventy and *eighty years of age, and six between eighty and ninety, the* continuous diminution of brain-weight corresponds with the increasing age; but in the male examples, sixty-five cases between sixty and seventy years of age yield an average brain-weight of 46·1 oz., while twenty-seven cases between seventy and eighty years of age give 47·9 as the average; falling in the next decade to 43·8.

It may be inferred from the number of cases pointing to an early attainment of the highest average brain-weight, not that the brain differs from all other internal organs of the human body in attaining its maximum before the period of puberty, but that physical as well as mental vigour are dependent on the maintenance of a nice equilibrium between the brain and the other organs while in process of development. The observations of Dr. Boyd, including the results of 2,614 *post mortem* examinations of sane and insane patients of all ages, showed that the average weight of the brain of "still-born" children at the full period was much greater than that of the new-born living child. It is a legitimate inference, therefore, that death in the former cases was traceable to an excessive premature development of the brain. Again, when it is shown from numerous cases

that the highest average weights of brain in both sexes occur not later than twenty years of age, it appears a more legitimate inference to trace to exceptional cerebral development towards the period of adolescence, the mortality which rendered available so many examples of unusually large or heavy brains, than to assume that the normal healthy brain begins to diminish at that age.

It is a fact familiar to popular observation that a large head in youth is apt to be unfavourable to life. A tendency to epilepsy appears to be the frequent concomitant of an unusually large brain; and with the congestion accompanying its abnormal condition, this may account for the weights of such diseased brains as have been repeatedly found in excess of nearly all the recorded examples of megalocephaly in the cases of distinguished men. But a greater interest attaches to a remarkable example of healthy megalocephaly recorded in the *British Medical Journal* for 1872. The case was that of a boy thirteen years of age, who died in Middlesex Hospital from injuries caused by a fall from an omnibus. His brain was found to weigh 58 oz. He had been a particularly healthy lad, without any evidence of rachitis, and very intelligent. This is a strikingly exceptional case of a healthy brain, at the age of thirteen, exceeding in weight all but two of the greatest ascertained brain-weights of distinguished men.

From the evidence already adduced of relative cubical capacity of the skulls of different races, it appears, as was to be expected, that there is a greater prevalence of the amply-developed brain among the higher and more civilized races. But all averages are apt to be deceptive; and the progressive scale from the smallest up to the greatest mass of brain is by no means in the precise ratio of an intellectual scale of progression. The results of Dr. J. B. Davis's investigations, based on the study of a large, and in many cases a seemingly adequate number of skulls, bring out this remarkable fact, that, so far from the Polynesians occupying a rank in the lowest scale, as affirmed by Professor Vogt, the Oceanic races of the Pacific generally rank in internal capacity of skull, and consequent size of brain, next to the European.

But it is of more importance for our present enquiry to note that, as exceptionally large and heavy brains occur among the most civilized races, in some cases—and in some only,—accompanied with corresponding manifestations of unusual intellectual power: so also it

becomes apparent that skulls much exceeding the average, and some of remarkable internal capacity, are met with among barbarian races, and even among some of the lowest savages. Taking the crania in the elaborate series of tables in Dr. J. B. Davis's "Thesaurus Craniorum," with an internal capacity above 100 cubic inches, they will rank in order as follows:

Chinese	111·6
Maduran	110.6
Marquesan	110.6
Kanaka	108·8
Javan	107·
Negro	105·8
Australian	104·5
Kafir	104·5
Bakele	103·3
Tidorese	103·3
Bhotia	102·7
Bodo	100·9
Hindoo	100·9
Sumatran	100·9

Among the European series the largest is an Irish cranium of 121·6 cubic in., and next to it comes an Italian, 114·3, and an Englishman, 112·4; an ancient Briton from a Yorkshire Long Barrow, 109·4: an ancient Roman, 106·4; a Lapp, 105·8; an ancient Gaul, 103·7; a Briton of Roman times, 103·3; a Merovingian Frank, 101·5; and an Anglo-Saxon, 100·9. Those and other examples of the like kind are full of interest as showing the recurrence of megalocephalic variations from the common cranial and cerebral standard among ancient races; and among rudest savages as well as among the most cultivated classes of modern civilized nations. But the order shown in the above instances is derived from purely exceptional examples, and is no key to the relative capacity of the races named.

Opportunities for testing the size and weight of the brain among barbarous races are only rarely accessible to those who are qualified to avail themselves of them for the purposes of science. Some near approximation to the relative brain-weight of the English, Scotch, German, and French, may now be assumed to have been established. Dr. Thurnam instituted a comparison between those and two of the prehistoric races of Britain—the Dolichocephali of the Long Barrows,

and the Brachycephali of the Round Barrows of England.* The results are curious, as showing not only a greater capacity in the ancient British skulls than the average modern German, French, or English head; but an actual average higher than that of all but five of the most distinguished men of Europe, whose brain-weights have been recorded. On comparing the ancient skulls with those of modern Europeans, as determined by gauging the capacity of both by the same process, the following are the results presented, according to the authorities named:

TABLE VII.

Skulls of Men.	No.	Weight of Sand.	Cubic Inches.	Capacity. Centimetres.	Brain-weight oz. av.
Ancient Britons, L. Barrows..	18	82	99	1622	54.
" " R. Barrows..	18	80½	98	1605	53.5
Modern English, Morton	*28*	77	*94*	*1540*	*52.2*
" French, *Broca*	357	74	91	1502	50.6
" German, *Welcker*	30	72	88	1450	49.

The highest average of any nationality, as determined by Drs. Reid and Peacock from the weighing of 157 brains of male patients, chiefly Scottish Lowlanders, in the Royal Infirmary of Edinburgh, is little more than 50 oz., or 1417 grammes; whereas the estimated average brain-weight in the ancient British skulls is 54 oz. for the Dolichocephali of the Long Barrows, which equals that of Sir James Simpson, and exceeds all but six of the most distinguished men. For the Brachycephali of the Round Barrows it is 53·5 oz., which is in excess of the brain-weights of Agassiz, Chalmers, Whewell, and other distinguished men, and exactly accords with that of Daniel Webster and Lord Chancellor Campbell. In so far, moreover, as this illustrates the cerebral capacity of ancient races, it is in each case an average obtained by gauging eighteen skulls, and not the cranial capacity of one or two exceptionally large ones. Dr. Thurnam does indeed suggest that the Barrows may have been the sepulchres of chiefs; nor is this unlikely; but the superior vigour and mental endowment which this implies fails to account for a cerebral capacity surpassing all but the most distinguished men of science and letters in modern Europe. Rather may we conclude from this, as

* "Mem. Anthropol. Soc., Lond.," Vol. I., p. 465.

from other evidence, that quality of brain may, within certain limits, be of more significance than mere quantity; and that brains of the same volume, and agreeing in weight, may greatly differ in minute structure and in powers of cerebration.

In the case of the ancient British Barrow Builders we seem to have large heads and remarkable development of brain, without any indications of an equivalent in intellectual power; and although the estimated brain-weight derived from gauging the capacity of the empty chamber of the skull proceeds on the assumption of mass and weight agreeing, sufficient data exist to justify the adoption of this for approximate results. The average weight of brain of twelve male Negroes of undetermined tribes, deduced from gauging their skulls, has been determined at 1255 grammes, or 44·3 oz. The actual weight of brain of the Negro of Guinea described by Professor Calori, was 1260 grammes; and other examples vary considerably from the average. Mascagni gives 1458 grammes as the weight of one Negro brain weighed by him; equivalent to an actual brain-weight of 51·5 oz., which is greater than that of Dupuytren, Whewell, Hermann, or Tiedemann. Nevertheless, although the extremes are great, and are confirmed by a like diversity in measurements of the horizontal circumference and of internal capacity, the average result given above appears to be a fair and reliable one. But the same process, when applied to determine the comparative cranial capacities of the native American races, discloses results of a wholly different character, and widely at variance with those above described relating to the ancient races of Britain. On the continent of America the native ethnical scale embraces a comparatively narrow range; and any intrusive elements are sufficiently recent to be easily eliminated. The Patagonian and the Fuegian rank alongside of the Bushman, the Andaman Islander, or the Australian, as among the lowest types of humanity; while the Aztecs, Mayas, Quichuas, and Aymaras, attained to the highest scale which has been reached independently by any native American race. We owe to the zealous and indefatigable labours of Dr. Morton, alike in the formation of his great collection of human crania, and in the published results embodied in the "Crania Americana," the chief knowledge derived from this class of evidence in reference to the races of the New World. In one respect, at least, those results stand out in striking contrast to the large-headed barbarian Barrow Builders of ancient Britain. Dr.

Morton subdivides the American races into the Toltecan Race, embracing the semi-civilized communities of Mexico, Bogota, and Peru, and the barbarous tribes scattered over the continent from the Arctic Circle to Tierra del Fuego. His latest views are embodied in a contribution to Schoolcraft's "History of the Indian Tribes of the United States," entitled "The Physical Type of the American Indians." In treating of the volume of brain, he draws special attention to the Peruvian skulls, 201 in number, obtained for him from the cemeteries of Pisco, Pachacamac, and Arica. "Herera informs us that Pachacamac was sacred to priests, nobles, and other persons of distinction; and there is ample evidence that Arica and Pisco, though free to all classes, were among the most favoured cemeteries of Peru." Dr. Morton accordingly adds: "It is of some importance to the present inquiry, that nearly one-half of this series of Peruvian crania was obtained at Pachacamac; whence the inference that they belonged to the most intellectual and cultivated portion of the Peruvian nation; for in Peru learning of every kind was an exclusive privilege of the ruling caste." In reality, however, the latest additions to our knowledge of the physical characteristics of the ancient Peruvians tend to confirm the idea of the existence of two distinct races: a patrician order occupying a position analogous to the Franks of Gaul or the Normans of England, though more aptly to be compared to the Brahmins of India; and a more numerous class, constituting the labouring and industrial orders of the community, abundantly represented in the Pacific Coast tribes of Peru, the cemeteries of which have furnished the larger number of crania to European and American collections.

To such a patrician order or cast the intellectual superiority and privileges of the governing race pertained. But whatever may have been the exclusive prerogatives of the patrician and sacerdotal orders, there is no doubt that the Peruvians as a people had carried metallurgy to as high a development as has been attained by any race ignorant of working in iron. They had acquired great skill in the arts of the goldsmith, the engraver, chaser, and modeller. Pottery was fashioned into many artistic and fanciful forms, showing ingenuity and great versatility of fancy. They excelled as engineers, architects, sculptors, weavers, and agriculturists. Their public works display great skill, combined with comprehensive aims of practical utility; and alone, among all the nations of the New World, they

had domesticated animals, and trained them as beasts of burden. It is not, therefore, without reason that Dr. Morton adds: "When we consider the institutions of the old Peruvians, their comparatively advanced civilization, their tombs and temples, mountain roads and monolithic gateways, together with their knowledge of certain ornamental arts, it is surprising to find that they possessed a brain no larger than the Hottentot and New Hollander, and far below that of the barbarous hordes of their own race. For, on measuring 155 crania, nearly all derived from the sepulchres just mentioned, they give but 75 cubic inches [equivalent, after due deduction for membranes and fluids, to a brain of 40·1 oz. av. in weight,] for the average bulk of the brain. Of the whole number, only one attains the capacity of 101 cubic inches, and the minimum sinks to 58, the smallest in the whole series of 641 measured crania. It is important further to remark that the sexes are nearly equally represented, viz., eighty men and seventy-five women."

Other collections subsequently formed have largely added to our means of testing the curious question thus raised of the apparent inverse ratio of volume of brain to intellectual power and progressive civilization among the native races of the American continent. In 1866, Mr. E. G. Squier presented to the Peabody Museum of American Archæology and Ethnology at Harvard, a collection of seventy-five Peruvian skulls, obtained by himself from various localities both on the coast and in the interior. "The skulls from the interior represent the Aymara on Lake Titicaca, as well as the Quichua, Cuzco, or Inca families; and the skulls of every coast family from Tumbes to Atacama, or from Ecuador to Chili."* Subsequently the curator, the late Professor Jeffreys Wyman, made this collection, along with two others, of skulls from the mounds of Kentucky and Florida, the subject of careful comparative measurements. The following are the results: The crania from Florida were chiefly obtained from a burial place near an ancient Indian shell mound of gigantic proportions, a few miles distant from Cedar Keys. They are eighteen in number, and have a mean capacity of 1375·7 cubic centimetres, or nearly 84 cubic inches. The skulls from the Kentucky mounds, twenty-four in number, show a mean capacity of 1313 cubic centimetres, 80·21 cubic inches, with a difference of 125 cubic centimetres, or 7·61 cubic inches in favour of the males. Yet, small as the Kentucky skulls

* "Peabody Museum Annual Report, 1868," p. 7.

are, they exceed the Peruvian ones. Keeping in view the varied sources of the latter, Professor Wyman remarks: "Although the crania from the several localities show some differences as regards capacity, yet in most other respects they are alike." And the numbers, when viewed separately, are too few to attach much importance to variations within so narrow a range. Nevertheless it is noteworthy that the highest mean is that of the Aymaras of Lake Titicaca; and this difference is considerably increased by measurements derived from subsequent additions to the Harvard collection, received since the death of Professor Wyman from the high valley of Lake Titicaca. In other respects besides their marked superiority in size, the latter crania differ from those of the Coast tribes, and confirm the earlier deduction of an ethnical distinction berween the more numerous race so abundantly represented in the coast cemeteries, and that which is chiefly represented by crania brought from the interior. The numbers from the several localities selected by Professor Wyman as fair average specimens of the whole stand thus: six from burial towers, or chulpas, near Lake Titicaca, 1292; five from Cajamaquilla, 1268·75; fourteen from Casma, 1254; four from Truxillo, 1236; four from Pachicamac, 1195; sixteen from Amacavilca, 1176·2; and seven from Grand Chimu, 1094·28.

In 1872, the collection of Peruvian crania in the Peabody Museum was augmented by a large addition from 330 skulls obtained by Professor Agassiz, through the intervention of Mr. T. J. Hutchinson, British Consul at Callao, in Peru. From those contributed to the Harvard Museum, Dr. Wyman selected eleven as apparently the only ones unaffected by any artificial compression or distortion, and therefore valuable as illustrations of the normal shape of the Peruvian head. They are quite symmetrical. The occiput, instead of being flattened or vertical, as in the distorted crania, has the ordinary curves, and in some of them is prominent. Two of them are marked by a low, retreating forehead; but in all the others the forehead is moderately developed. As, moreover, the larger half appear to be the skulls of females, this accounts for the mean capacity falling below the Peruvian average. But they are all small. The largest of them is only 1260 cub. cent., or less than 74 cub. in.; and the average capacity of ten of them is 1129 cub. cent., or 69 cub. in.

The collection, as a whole, differs from that of Mr. Squier, in having

been derived from the huacas, or ancient graves of one locality that of Ancon, near Callao. Professor Wyman stated as the result of his careful study of them: "The average capacity obtained from the whole collection, including those having the distorted as well as the natural shape, varies but little from that of previous measurements," including those of Morton and Meigs, and his own results from the Squier collection.

Another collection of one hundred and fifty ancient skulls, obtained by Mr. Hutchinson during his residence in Peru, and presented to the Anthropological Institute of London, has the additional value, like that of Mr. Squier, of having been carefully selected from different localities, including Santos, Ica, Ancon, Passamayo, and Cerro del Oro, and the same may be said of those enumerated in the "Thesaurus Craniorum" of Dr. J. B. Davis. We have thus unusually ample materials for determining the cranial characteristics of this remarkable people, and the results in every case are the same. After a careful examination of the Peruvian skulls, in the London anthropological collection, Professor Busk states his conclusions thus: "The mean capacity of the larger skulls, which may be regarded as males, appears, as far as I have gone, to be about 80 cubic inches, equivalent to a brain of about 45 ounces, roughly estimated. This capacity, and the measurements above cited, show that the crania generally are of small size;" and he adds: "this is in accord with the statements of all observers." *

Dr. J. B. Davis has added to the valuable data included in his "Thesaurus Craniorum," a series of measurements of skeletons. Unfortunately that of a male Quichua, procured by him in the form of a "Peruvian mummy," proved to be affected with carious disease about the last dorsal and upper lumbar vertebræ; and consequently the length of the vertebral column essential for comparison with the skeletons of other races, is wanting; but the other measurements indicate in this example a stature below the average, while the skull exceeds it. The average internal capacity of eighteen Quichua male skulls, as given by Dr. J. B. Davis, is 73, whereas this is 78·5. That the ancient Peruvian skulls are, with rare exceptions, of small size, is undoubted; and in view of this it becomes a matter of some importance to determine whether this was in any degree due to a correspondingly small stature. Obscure references

* "Journal of Anthropol. Inst.," Vol. III., p. 92.

are found in the legendary history of Peru to a pigmy race. Pedro de Cieza de Leon, whose travels have been translated by Mr. Markham, refers to the first emigration of the Indians of Chincha to that valley, "where they found many inhabitants, but all of such small stature, that the tallest was barely two cubits high" (p. 260). Garcilasso de la Vega repeats another tradition heard by himself in Peru, of a race of giants who came by sea to the country, and were so tall that the natives reached no higher than their knees. They lived by rapine, and wasted the whole country till they were destroyed by fire from heaven. Traditions of this class may possibly point to the existence of an aboriginal race of small stature. The aborigines of Guatemala, Salvador, and Nicaragua, are described as below the middle size (Bancroft, Vol. I., p. 688); and Von Tchudi divides the wild Indians of Peru into the Iscuchanos, the natives of the highlands, a tall, slim, vigorous race, with the head proportionally large and the forehead low; and those of the hot lowlands, a *smaller race, lank, but broad shouldered, with a broad face and small* round chin. There appear, therefore, to be traces of one or more aboriginal races of small stature. But Dr. Morton says expressly of the Peruvians: "Our knowledge of their physical appearance is derived solely from their tombs. In stature they appear not to have been in any respect remarkable, nor to have differed from the cognate nations except in the conformation of the head, which is small, greatly elongated, narrow its whole length, with a very retreating forehead, and possessing more symmetry than is usual in skulls of the American race." Some of the characteristics here referred to are, in part at least, the result of artificial modifications; but the small head appears to be an indisputable characteristic of the most numerous ancient people of Peru.

It may not unreasonably excite surprise that Dr. Morton should have adduced results apparently pointing to the conclusion that civilization had progressed among the native races of the American continent in an inverse ratio to the volume of brain; and yet passed it over with such slight comment. The only hint at a solution of the difficulty is where, as he draws his work to a close, he indicates the recognition of a greater anterior and coronal development in the smaller Peruvian brain. "It is curious," he says, "to observe that the barbarous nations possess a larger brain by five and a half cubic inches, than the Toltecans; while, on the other hand, the Toltecans

possess a greater relative capacity of the anterior chamber of the skull in the proportion of 42·3 to 41·8. Again, the coronal region, though absolutely greater in the barbarous tribes, is rather larger in proportion in the demi-civilized tribes."* But Dr. Morton also noted that the heads of nine Peruvian children in his possession "appear to be nearly if not quite as large as those of children of other nations at the same age;"† so that he seemed to recognize something equivalent to an arrested cerebral development accompanying the intellectual activity of this remarkable people at some later stage, yet without apparently affecting their mental power. But it was characteristic of this minute and painstaking observer to accumulate and set forth his results, unaffected by any apparent difficulties or inconsistencies which they might seem to involve. In summing up his investigations "On the internal capacity of the cranium in the different races of men," he thus concludes:‡ "Respecting the American race, I have nothing to add, excepting the striking fact that of all the American nations, the Peruvians had the smallest heads, while those of the Mexicans were something larger, and those of the barbarous tribes the largest of all," viz.:

Toltecan Nations	Peruvians, collectively...	75 cub.	inches.
	Mexicans, " ...	79 "	"
Barbarous Tribes	...	82 "	"

The enlarged tables given in the catalogue of Dr. J. Aitken Meigs, increase this inverse ratio of cerebral capacity, thus:

Peruvians	75·3
Mexicans	81·7
Barbarous Tribes	84·0

"The great American group," he says, "is, in several respects, well represented in the collection. It includes 490 crania and 13 casts, making a total of 503 from nearly 70 different nations and tribes. Of this large number 256 belong to the Toltecan race [embracing the semi-civilized communities of Mexico, Bogota and Peru,] and 247 to the barbarous tribes scattered over the continent. Of 164 measurements of crania of the barbarous tribes, the largest is 104 cubic inches; the smallest 69; and the mean of all 84. One hundred and fifty-two Peruvian skulls give 101 cubic inches for the largest internal capacity, 58 for the smallest, and 75·3 for the average of all."§

* "Crania Americana," p. 260.
† "Crania Americana," p. 132.
‡ "Crania Americana," p. 261.
§ "Introductory Note, Catalogue," p. 10.

The results which Professor Jeffreys Wyman arrived at from a careful comparative measurement of the Squier collection, were confirmed by his subsequent study of that of Professor Agassiz, and may be quoted as applying to both; for he sums up his later investigations with the remark: "These results agree with all previous conclusions with regard to the diminutive size of the ancient Peruvian brain."* Of the Squier collection he says: "The average capacity of the fifty-six crania measured agrees very closely with that indicated by Morton and Meigs, viz., 1230 centimetres, or 75 cub. inches, which is considerably less than that of the barbarous tribes of America, and almost exactly that of the Australians and Hottentots as given by Morton and Meigs, and smaller than that derived from a larger number of measurements by Davis. Thus we have, in this particular, a race which has established a complex civil and religious polity, and made great progress in the useful and fine arts—as its pottery, textile fabrics, wrought metals, highways and aqueducts, colossal architectural structures and court of almost imperial splendour prove, on the same level, as regards the quantity of brain, with a race whose social and religious conditions are among the most degraded exhibited by the human race. All this goes to show, and cannot be too much insisted upon, that the relative capacity of the skull is to be considered merely as an anatomical and not as a physiological characteristic; and unless the quality of the brain can be represented at the same time as the quantity, brain measurement cannot be assumed as an indication of the intellectual position of races any more than of individuals."†

The only definite attempt which Dr. Morton made to solve the difficulty thus presented to us, curiously evades its true point. "Something," he says, "may be attributed to a primitive difference of stock; but more, perhaps, to the contrasted activity of the two races." Here, however, it is not a case of intellectual activity accompanied by, and seemingly begetting an increased volume of brain; but only the assumption of greater activity in the small-brained race to account for its *triumph* over larger-brained barbarous tribes in the attainment of numerous *elements* of a native-born civilization. The question is, how to account for this intellectual activity, with all its marvellous results, attained by a race with an

* "Peabody Museum Report, 1874," p. 10.
† "Peabody Museum Report, 1871," p. 11.

average brain of no greater volume than that of the Bushman, the Australian, or other lowest types of humanity.

The Nilotic Egyptian race, of composite ethnical character, presents striking elements of comparison, in the ingenious arts and constructive skill of the ancient dwellers in the Nile valley; but whether we take the Egyptian of the Catacombs, the Copt, or the Fellah, we seek in vain for like microcephalous characteristics. Among modern races the Chinese exhibit many analogies in arts and social life to the ancient Peruvians. But their cerebral capacity presents no correspondence to that of the American race. Dr. Morton gives a mean capacity for the Chinese skull of 85, as compared with the Peruvian 75·3, while Dr. Davis derives from nineteen skulls a mean internal capacity of 76·7 oz. av., or 93 cubic in.

But another Asiatic race, that of the Hindoos—also associated with a remarkable ancient civilization, and a social and religious organization not without suggestive analogies both to ancient Egypt and Peru,—is noticeable for like microcephalous characteristics. In completing the anatomical measurements with which Dr. Morton closes his great work, he places the Ethiopian lowest in the scale of internal capacity of cranium; but, while including the Hindoo in his Caucasian group, he adds: "It is proper to mention that but three Hindoos are admitted in the whole number, because the skulls of these people are probably smaller than those of any other existing nation. For example, seventeen Hindoo heads give a mean of but 75 cubic inches."* The Vedahs of Ceylon, the Mincopies, the Negritos, and the Bushmen, appear to vie with the Hindoos in smallness of skull; but all of them are races of diminutive stature. This element, therefore, which has been referred to as important in individual comparisons, is no less necessary to be borne in view in determining such comparative results as those which distinguish the Peruvians from other American races. Certain races are unquestionably distinguished from others by difference of stature. Barrow determined the mean height of the Bushman, from measurements of a whole tribe, to be 4 ft. 3½ in. D'Orbigny, from nearly similar evidence, states that of the Patagonians to be 5 ft. 8 in. The internal capacity of the Peruvian skull, as derived from eighteen male and six female Quichua skulls in Dr. Davis's collection, is 70, while he states that of the Patagonian skull as 67 and of the Bush-

* "Crania Americana," p. 261.

man as 65; but it is manifest that the latter figures, if taken without reference to relative stature, furnish a very partial index of the comparative volume of brain.

Professor Goodsir, as already noted, held that symmetry of brain has more to do with the higher faculties than mere bulk. In the case of the Peruvians the systematic distortion of the skull precludes the application of this test. But in the small Hindoo skull the fine proportions have been repeatedly noted. Dr. Davis, in describing one of a Hindoo of unmixed blood, born in Sumatra, says: "His pretty, diminutive skull is singularly contrasted with those of the races by whom, alive, he was surrounded;"* and he adds: "The great agreement of the elegant skulls of Hindoos in their types and proportions, although not in dimensions, with those of European races, has afforded some support to that wide-spread and learned illusion, 'the Indo-European hypothesis.' The Hindoo skulls are generally beautiful models of form in miniature."

Mr. Alfred R. Wallace, in his "Malay Archipelago," discusses the value of cranial measurements for ethnological purposes; and, employing those furnished by Dr. J. B. Davis in his "Thesaurus Craniorum" as a "means of determining whether the forms and dimensions of the crania of the eastern races would in any way support or refute his classification of them," he finally selected as the best tests for his purpose—1. The capacity of the cranium; 2. The proportion of the width to the length taken as 100; 3. The proportion of the height to the length taken as 100. But here again, unfortunately, the systematic distortion of the Peruvian skulls limits us to the first of those tests. There are, indeed, the eleven normal Peruvian crania selected as such from the numerous Ancon skulls brought by Professor Agassiz from Peru. But those are stated by Professor Wyman to be on an average less by six inches than the ordinary skull. Some partial results embodied in the following table admit of comparison with those based on the more ample data of Table IX. Dr. Lucae, in his "Zur Organischen Formenlehre," already referred to, gives the cranial capacity of single skulls of different races, selected as examples of each. In these, as in others already referred to, the capacity was determined with peas; and the results—assumed to be given in Prussian ounces,—are dealt with here, as in the skulls of Heinse and Bünger. The experiments carried on for the purpose of

* "Thesaurus Craniorum," p. 148.

testing the process fully confirmed the results stated by Professor Wyman as to the differences in apparent cubical capacity according to the material employed. Taking a sound Huron Indian skull, a mean internal capacity of 1490 grms. was obtained by repeatedly gauging it with peas, and of 1439·5 with rice. The position of the Negro, heading the list, serve to show the exceptional nature of the evidence; though this is rather due to the inferiority of other examples, such as the Chinese and Greenlander, than to its greatly exceeding the Negro mean. In the first column the unzen, as Prussian ounces, are rendered in grammes. The second column gives the nearer approximation to the true specific gravity, according to the standard referred to, based on a series of experiments undertaken for me by Professor Croft, and assuming 82·5 grms. of peas to occupy the space of 100 grms. of water. The third and fourth columns represent the estimated brain-weight, after the requisite deductions, on the basis of s.g. of brain as 1·0408.

TABLE VIII.

COMPARATIVE CAPACITY OF RACES: LUCAE.

	Internal Capacity. Grms.	I. C. Corrected. Grms.	Brain-weight. Grms.	Brain-weight. Oz. Av.
Negro	1169·28	1424·12	1281·71	45·2
Chinese	1081·58	1364·48	1228·04	43·4
Nubian	1041·24	1313·54	1182·19	41·7
Floris	1033·93	1304·36	1173·94	41·4
Papuan	1030·42	1299·95	1169·96	41·3
Greenlander	1023·12	1290·74	1161·67	41·0
Javanese	995·06	1254·54	1129·91	39·8

In the following table the examples are derived from Dr. J. B. Davis's tables, with the exception of the Peruvians. For these I have availed myself of Dr. Jeffreys Wyman's careful observations on the large collection in the Peabody Museum, the results of which confirm Dr. Morton's earlier data. One further fact, however, may be noted as a result of my own study of Peruvian crania, amply confirmed by the published observations of others, viz., that while the Peruvian head unquestionably ranks among those of the microcephalous races, the range of variation among the Coast tribes appears to be less than that even of the Australian. Of this there is good evidence, based on the comparison of several hundred crania. But

exceptional examples of unusually large skulls may be looked for in all races; and a few of such abnormal Peruvian or other skulls would modify the mean capacities and weights in the following table. Nevertheless the average results, as a whole, are probably a close approximation to the truth:

TABLE IX.

COMPARATIVE CEREBRAL CAPACITY OF RACES.

Race.	Number.	Capacity. Cub. Inches.	Brain-Weight. Oz. Av.
European	299	92·3	47·12
English	21	93·1	47·50
Asiatic	124	87·1	44·44
Chinese	25	92·1	47·00
Hindoos	35	82·5	42·11
Negroes	16	86·4	44·08
Negro Tribes	69	85·2	43·47
American Indians	52	87·5	44·64
Mexicans	25	81·7	41·74
Peruvians	56	75·0	38·25
Esquimaux	13	91·2	46·56
Oceanic	210	89·4	45·63
Javans	30	87·5	44·64
Australians	24	81·1	41·38

Looking for some definite results from the various data here produced, the deductions to which they seem to point may be thus stated. While Professor Wyman justly remarks that the relative capacity of the skull, and consequently of the encephalon, is to be considered as an anatomical and not as a physiological characteristic, relative largeness of the brain is nevertheless one of the most distinguishing attributes of man. Ample cerebral development is the general accompaniment of intellectual capacity, alike in individuals and races; and microcephaly, when it passes below well defined limits, is no longer compatible with rational intelligence; though it amply suffices for the requirements of the highest anthropomorpha. Wagner thus definitely refers the special characteristics which separate man from the irrational creation to one member of the encephalon: "The relation of the lobes of the cerebrum to intelligence may, perhaps, be expressed thus: there is a certain development of the mass of the cerebrum, especially of the convolutions, requisite in

order to such a development of intelligence as divides man from other animals."

The important data accumulated by Morton, Meigs, Davis, Tiedemann, Pruner Bey, Broca, and others, by the process of gauging the skulls of different races, proceeds on the assumption of brain of a uniform density. But it seems by no means improbable that certain marked distinctions in races may be traceable to the very fact of a prevailing difference in the specific gravity of the brain, or of certain of its constituent portions; to the greater or less complexity of its convolutions; and to the relative characteristics of the two hemispheres. Moreover, it may be that some of those sources of difference in races may not lie wholly out of our reach, or even beyond our control. The diversity of food, for example, of the Peruvians and of the American Indian hunter-tribes was little less than that which distinguishes the Esquimaux from the Hindoo, or the nomad Tartar from the Chinese. The remarkable cerebral capacity characteristic of the Oceanic races is the accompaniment of well defined peculiarities in food, climate, and other physical conditions; and Australia is even more distinct in its physical specialties than in its variety of race.

Looking then to the unwonted persistency of the Peruvian cranium within such narrow limits, so far at least as the physical characteristics of the predominant population of Peru are illustrated by means of the great coast cemeteries; and to the striking discrepancy between the volume of brain and the intellectual activity of the race: I am led to the conclusion that, in the remarkable exceptional characteristics thus established by the study of this class of Peruvian crania, we have as marked an indication of a distinctive race-character as anything hitherto noted in anthropology.

HAECKEL'S "ANTHROPOGENIE."

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The object of the following paper is to give an idea of the present state of the doctrine of evolution. The Jena Professor's name has been so constantly associated with this doctrine since he established himself as its chief champion in Germany by the publication of his "Generelle Morphologie" (1866), that it would be impossible to give such an account without drawing largely on his works for information. Of these I have selected one of the latest, the "Anthropogenie," for a sketch of its contents will afford a general view of the subject, especially in relation to the development of man, together with an account of the more recent additions with which Haeckel has fortified the theory.

The book is essentially a popular one, and no difficulty need be experienced by any one in becoming acquainted with those arguments which are most favourable to the evolution theory. Those facts, however, which are still stumbling-blocks to the evolutionists are noticeable by their absence; and indeed it is difficult to avoid reproaching the author with dogmatism in stating his own case, a reproach of which he is not sparing when his opponents are in question.

The parts of the book likely to be of most general interest are those which are concerned with the history of the science of development and with the attempt to establish a genealogical system. The rest of the work is occupied with an account of the embryology (ontogenesis) of man, and of the mode of development of the various organs (organogenesis). These subjects are treated in an admirably lucid manner, so that from this book some knowledge of the remarkable changes which the human being passes through, from the simple unicellular condition to the complex fully-formed body, can be readily acquired, even without previous physiological training.

That this series of changes presents a great resemblance to different animals has been long recognized, but the cause of the resemblance

remained in obscurity till it was brought to light by Darwin, and by him forced upon the attention of embryologists. "Heredity" is the key-word which suffices to indicate the nature of the resemblance: the human being passes through certain stages in his ontogenesis because these were likewise present in his phylogenesis, *i.e.*, among the series of ancestral forms which constitute his pedigree. It is evident that embryology must thus be one of the most important sources from which material for the establishment of a genealogical system can be taken, and Haeckel formulates a law which gives expression to this. "The ontogenesis of any form is a short recapitulation of its phylogenesis." The recapitulation, however, is not complete, nor is it always correct, for not only is the conservative tendency of heredity a factor in determining certain embryological stages, but adaptation to new conditions also steps in with its modifying agency. Certain difficulties are thus placed in the way of the evolutionist. These are not insurmountable, for he is by no means restricted to embryology for his working material; he has comparative anatomy and palæontology to fall back upon, and the conclusions which he forms from one or other of these sciences he is enabled to corroborate or to modify from a study of the evidence afforded by the third. In addition to the arguments from the above-named sciences, those from dysteleology (the science of rudimentary organs) are of great importance, for many matters which seemed incapable of any rational explanation, and were especially puzzling to the teleologist, have had a flood of light shed upon them by the establishment of the relation of ontogenesis to phylogenesis.

These sciences are comparatively new. The former dates from the appearance of Wolff's "Theoria Generationis" in 1759, the latter from that of Lamarck's "Philosophie Zoologique" in 1809.

Aristotle's treatise, "Περὶ Ζώων Γενέσεως," remained the sole text book on the subject of ontogenesis for 2,000 years, and from his writings it is evident that he had an inkling of the true doctrine of epigenesis. It was only after the Reformation that new observations began to be made—by Fabricius in 1600, Harvey in 1652, Malpighi in 1672, and others. In the first half of the 18th century, naturalists were incited to the study of classification by the appearance of Linnæus' great work, so that little advance was made in ontogenesis. Theories were rife, however, on the insufficient data already acquired (insufficient through the imperfection of the micro-

scope); and that of "prædelineation," of which the chief champions were Haller and Bonnet, was most generally received. According to the most advanced form of this theory, development is nothing but the growth of parts preformed at the creation, though infinitely small, and the ovum contains within it the rudiments of all its future progeny encased one within the other. Leeuwenhoek's discovery of spermatozoids in 1690 divided the prædelineationists into animalculists and ovulists, the latter having decidedly the best of it, when Bonnet's observations on the parthenogenesis of Aphis were made known in 1745.

Wolff's "Theoria Generationis"—the only true one, that of epigenesis—put forward in 1759, met only with abuse. Especially he showed, in reference to the development of the intestinal canal, that not a trace of it is to be found in the earliest condition of the egg; that the ovum and spermatozoid indeed are entirely different in their structure from the adult. He described the embryo as a flat leaf-like body, divisible into four layers, each layer being converted into a tube by the convergence of its edges, and all giving rise to the four great systems—nervous, muscular, vascular, and alimentary. He recognized the fact that these layers were formed of ultimate vesicles (cells) similar to each other. The translation of Wolff's work into German, in 1812, gave a great impulse to the study of ontogenesis. Würzburg was the seat of the most important investigations: there Pander, in 1817, supplemented Wolff's theory, and described the division of the germ into the serous and mucous layers. Shortly afterwards Baer began his researches, and in 1828 appeared the first part of the classical work on the developmental history of animals. This was followed by the second part in 1837. He showed the mode of derivation of the four secondary germ-layers from the two primary (animal and vegetative), and what Wolff had previously but inaccurately indicated, the mode of formation of the different systems of organs from these different layers. It was he who first described the human ovum as found in the interior of the Graafian follicle, which had formerly been mistaken for the ovum: it was he who first discovered the mode of formation of the blastoderm and of the chorda dorsalis.

Much more important than the above were his comparative observations, which led him to divide the animal kingdom into four groups, radically differing in their types of development; a division simul-

taneously made by Cuvier from comparison of adult structure. These observations led to the enunciation of the law which bears his name. "Development is from the general to the special;" type of development depends upon the relative position of the parts, grade of development within a type on the amount of histological and morphological differentiation. The former is the mechanical consequence of heredity, the latter that of adaptation.

The application of the cell-theory (1835) to ontogenesis was productive of great advantage in the hands of Remak. He described the mode of formation of the cellular layers from the unicellular ovum in 1851, and by his investigations into the development of the tissues from cells laid the foundation stone of histiogeny.

The most important advance in late years has been the establishment of the occurrence of the two primary germ-layers in all animals except protozoa (by Huxley, in 1849, medusæ; Kowalevski, 1866, in amphioxus, ascidiæ, and afterwards in vermes, echinodermata, arthropods; Haeckel, 1872, calcareous sponges; Ray Lankester, molluscs). The absolute homology of these two germ-layers throughout the whole animal series has been especially contended for by Haeckel.

The recognition of the causes of these facts has only taken place since the appearance of Darwin's work on the "Origin of Species," but the theory of evolution was scientifically sketched half a century before that by Lamarck.

The whole question of phylogenesis depends on that of the nature and origin of Species. Linnæus first definitely applied the word in 1735, and grounded his belief in its nature on the Mosaic account of the creation. No scientific theory of creation could then be formed, for the science of palæontology did not exist. Cuvier, however, the father of palæontology, adhered to the Mosaic doctrine; but recognizing the different sets of animals that had inhabited the world, he explained these by different acts of creation and different revolutions or cataclysms similar to the flood. This catastrophic theory was supported by the geological discoveries of the Wernerian school; but the falsity of the inferences derived from these was first shown in 1830 by Lyell, whose uniformitarian theory is now universally accepted. In spite of this, it was thirty years before the connection of the present with the past inhabitants of the earth was scientifically established by Darwin.

Before his time, however, the theory of evolution had been arrived at by several men, many of them independently—Lamarck, St. Hilaire, Blainville, Treviranus, Oken, Goethe.

Lamarck was sixty-five years of age when the "Philosophie Zoologique" appeared in 1809. In it he formulated the theory of descent, and asserted its extreme consequences, the development of organic from inorganic matter, and the development of man from the ape. In explaining the latter he shows that he well knew the principles of heredity and adaptation, and the development of species by the cumulative effect of heredity. Partly the fact that he failed to discover the principle of natural selection brought about by the struggle for life, partly the incomplete state of all biological knowledge, prevented him from putting his theory on a still firmer basis.

There are many points in Goethe's morphology (to which science he made so many important contributions) which point to a belief in evolution, although he gives no connected exposition of his views on the subject. The use of the terms centrifugal and centripetal force especially indicate his appreciation of the importance of heredity and adaptation.

It is impossible to point out a book which has opened up the way to more research than Darwin's "Origin of Species by Means of Natural Selection," which appeared in 1859. The advantages which he had for the preparation of such a book were threefold: 1st. The enormous strides made by biology in the preceding fifty years. 2nd. The opportunities for observation afforded him by his five years' voyage round the world. 3rd. The time which his circumstances allowed him to spend on the systematic study of domestic plants and animals. The clue to the "struggle for existence" he obtained from reading Malthus' work on "Population." The same solution of the problem was indicated by others about the same time, notably by Wallace, 1855-58.

Several years passed before botanists and zoologists began rightly to appreciate the book, and it is only within the last few years that its effect has been felt on the sciences of anatomy and embryology.

It was not until 1871 that Darwin insisted on the applicability of his theory to man, but this had been done in the meantime by Huxley (1863), and shortly afterwards by Vogt and Rolle. Haeckel was the first (1866) to attempt to establish a genealogical system, the natural consequence of the theory.

The application of the theory to man is only a deduction from the general inductive law of descent. This law is based on evidence derived from different sources. Firstly, from palæontology, we find a gradual increase of number of species and a higher grade of evolution within the "type" reached as we ascend in the series; secondly, from comparative anatomy we find similarities of structure, on which we base the natural system of classification; thirdly, from dysteleology in all higher animals we find rudimentary organs of no use to their possessors; fourthly, from geographical distribution; fifthly, the most important inductive proof, from embryology.

The theoretical nature of species may now be considered definitely settled. There are no limits between genus, species and variety. This is established by *Haeckel's* researches on the calcareous sponges' which thus afford an analytical proof of the validity of the theory of descent. It is necessary to have a clear conception of the nature of the cell before entering on the study of ontogenesis, for every animal (and plant) consists at one time of its life of a single cell. Such a cell is an independent organism, for it is capable of replying to a stimulus, of movement, of nutrition and of reproduction. This view of the individuality of the cell is expressed by classifying cells along with cytodes as individuals of the first order (plastida). The cytode differs from the cell in that its plasma is not yet differentiated into nucleus and protoplasm. If the cell has a cell wall (as is rarely the case with animal cells), it is entirely an after-production, and is not essential to the constitution of a cell. An organism may remain unicellular, or it may form a commonwealth of individual cells, and the great problem of ontogenesis is, "How is a multicellular developed from a unicellular organism?"

The essential characteristics of the eggs of all animals are the same, as they are formed in the ovary of yolk, germinal vesicle and germinal spot. In many lower animals they remain naked until fertilized, and are thus amœboid in form—sponges, hydroid polypes; indeed, they have been taken in sponges for parasitic amœbæ. Usually, however, there are special additions in the form of protective coverings or extra nutritive matter. The mammalian egg is throughout the series about ¼ m.m. in diameter, and is *provided* with *a covering*—the zona pellucida—in which there are innumerable porous canals. The bird's egg is, however, very different; it is also unicellular, however large, but is provided with a complicated series

of membranous and calcareous coverings as well as nutritive matter, in the shape of food-yolk and albumen. The food-yolk (red) is easily distinguished from the germinal yolk (white), and most of the latter is found at one point on the surface (cicatricula), with the nucleus imbedded in it. It is only this portion of the white yolk which after fertilization and fission forms the germinal membrane.

By the application of Haeckel's "biogenetic fundamental law," we can thus infer a unicellular ancestral form, most likely amœboid from the occurrence of amœboid eggs in the lower animals, and the wide distribution of such cells in the higher animals (blood, &c.) The mode in which the unicellular organism is transformed into a colony of cells *might be arrived at à priori by reflection on the* way in which a colony would be formed by a male and female savage thrown on an uninhabited island. At first merely nutrition and reproduction are attended to; but by the dispersion of children families are constituted, reciprocal relations established, and the principle of the division of labour steps in, its result the development of castes. So it is with the cell: at first the individuals are of equal physiological value; but as the principle of the division of labour begins to operate, different cells are set apart to perform different functions; so that reproductive cells, muscular cells, nerve cells, protective cells, &c., replace the formerly uniform mass.

The functions that are especially engaged in individual as well as in phylogenetic development are the following: Nutrition, adaptation, growth, reproduction, heredity, differentiation, retrogression, concrescence. Of these heredity, adaptation and growth are most efficient in determining form. Heredity, conservative as well as progressive, is intimately connected with reproduction; adaptation, which initiates all variations, with nutrition; in fact, all of these functions are dependent the one on the other. Growth is surplus nutrition, and reproduction surplus growth. Differentiation, or the division of labour, occurs in phylogenesis as it occurs in a state, in ontogenesis as the result of heredity: the gradual disappearance or degradation of some of the cells may be for the advantage of the colony, and this leads us to the formation of rudimentary organs. Concrescence also is connected with reproduction, or rather occurs in both forms of sexual reproduction (true sexual reproduction and conjugation). Those tissues which perform the highest functions are formed of cells

which have been fused together, totally losing their individuality. But not only cells; organs also, and even persons, may thus become coalesced with each other.

We now know that development may take place without such concrescence (parthenogenesis); but usually the two elements, sperm-cell as well as germ-cell, are necessary. These are, as a rule, very different in form and size, the sperm-cell being ordinarily flagellate (rarely amœboid) and very much smaller than the germ-cell.

After impregnation the first processes of development are essentially the same in all the animal kingdom, and with regard to the mammalian series precisely the same throughout. First, the nucleus disappears, the cell becomes a cytode (monerula—it is no longer amœboid, but moneroid); second, a nucleus is formed anew only to initiate the process of fission, which being repeated, results in the formation of a mulberry-like mass of cells (morula). By collection of fluid in the interior of the morula, a vesicle, the blastosphere, is formed, the wall of which consists of a single layer of cells except in one spot (area germinativa), where a little heap of cells remain, and which spot alone is concerned in the formation of the body of the animal. By the growth of the edge of the little heap the blastoderm becomes two-layered, and these layers, exhibiting different chemical and physical characters, are distinguished—the outer as the animal, the inner as the vegetative layer, and correspond to the exoderm and entoderm of all animals *except protozoa*.

Such is a summary of the early developmental processes in mammalia, and essentially the same stages are passed through by all other animals, obscured frequently, however, by the presence of food-yolk, disposed in one way or another in the egg. In the bird's egg, *e.g.*, which belongs to the discoblastic type of development, change merely takes place in the superficial part of the germinal yolk, and the blastoderm thus formed as a patch on the surface of the egg grows round by its edges, so as to be transformed into a vesicle including the food-yolk.

In the lower animals there is frequently formed a gastrula stage by the invagination of part of the blastodermic vesicle, the result being an elliptical body with a primitive intestine and a primitive mouth, the wall of the body being formed of the two germinal layers.

These two layers of the gastrula are homologous with the two layers of the blastoderm; because from the outer layer all the animal

organs, from the inner all the vegetative organs, are produced. Even when each of these primary layers splits into two secondary layers (as is the case with all higher animals), precisely the same holds good. A seeming exception to the splitting of the primary layers is afforded by most vertebrates, but this is explained by the fact that the recapitulation which the ontogenesis of an animal gives us of its phylogenesis is not a complete one. The reasons for this have been ably pointed out by Fritz Müller. These are, firstly, that there is a tendency for the record of phylogenesis to be blotted out, in consequence of development always seeking a straighter road to the adult stage; and secondly, that there is a tendency for the record to be falsified by the struggle for existence which the larvæ have to enter. As a corollary of the first law, it is evident that the higher the animal the less complete is the recapitulation.

In consequence of this the phylogenist is compelled to adopt the comparative procedure of the geologist; and thus, by piecing together phylogenetic fragments, he arrives at an approximate evolutionary history of man.

The comparison of the ontogenesis of amphioxus and the ascidia is most important, as both stand on the boundary line between the invertebrate and vertebrate animals. The true position of amphioxus, when first discovered, was not recognized, Pallas (1778) referring it to the genus limax. Müller was the first to give a systematic description of its anatomy (1839). He assigned to it the lowest place in the class pisces, pointing out, however, that it differed from other fishes more than the fishes do from the amphibia. Haeckel placed it in a group apart from all other vertebrata (acrania), asserting that its structure is more different from fishes than that of the fishes is from man. From its isolation we may conclude that it is the last living representative of a previously existing group, although the softness of its body is such as to preclude the possibility of fossil remains.

In structure amphioxus is a highly generalised vertebrate, but it presents many peculiarities worthy of remark, *e.g.*, the branchial chamber, the ciliated hypobranchial furrow (thyroid gland), the arrangement of the vascular system, of the sexual organs, and the primordial renal duct. A comparison of the adult amphioxus with the larval petromyzon (ammocœtes) is also very instructive. Goodsir was the first to point out any relation between the ascidia and amphi-

oxus, showing that the perforated anterior portion of the alimentary canal enclosed in an ætrium is common to both. The *resemblance*, however, ends here in most adult ascidia, except that the hypobranchial furrow is also represented. It is before their retrograde metamorphosis begins that the likeness is most marked. The discovery of the embryology of amphioxus in 1866, by Kowalevsky, furnished the mode of passage from the invertebrate to the vertebrate group, which seemed so impossible from the point of view of the "type-structure," according to Cuvier and Baer. The egg of amphioxus, after passing through the stages of morula and blastosphere, becomes by invagination a gastrula, with a ciliated exoderm. This stage has since been shown to exist in all the different sub-kingdoms, and this fact has caused Haeckel to propose his "gastræa theory," which is, that all animals, except protozoa, are descended from an ancestral form (gastræa), which consisted of a primitive intestine surrounded by a two-layered body-wall. In amphioxus the gastrula becomes flattened, a primitive groove appears and is transformed into the medullary tube, which remains open anteriorly—the two primary layers of the germ split into the four secondary, and the chorda is developed in the upper of the two middle layers. The gastrula mouth becomes the anus, and a new mouth is formed; metamera begin to appear from before backwards; and a fold growing over the gill fissures, and coalescing with that of the other side, constitutes the atrial cavity.

If we compare the above with the development of an ascidian (phallusia), we shall find agreement to the minutest particulars, excepting in the fact that the chorda does not extend so far forwards between the medullary tube, which has a well marked anterior vesicular expansion, and the intestinal canal. When it reaches this stage of development it bursts the egg-case and swims about freely as the ascidian tadpole-like larva. After some time it becomes fixed, and as retrogression advances, all likeness to amphioxus disappears; the medullary tube shrinks up, and nothing is left but the supra œsophageal ganglion; the chorda disappears with the tail, and a cellulose sac is secreted by the epidermis, which heightens the dissimilarity.

It is thus among animals allied to tunicata that we must look for the bridge which allows us to pass from the invertebrate to the vertebrate group; and the latest invertebrate ancestors of man must have been closely connected with that group.

Phylogenesis is chiefly an inductive science, built up on facts derived from ontogenesis, palæontology, comparative anatomy, dysteleology, &c.; but it must also be regarded as a comprehensive deductive law, inasmuch as it alone is capable of reconciling all the appearances with which we are acquainted. To apply it we must form special deductive hypotheses. Such, however, cannot be complete as long as our sources of information are incomplete, and the construction of a genealogical tree will vary with the amount of material which is at our command to work with. However, somewhere about twenty-two forms can be indicated as ancestral, eight of them invertebrate, fourteen vertebrate, eleven archozoic, three palæozoic, three mesozoic, four cainozoic. In considering these, it will be convenient to refer at the same time to the nearest living representatives, and to the stages of ontogenesis to which they correspond.

The Monera are the simplest organisms with which we are acquainted, being formed of simple plasma, cytodes indeed, and not cells. There are forms which live in colonies (protomyxa), but the simple forms like protamœba must be regarded as the starting point for all organisms, vegetable or animal. One of the most interesting of the monera is bathybius, its existence necessitating spontaneous generation, and showing us how the transition from an organic carbonaceous substance to living matter just as little requires supernatural interference as the slow evolution of higher from lower forms. This ancestral form is repeated in ontogenesis by the "monerula" stage, that which results from the disappearance of the nucleus.

The amœba is a simple cell, differing from the protamœba in the possession of a nucleus, and evidently developed from such a moneron. The similarity between the amœba and the egg-cell cannot be too strongly insisted on, although it is sometimes masked by the development of a limiting vitelline membrane.

The synamœbium was formed from the amœba, and consisted of a colony of amœboid organisms developed by repeated fission, but remaining in connection. The nearest living representatives are cystophrys and labyrinthula; and the "morula" stage recapitulates this in the onogenetic process.

The planæa was a hollow, globular animal, the wall of the body formed of a single layer of ciliated cells, represented in ontogenesis by the blastosphere or planula, and at the present day by magosphæra planula—a peculiar organism discovered by Haeckel on the coast of

Norway, and which, at one period of its life at any rate, would seem to be most nearly related to the flagellate infusoria.

The gastræa, the ancestral form of all animals except protozoa, possessed a simple, primitive intestine, with a primitive mouth, and a body-wall formed of two layers, ectoderm and entoderm. The gastrula stage of all metazoa repeats this in ontogenesis, and the nearest living representatives are to be sought among the simplest calcareous sponges, the asconidæ.

From the gastræadæ development diverged in two lines: one of these, radiate, giving rise to sponges and cœlenterata, the other, bilateral, to the vermes. It is among the latter that we must look for the ancestors of man, from which group the vertebrate bilaterality has been inherited. The recent vermes are divided into acœlomi and cœlomati, according to the absence or presence of a body-cavity. The phylogenetic relationships of the acœlomi are sufficiently patent; but intermediate forms must have existed between the gastræadæ and such highly organized forms as the recent turbellaria. These intermediate forms (necessarily without a body-cavity) may be called archelminthes, and from that group the acœlomi and the cœlomati diverge.

The next stage must be looked for among the archelminthes, may be called prothelmis, and must have resembled a low turbellarian in the shape of intestine, absence of anus, possession of excretory canals, hermaphroditism, &c. Prothelmis represents only one of a very long row of forms which must have connected the gastræadæ with the cœlomati. The passage from prothelmis, with four secondary germ-layers, as many turbellaria have, to a cœlomatous form, is easy to understand, and the formation of a body-cavity would be correlated with a number of other important organological changes. The living cœlomati only represent the terminal twigs of an enormous tree, and the only forms among them which are closely related to the vertebrata are the tunicata. This resemblance, however, is to be observed chiefly in development (and in such a persistent larval form as appendicularia), and we must thus consider the tunicata and vertebrata to be related merely by descent from a common ancestral group, the chordonia, characterized by the possession of a chorda.

Just as in the acœlomi, so in the cœlomati, there must have been a long row of intermediate forms which led from prothelmis to chordonium, and one such stage may be easily arrived at and may be called the scolecida. This seventh stage is characterized by the

separation of the intestinal tract into respiratory and digestive parts, by the formation of an anus and a blood-vascular system, by the ciliated external surface and the persistent hermaphroditism. The nearest living representative is the peculiar worm, balanoglossus.

From this scolecida group spring the eighth stage, the chordonia. In these a chorda was developed by the necessity of an axial line of attachment for locomotive muscles, and in correlation with this there took place the backward prolongation of the nervous centres. The nearest living representative of the chordonium is the appendicularia and the larval ascidian; but these must rather be regarded as common descendants from the chordonia than as ancestral forms of the vertebrata.

In considering the phylogenesis of the vertebrata, it is thus seen that we need pay no attention to any of the other great groups of the animal kingdom—annelides, arthropods, echinoderms, molluscs—for these diverged in different directions from the lower cœlomati before the scolecida were developed.

The vertebrata sprung from the chordonia in the archozoic age, for we find in upper silurian strata remains of a primordial selachian. Palæontology can tell us nothing of our oldest vertebrate ancestors, but it is certain that all were derived from a skull-less form, from which the living acrania and craniota have diverged. This constitutes the ninth stage, and may be called provertebratum, of which the only acraniate vertebrate living, "amphioxus," is the nearest representative.

The craniota have diverged in two lines, the living monorrhina and the amphirrhina: the former are represented solely by the lampreys and ray fishes, have advanced little, and are almost extinct; the latter comprise all other vertebrata. The tenth stage would be one of the primordial monorrhina, intermediate between the acrania and the amphirrhina.

Between the amphirrhina (gnathostomata) and the lowest vertebrates there is a wide break, for besides the paired nose, there are other essential distinguishing characteristics, such as the presence of the maxillary and internal branchial arches, of the swim-bladder or lung, and of the two-paired limbs, of the sympathetic nervous system, spleen and pancreas.

The oldest group of the amphirrhina, from which all others diverged, was that of the selachia. The ganoids and the dipnoi form two

diverging branches, from the first of which the teleostei were developed in the mesozoic period; from the latter, the amphibia, in the Devonian period. In the ancestral series, then, the selachia constitute the eleventh stage, the dipnoi the twelfth, and the amphibia the thirteenth. The living selachia and dipnoi are mere remnants of formerly much developed groups. The dipnoi represent a considerable advance on the selachia from the change of habit of life, for the dipnoi are true amphibious animals according to the ordinary sense of the word. This advance shows itself in the modification of the air-bladder into a lung, the communication of the nasal cavity with the mouth, and the development of three chambers to the heart. Among living dipnoi, ceratodus is an especially conservative and primordial form, as marked by the skeleton of its fin and single lung, yet the three living forms with which we are acquainted must have differed widely from the common ancestral form. The dipnoi form a stage exactly intermediate between the fish and the amphibian.

None of the existing amphibia can be looked upon as representing the ancestral form from which sprung the higher vertebrate groups, but the group was abundantly represented by highly developed forms in the carboniferous period. The advance on the dipnoi is especially marked in limbs, and is correlated with their new mode of life. The limbs become transversely segmented, and possess each five toes. This number five has been inherited by all other vertebrata, and when there are less this can always be explained by adaptation: the evidence on this point is so complete that no comparative anatomist can doubt that the higher vertebrates have been developed from a four-limbed and five-toed ancestor, *e.g.*, the relation of equus to anchitherium.

The amphibia form a particularly interesting group, on account of the fact that several of the lower forms have stopped at the different stages of phylogenesis indicated by the ontogenesis of the higher forms; and an acquaintance with the comparative anatomy and ontogeny of the amphibia is sufficient to convince one that man, like all higher vertebrates, is derived from a long-tailed branchiate ancestor, and that only this hypothesis is sufficient to account for his rudimentary tail and visceral arches and clefts.

Among the amphibia there may then be established two stages, the thirteenth with persistent gills, and the fourteenth with the tail but without the gills.

The presence of the amnion in the vertebrate embryo is associated with so many important peculiarities of organization, that all amniota must be regarded as descended from a single ancestral form—the lizard-shaped "protamnion," which was developed from an amphibian form, probably in the carboniferous period, as we already meet with certain saurian remains in the permian formation.

From the protamniata, which constitute the fifteenth evolutionary stage, the sauropsida and mammalia diverge in two different lines, and it is to the latter group that man certainly belongs. The anatomical peculiarities of the mammalia necessitate their descent from a common ancestral form (promammalia), one of the two branches of the protamnia, and presenting an advance on the protamnia by the peculiarities in skull and brain, the development of a covering of hair, diaphragm, and of mammary glands. This advance must have taken place in the triassic period, although it is not in the mesozoic age that the mammals were most developed. Especially interesting is it that the mammalian fossils of this age all indicate marsupial and probably monotrematous animals. It is only in the tertiary period that traces of placental mammals are found. Comparative anatomy and ontogeny support the evidence derived from palæontology. The mammalia are divided by Blainville into the ornithodelphia (the monotremes), the didelphia (the marsupial), and the monodelphia (all other mammalia), and this corresponds to the order of appearance in time.

The sixteenth stage is formed by the monotremata, which still retain the cloaca inherited by the protamnia, and are further characterized by the absence of teats. Brain-skeleton, and indeed all the peculiarities of the anatomy of these animals, are inherited from the protamnia. The absence of teeth must be regarded as secondary, for the first traces of mammalia indicate the possession of teeth (microlestes, dromatherium). The ornithodelphia and didelphia form two widely diverging lines of descent from the promammalia, and it is among the latter that we must look for the next stage of development. The didelphia (marsupialia) of the present day are remarkably restricted in their distribution, but this was by no means the case in mesozoic and cainozoic times. Their anatomical peculiarities are so characteristic for all, that they must be regarded as forming one branch of the promammalian stem, and as the seventeenth stage of evolution of man. The remaining stages, (eighteenth-twenty-

second), all belong to the placentalia, which were developed either in the end of the mesozoic or in the beginning of the tertiary period. The fact that the placentalia must have been entirely developed during this proportionately very short time (not more than three per cent. of the whole length of the earth's history) accords fully with the phylogenetic hypothesis. The chief anatomical peculiarities of the placentalia, as distinguished from their ancestors, are to be found in the mode of nutrition of the fœtus and the extent of development of the brain. The lower placentalia have no decidua, the higher have; and thus we distinguish the indeciduata from the deciduata. To the indeciduata belong the ungulata, the sirenia, the cetacea and the anteaters; to the deciduata, the carnivora, insectivora, rodentia, elephants, bats, lemurs and primates. These two groups diverged from each other, and consequently it is only with the deciduata that we have now to do. According to the shape of the placenta, the deciduata may be divided into zonoplacentalia and discoplacentalia, among which latter group man stands.

The limited distribution and the wide diversity of *character of* the prosimiæ, point to their being very old forms, and it is easy to trace resemblances in the different discoplacentalia to different groups of that order; so that we may conclude that among living forms the prosimiæ are those which stand nearest to the common ancestral form of discoplacentalia. The eighteenth ancestral stage is thus to be found in the primordial prosimiæ, and has probably its nearest living representatives in the lemurs.

The true apes form the nineteenth stage of evolution, and the question of their relations to man has been finally disposed of by Huxley. The fact of this relationship was recognized by Linnæus when he established his order primates, which, from a misconception of the nature of hand and foot, was afterwards split up into quadrumana and bimana. The primates are naturally divided into two groups, the catarhinæ and the platyrhinæ, the former characteristic of the Old, the latter of the New World. To the former group man belongs, and this is shown by his participation in the anatomical peculiarities of the catarhine group, and notably the form of the nose and the dentition. These two groups must be regarded as divergent descendants of the primordial apes, and consequently the relationship of man to the New World apes is only a very distant one. On the contrary, his relation to the highest catarhines is a very much nearer

one than that of those to the lowest catarhines. A long series of catarhine forms must have been passed through before man was developed, before he became accustomed to the upright gait and the correlated further differentiation of anterior and posterior extremities, before the larynx and brain became further developed, along with the functions attaching to these organs.

With reference to these advances, it is possible to mark out four stages which indicate important points in the evolution of man. As the nineteenth stage, then, the lowest catarhine stands forth characterized by the possession of the characteristic nose, dentition and brain; menocerca, existing in the eocene time, as remains teach us; probably semnopithecus is the most nearly allied living form.

The tailless apes, or anthropoids, must be reckoned as the twentieth stage, characterized by loss of tail and partial loss of hair; and among the living forms two well marked groups are distinguishable, an African and an Asiatic. Both the African anthropoids are dark and dolicocephalic, like the Negroes; while the Asiatic forms are brown or yellow and brachycephalic, like their countrymen, the Malays and Mongolians. None of the anthropoids can be reckoned as the absolutely nearest to man. They must rather be regarded as the last widely separated remains of an old catarhine branch, a particular twig of which gave rise to man.

A twenty-first stage will thus be formed by the pithecanthropi, intermediate between the old anthropoid family and man characterized by the complete differentiation of the limbs, but still destitute of speech (alali).

Comparative philology shows that language is of polyphyletic origin; probably it formed after the divergence of the races in the diluvial period. The alali must have thus existed towards the end of the tertiary period.

The twenty-second and last stage is constituted by man endowed with speech, probably formed during the diluvial time in the tropical zone of the Old World, either on the continent of Africa or Asia, or on an earlier continent now sunk, which reached from East Africa to East Asia, the "lemurian" continent.

The above is a mere sketch of the pedigree constructed by Haeckel for man; for the genealogical system of the whole of the animal kingdom, the "Natürliche Schöpfungsgeschichte" must be consulted.

The last chapters of the "Anthropogenie" are taken up with the account of the development of the various organs in man; and here the arguments from comparative anatomy, and the presence of rudimentary organs, are especially brought forward. We find the same assertive tone here, as throughout the rest of the work, about matters that can hardly be regarded as thoroughly settled. As an instance may be taken the assertion that the primordial renal duct is developed by involution from the epiblast. Although this mode of development would accord very well with Haeckel's speculations as to the homologies of that organ, it would seem to be at variance with the researches of most embryologists. Such an assertion we hardly think necessary, especially when the great latitude allowed to the evolutionist by the doctrine of heterotopy (p. 364) is considered—if an organ be not developed in the place where theoretically it may be expected, this may be attributed to an early phylogenetic wandering of cells from one germ-layer into the other.

Haeckel's opponents, scientific and unscientific, are treated in somewhat cavalier fashion. Among the former, W. His, and among the latter the theologians, come in for a good share of abuse.

The admirable diagrams with which the book is copiously provided, and the useful synoptical tables, will render it valuable for giving a good notion of the doctrine of evolution. An American translation is announced, so that it will shortly be accessible to all.

ON SOME BLOWPIPE-REACTIONS.

BY E. J. CHAPMAN, PH. D.,
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I.—ON THE REACTIONS OF METALLIC THALLIUM BEFORE THE BLOWPIPE.

The following reactions are given from direct experiments by the writer: *

In the closed tube, thallium melts easily, and a brownish-red vitreous slag, which becomes pale-yellow on cooling, forms around the fused globule.

In the open tube, fusion also takes place on the first application of the flame, whilst the glass becomes strongly attacked by the formation of a vitreous slag, as in the closed tube. Only a small amount of sublimate is produced. This is of a grayish-white colour, but under the magnifying-glass it shews in places a faint ridescence.

On charcoal, *per se*, thallium melts very easily, and volatilizes in dense fumes of a white colour, streaked with brown, whilst it imparts at the same time a vivid emerald-green coloration to the point and edge of the flame. *If the heat be discontinued, the fused globule continues to give off copious fumes, but this action ceases, at once, if the* globule be removed from the charcoal. A deposit, partly white and partly dark-brown, of oxide and teroxide is formed on the support; but, compared with the copious fumes evolved from the metal, this deposit is by no means abundant, as it volatilizes at once where it comes in contact with the glowing charcoal. If touched by either flame, it is dissipated, immediately, in imparting a brilliant green colour to the flame-border. The brown deposit is not readily seen on

* The reactions given by CROOKES are as follows:—"The metal melts instantly on charcoal, and evolves copious brown fumes. If the bead is heated to redness, it glows for some time after the source of heat is removed, continually evolving vapours which appear to be a mixture of metal and oxide. A reddish amorphous sublimate of proto-peroxide surrounds the fused globule. When thallium is heated in an open glass tube, it melts and becomes rapidly converted into the more fusible protoxide, which strongly attacks the glass. This oxide is of a dark red colour when hot, solidifying to a brown crystalline mass. The fused oxide attacks glass and porcelain, removing the silica. Anhydrous Peroxide of Thallium is a brown powder, fusing with difficulty and evolving oxygen at a red heat, becoming reduced to the protoxide. The phosphate and sulphate will stand a red heat without change."

charcoal; but if the metal be fused on a cupel, or on a piece of thin porcelain or other non-reducing body, the evolved fumes are almost wholly of a brownish-colour, and the deposit is in great part brownish-black. It would appear, therefore, to consist of TlO^3, rather than of a mixture of metal and oxide. On the cupel, thallium is readily oxidized and absorbed. It might be employed, consequently, as suggested by Crookes, in place of lead, in cupellation; but to effect the absorption of copper or nickel a comparatively large quantity is required. When fused on porcelain, the surface of the support is strongly attacked by the formation of a silicate, which is deep-red whilst hot, and pale-yellow on cooling.

The teroxide, as stated by Crookes, evolves oxygen when heated, and becomes converted into TlO. The latter compound is at once reduced on charcoal, and the reduced metal is rapidly volatilized with brilliant green coloration of the flame. The chloride produces the same reaction, by which the green flame of thallium may easily be distinguished from the green copper-flame, the latter, in the case of cupreous chlorides, becoming changed to azure-blue. With borax and phosphor-salt, thallium oxides form colourless glasses, which become gray and opaque when exposed for a short time to a reducing flame. With carb.-soda, they dissolve to some extent, but on charcoal a malleable metallic globule is obtained. The presence of soda, unless in great excess, does not destroy the green coloration of the flame.

Thallium alloys more or less readily with most other metals before the blowpipe. With platinum, gold, bismuth, and antimony, respectively, it forms a dark-gray brittle globule. With silver, copper, or lead, the button is malleable. With tin, thallium unites readily, but the fused mass immediately begins to oxidize, throwing out excrescences of a dark colour, and continuing in a state of ignition until the oxidation is complete. In this, as in other reactions, therefore, the metal much resembles lead.

II.—ON THE OPALESCENCE PRODUCED BY SILICATES IN PHOSPHOR-SALT.

It is well-known that most silicates when fused with phosphor-salt are only partially attacked: the bases, as a rule, gradually dissolving in the flux, whilst the silica remains in the form of a flocculent mass technically known as a "silica-skeleton." Very commonly, almost

invariably, indeed, if the blast be long continued, the bead becomes more or less milky or opalescent on cooling. This latter reaction was apparently regarded by Plattner as essentially due to the presence of alkaline or earthy bases, such as exhibit the reaction *per se*. He states (*Probirkunst: Dritte Auflage, 468*)—"Da man nun von mehreren Silikaten ein Glas bekommt, welches, so lange es heiss ist, zwar klar erscheint, aber unter der Abkühlung mehr oder weniger opalisirt, so muss man sich von der ausgeschiedenen Kieselsaure überzeugen, so lange das Glas noch heiss ist, und dabei die Loupe zu Hülfe nehmen. Die so eben erwähnte Erscheinung tritt gewöhnlich bei solchen Silikaten ein, deren Basen Kalkerde, Talkerde, Beryllerde oder Yttererde sind, die für sich mit Phosphorsalz, bei gewisser Sättigung des Glases, unter der Abkühlung oder durch Flattern milchweiss oder opalartig werden." Dr. Theodor Richter, the editor of the 4th edition of Plattner's work, leaves out the "gewöhnlich" of the above quotation, and so makes the implication still stronger. In this *vierte Auflage*, the statement runs—"Bei solchen Silikaten deren Basen für sich mit Phosphorsalz, bei gewisser Sättigung des Glases, unter der Abkühlung oder durch Flattern milchweiss oder opalartig werden (Kalkerde, Talkerde, Beryllerde, oder Yttererde) wird die Perle unter der Abkühlung mehr oder weniger trübe." It is true enough that silicates in which these bases are present, exhibit the reaction; but as other silicates, practically all, indeed, exhibit the reaction also, the inference implied in the above statement is quite erroneous. The opalescence of the glass arises entirely from precipitated silica. If the blast be sufficiently kept up, a certain amount of silica is almost always dissolved, but this becomes precipitated as the glass cools. A simple experiment will shew that this is the true cause of the opalescence. If some pure silica (or a silicate of any kind) in a powdered condition, be dissolved before the blowpipe-flame in borax until the glass be nearly saturated, and some phosphor-salt be then added, and the blowing be continued for an instant, a precipitation of silica will immediately take place, the bead becoming milky—or, in the case of many silicates, opaque-white—on cooling. This test may be resorted to for the detection of silica in the case of silicates which dissolve with difficulty in phosphor-salt alone, or which do not give a well-pronounced "skeleton" with that reagent.*

* By whom was the formation of a "silica skeleton" first made known? There is no reference to it in the early treatise of Von Engestrom attached to his translation of Cronstedt's "Miner-

III.—ON THE REACTIONS OF CHROMIUM AND MANGANESE WITH CARBONATE OF SODA.

When a mineral substance is suspected to contain manganese, it is commonly tested by fusion with carbonate of soda. But chromium compounds form with that reagent a green enamel much resembling that formed by compounds of manganese.

The chromate-of-soda enamel, however, is yellowish-green after exposure to an oxidating flame, and the green colour never exhibits any tinge of blue.

The manganate-of-soda enamel, on the other hand, is generally greenish-blue when quite cold.

To avoid, however, any risk of error in the determination, the bead may be saturated with vitrified boracic acid until all the carbonic acid is expelled, and a clear glass is obtained. The chrome glass will retain its green colour, whilst the manganese glass will become amethystine or violet. In place of boracic acid, silica may be used if more convenient. In this case, the reaction is assisted by the addition of a very small amount of borax.

IV.—ON THE DETECTION OF CADMIUM IN THE PRESENCE OF ZINC, IN BLOWPIPE EXPERIMENTS.

When cadmiferous zinc ores, or furnace-products derived from these, are treated in powder with carb.-soda on charcoal, the characteristic red-brown deposit of cadmium oxide is generally formed at the commencement of the experiment. If the blowing be continued too long, however, this deposit may be altogether obscured by a thick coating of zinc oxide. When, therefore, the presence of cadmium is suspected in the assay-substance, it is advisable to employ the following process for its detection. The substance, if in the metallic state, must first be gently roasted on a support of porcelain or other non-reducing body. Some of the resulting powder is then fused with

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alogie" (edition 1., 1770; ed. 2. by JOHN HYACINTH DE MAGELLAN, 1788), although phosphor-salt is mentioned as a reagent under the term of *sal fusibile microcosmicum*, and was indeed used by CRONSTEDT before 1758, the year in which his "Mineralogie" was anonymously published. BERGMANN, who followed as a blowpipe worker, states that "siliceous earth" is very slowly attacked by microcosmic salt, but he does not seem to have remarked the skeleton formation in the case of any silicate. The reaction appears to have been first definitely pointed out by BERZELIUS in his standard work on the blowpipe, published in 1821. It was therefore most probably discovered by him, or perhaps—as he lays no claim to its discovery, whilst claiming to be the originator of other tests—it may have been communicated to him by GAHN?

borax or phosphor-salt on a loop of platinum wire, and bisulphate of potash in several successive portions is added to the fused bead. The latter is then shaken off the wire into a small porcelain capsule, and treated with boiling water. A bead of alkaline sulphide is next prepared by fusing some bisulphate of potash on charcoal in a reducing flame, and removing the fused mass before it hardens. A portion of the solution in the capsule being tested with this, a yellow precipitate will be produced if cadmium be present. The precipitate can be collected by decantation or filtration, and tested with some carb.-soda on charcoal. This latter operation is necessary, because if either antimony or arsenic were present, an orange or yellow precipitate would also be produced by the alkaline sulphide. By treatment with carb.-soda on charcoal, however, the true nature of the precipitate would be at once made known.

V.—ON THE SOLUBILITY OF BISMUTH OXIDE IN CARBONATE OF SODA BEFORE THE BLOWPIPE.

Neither in the treatise of Berzelius, nor in the more modern and advanced work of PLATTNER, is any reference made to the behaviour of oxide of bismuth with carb.-soda in an oxidating flame. In PLATTNER'S "Tabellarische Uebersicht des Verhaltens der Alkalien, Erden, und Metalloxyde für sich und mit Reagentien im Löthrohrfeuer," whilst oxide of lead is stated, correctly, to be soluble in carb.-soda in an oxidating flame, the reference to oxide of bismuth is, simply, that with carb.-soda on charcoal it becomes immediately reduced to metallic bismuth; and none of his translators seem to have thought it necessary to supply the omission. In HARTMANN'S tabular "Untersuchungen mit dem Löthrohr," in the handy little work of BRUNO KERL ("Leitfaden bei qualitativen und quantitativen Löthrohr-Untersuchungen"), in the "Löthrohr-Tabellen" of HIRSCHWALD, and all other blowpipe books that I have met with, the same singular omission occurs. This seems to bear out very forcibly the somewhat cynical adage that "books are made from books." To supply the omission, it may be observed that bismuth oxide dissolves in carb.-soda very readily in an oxidating flame, if the supporting agent be platinum wire or other non-reducing body. The glass is clear yellow whilst hot, but on cooling it assumes an orange or yellowish-brown colour, and becomes pale-yellow and opaque when cold. As regards their solubility by fusion in carb. soda, metallic oxides

fall into three groups: (1), *Easily soluble, e.g.*, PbO, Bi^2O^3, BaO, &c.; (2), *Slightly or partially soluble, e.g.*, Mn^2O^3 CoO, &c.; and (3), *Insoluble, e.g.*, Fe^2O^3, Ce^2O^3, NiO, CaO, MgO, &c.

VI.—ON THE DETECTION OF BROMINE IN BLOWPIPE EXPERIMENTS.

When fused with phosphor-salt and copper oxide, the bromides, it is well known, impart an azure-blue coloration to the flame, much like that produced by chlorides under similar treatment, although streaked more or less with green, especially at the commencement of the operation. To distinguish these bodies more closely, Berzelius recommended the fusion of the test substance with 6 or 7 volumes of bisulphate of potash in a closed tube. Bromides by this treatment become decomposed, as a rule, and give off strongly-smelling brownish or yellowish-red vapours of bromine. But this process does not always give satisfactory results, as in some instances the bromide is very slightly attacked. In this case, the following method, based on a peculiar reaction of bromide of silver, first pointed out by Plattner, may be resorted to. If insoluble, the bromide is fused with 2 or 3 volumes of carb.-soda. A soluble bromide of sodium is thus formed, with separation of the base. To the filtered or decanted solution of the fused mass, a small fragment of nitrate of silver is added, in order to precipitate bromide of silver. This, collected by decantation, is fused with a small quantity of bisulphate of potash in a little flask or test-tube. The bromide of silver will quickly separate from the flux in the form of a blood-red globule, which becomes pale-yellow when cold. The little globule, washed out of the tube by dissolving the fused bisulphate in some warm water, is carefully dried by being rubbed in a piece of blotting or filtering paper, and is then placed in the sunlight. After a short time, it will turn green. Chloride of silver, as obtained in a similar manner, melts into an orange-red globule, which changes to clear-yellow on cooling, and finally becomes white, or nearly so. Placed in sunlight, it rapidly assumes a dark-gray colour. Iodide of silver, under similar treatment, forms while hot an almost black globule, which becomes amethyst-red during cooling, and dingy-yellow when cold. In the sunlight it retains the latter colour. A mixture of chloride and iodide of silver assumes a greenish tint somewhat resembling the colour acquired by the bromide globule. This, however, can scarcely give rise to any

error, as the presence of iodine is revealed—even if no violet-coloured fumes be emitted—by the dark amethystine colour of the bead whilst hot.

VII.—ON THE DETECTION OF CARBONATES IN BLOWPIPE PRACTICE.

A mineral substance of non-metallic aspect, in nine cases out of ten, will be either a silicate, sulphate, phosphate, borate, carbonate, fluoride, or chloride color: more especially if the streak be uncoloured or merely exhibit some shade of green or blue, or if the substance evolve no fumes when heated on charcoal.

Simple fusion with phosphor-salt on a loop of platinum wire serves at once to distinguish a silicate from any of the other bodies enumerated above, as, whilst the silicate is but slowly attacked, these other bodies are readily and rapidly dissolved. Among the latter, again, the carbonates are distinguished without risk of error by the marked effervescence which they produce in the bead by the evolution of carbonic acid during fusion—the phosphates, sulphates, &c., dissolving quietly. The reaction is quite as distinctive as that produced by the application of an ordinary acid; but, of course, it may arise in both cases not only from a carbonate proper, but from the presence of intermixed calcite or other carbonate in a silicate or other body. It was by its use, upwards of twenty years ago, that the writer detected the presence of carbonate of lime in certain specimens of Wernerite (the "Wilsonite" variety), portions of which had previously been analyzed without the impurity having been discovered. It need scarcely be stated that the test-substance must be added to the phosphor-salt, on the platinum loop, only after the quiet fusion of the flux into a transparent glass. The reaction is, of course, manifested equally well with borax.*

VIII.—ON THE USELESSNESS OF TURNER'S FLUX AS APPLIED TO THE DETECTION OF BORACIC ACID.

Many years ago—about 1827 or 1828—TURNER proposed, in examining a body for the presence of boracic acid, to mix the test-substance with bisulphate of potash and fluor-spar (in the proportions

* It is singular that this very marked and useful reaction should not have been alluded to in any of the standard treatises on Blowpipe Practice. The only work known to the writer in which a passing reference is made to it, is that of Hirschwald ("Löthrohr-Tabellen"), published in 1875. The present writer called attention to it in 1871.

of 4½ parts of the former to 1 part of the latter), and to expose the mixture on a clean platinum wire to the point of the blowpipe flame. Fluo-boric acid is thus produced; and by its volatilization, a momentary green colour is imparted to the edge of the flame. MERLET recommends the employment of 3 or 4 parts of this flux to 1 part of the substance under examination. This test is much quoted in blowpipe books and works on chemical analysis generally; but it is altogether superfluous. With borate of soda it fails entirely, or yields very unsatisfactory results; and although it answers for most other borates and for boro-silicates, it is uselessly applied to them, because these bodies colour the flame equally well, *per se*. BERZELIUS seems strangely to have overlooked the coloration of the flame as produced by many substances under blowpipe treatment. In his work on the blowpipe, for example, he fails to notice the character in describing the reactions of lepidolite, sulphate of baryta, datolite, triphylline, and other minerals, which exhibit it most distinctly. Under axinite, moreover, he has the following statement: "Turner asserts that a flame tinged green by boracic acid is obtained by the aid of sulphate of ammonia (or bisulphate of potash) and fluor spar." This "assertion" is true enough; but *all specimens of axinite colour the flame green, per se*. The uselessness of the flux was pointed out, I find, by BUZENGEIGER as long ago as 1829. In the *Annales des Mines* for that year (tome v., p. 36), he states: "J'ai essayé, pour reconnaître la présence de l'acide borique, d'employer le flux indiqué par M. Turner, mais ces tentatives ne m'ont pas réussi, probablement par défaut d'habitude. Quoi qui en soit, tous les mineraux que M. Turner a vu colorer la flamme en vert en les melant avec son flux, m'ont donné la meme réaction en les introduisant avec quelque soin dans la flamme bleue, sans les mélanger avec aucun réactif." BUZENGEIGER, whose name does not seem to be quoted in any blowpipe work, appears to have first proposed the sloping blowpipe-wick, long before it was adopted by PLATTNER; and he noticed, at the same early date, that the crimson coloration of the strontium-flame was entirely obliterated by the presence of barytic compounds.

IX.—ON THE COMPORTMENT OF CERTAIN ALLOYS UNDER THE ACTION OF THE BLOWPIPE.

In examining these reactions, about equal portions of the metals (forming the alloy) may be placed together, on charcoal, and subjected to the action of a reducing flame.

1. *Platinum and Tin* unite with violent deflagration and emission of light, forming a hard, brittle, and infusible globule.

2. *Platinum, Zinc and Tin* unite with violent action, the zinc throwing off long flakes of oxide.

3. *Platinum and Zinc, per se,* do not combine, the zinc burning into oxide.

4. *Platinum and Lead* unite quietly, forming a brittle globule.

5. *Platinum and Thallium* unite quietly; the resulting globule is dark externally, gray internally, and quite brittle.

6. *Platinum and Bismuth* unite quietly, or with merely slight spitting, into a dark brittle globule.

7. *Platinum and Copper* combine quietly, though not very readily, into a hard, light-coloured, malleable globule.

8. *Platinum and Silver* unite quietly, but not very readily unless the silver be greatly in excess, into a white malleable globule.

9. *Platinum and Gold* unite quietly, forming (if the gold be somewhat in excess) a yellow malleable globule.

10. *Gold and Tin* unite quietly into a very brittle globule.

11. *Gold and Zinc* do not combine *per se;* the zinc burns into oxide.

12. *Gold and Lead* combine quietly, forming a gray brittle bead.

13. *Gold and Thallium* unite quietly, but separate again to some extent during cooling. The globule may thus frequently be flattened out, but not without cracking at the sides. If the metals remain united, the button is dark blackish-gray, and quite brittle.

14. *Gold and Bismuth* unite quietly and readily, forming a very brittle globule.

15. *Gold and Copper,* and 16, *Gold and Silver,* unite, and form a malleable globule.

17. *Silver and Tin* unite quietly into a malleable globule.

18. *Silver and Lead* unite readily into a malleable globule.

19. *Silver and Thallium* combine readily: globule, malleable.

20. *Silver and Bismuth* unite readily and quietly: the globule is brittle, but admits of being slightly flattened out.

21. *Silver and Copper,* and 22, *Silver and Gold,* form malleable globules. The gold alloy, even with gold largely in excess, is quite white. If it be flattened out, and heated in a platinum spoon with some bisulphate of potash, it will become yellow from the silver

on the surface being dissolved. On re-melting the flattened disc, a silver-white globule is again obtained.

23. *Copper and Tin* unite into a gray and partially malleable bead, the surface of which, in the O. F., becomes more or less thickly encrusted with cauliflower-like excrescences of oxide.

24. *Copper and Zinc* do not unite *per se* into a globule, the zinc burning into oxide. Under carb.-soda, or carb.-soda and borax, brass is readily formed.

25. *Copper and Lead* form a dark-gray globule, which is sufficiently malleable to admit of being extended on the anvil.

26. *Copper and Thallium* melt into a dark-gray malleable globule.

27. *Lead and Tin* unite readily, but the globule commences immediately to oxidize, throwing out excrescences of white and yellow oxide. On removal from the flame, it still continues in ignition, and pushes out further excrescences. The unoxidized internal portion (if any remain) is malleable.

28. *Lead and Bismuth* unite readily: the molten globule acquires a thin dark coating of oxide on the surface only, and admits of being flattened out, more or less, upon the anvil.

29. *Lead and Thallium* form a malleable globule.

30. *Bismuth and Tin* unite readily, but the fused mass immediately throws out excrescences, and becomes covered with a dense crust of oxides. The reaction, however, it not so striking as with lead and tin.

31. *Thallium and Tin* exhibit the same reaction as lead and tin, but the cauliflower-like excrescences are brownish-black.

SOME CANADIAN NOMS-DE-PLUME IDENTIFIED:

WITH SAMPLES OF THE WRITINGS TO WHICH THEY ARE APPENDED.

BY HENRY SCADDING, D. D.

I suppose all countries that have a literature at all, have a certain number of pseudonymous writings to shew, which have become classic, so to speak; a certain number of productions under feigned names, that have acquired a repute or a notoriety beyond anything perhaps that their authors had ever anticipated for them. The oldest literatures of which we have any knowledge exhibits examples of such writings. To this day we have in circulation compositions assigned to Orpheus, Musæus, Homer, Hesiod, Pythagoras, which it is certain those personages never penned. In like manner, in the far east of Asia, the names of Confucius, Mencius, Manes, Sakyamouni, Mahomet, are abused. And all this not, in every instance, originally from a gross intention to deceive. It seems to have been an early practice, everywhere perhaps, and one held to be within certain limits legitimate, to give importance to compositions by attributing them to great men long previously deceased.

And then the sophists and rhetoricians, and, at later periods, the disputants in the schools at universities, have now and then unintentionally misled posterity by their declamations, in which illustrious characters were personated and their style imitated. These productions, intended simply as exercises of subtlety and skill, have been, in the lapse of time, occasionally assigned to the authors respectively mimicked, as their genuine offspring. Thus we now have a Plato and a pseudo-Plato; an Aristotle and a pseudo-Aristotle; a Lucian and a pseudo-Lucian; a Cicero and a pseudo-Cicero. Thucydides and Livy have much to answer for in this regard, having led the example of putting into the mouths of their heroes formal speeches, which, however worthily and truthfully conceived, were never uttered.

In theology, sad to say, a like practice has prevailed, to such an extent that the modern divine has to be very wary in regard to the writings which he quotes as authority. For among the Fathers and

the Decretalists it is discovered now that, as the French say, "*Il y a fagots et fagots.*" When we buy the Glenfield starch, are we not constantly told to see that we get it? It is just so with Cyprian and Athanasius, and many others of that class; when you cite them, you have to see to it that it is they.

At later periods, pseudonyms have been used for purposes of concealment, and the writings to which they were attached became famous. The Abbé St. Cyran in 1635 wrote his famous defence of the French hierarchy, under the title of Petrus Aurelius; and Paschal originally subscribed the name of Louis de Montalte to his well-known Provincial Letters. There is in France a whole Dictionary of "Auteurs Déguisés sous les noms Etrangers, Empruntés, Supposés, Feints à plaisir, Chiffrés, Renversés, Retournés, ou Changés d'un Langue en une autre." Baillet, the compiler of this work, has also a department in his "Jugements des Savants" for "Auteurs Déguisés." The name by which Paul Sarpi was known as historian of the Council of Trent was Pietro Soave Polano, an imperfect anagram of Paolo Sarpi, Venetiano. That Sarpi had some reason to protect himself by a disguise, is shown by what befel him on the Bridge of St. Mark's, where he was waylaid by assassins and stabbed all but mortally. In Germany, Frederick von Hardenberg, author of "Hymns to Night" and the mystic romance entitled "Heinrich von Ofterdingen," is usually known and quoted as Novalis.

In Great Britain and Ireland, while yet open criticism of the policy of Ministers was held to be seditious—when the publication of parliamentary debates was forbidden, and the press generally was gagged—a pseudonymous literature of a wide range of course sprung up. It was only under disguised names that enlightened men, in many an instance, ventured to promulgate their doctrines which, however salutary to mankind, were yet inacceptable to those in power, and sometimes to the bulk of the community likewise. Sometimes the mask assumed was so effectually retained that, in spite of considerable curiosity on the point, posterity has been left in doubt. Whole shelves are filled with conjectural replies to the queries, Who was Martin Marprelate? Who was Junius? But Peter Pindar's secret was quickly discovered, as also was Peter Porcupine's and Peter Plimley's, no particular pains having been taken in any of these cases to preserve it. The same may be said of Runnymede and Historicus.

In very recent times, several literary ladies have veiled their sex under such *noms-de-plume* as George Sand, George Eliot, Currer Bell, Acton Bell, Ellis Bell; and by the adoption of this course, they have created for themselves an entity, so to speak, independent of their proper persons; a thing which has happened in similar manner to some male authors also. When we hear or read of Sholto and Reuben Percy, of Thomas Ingoldsby, of Father Prout, of Arthur Sketchley, of Barry Cornwall, who is not inclined to think of each of them as substantial, real personages? We hear sometimes of persons carving out a name for themselves; here the process is reversed—names carve out and create for themselves persons.

In the United States they have closely followed the literary practices and caprices of the mother country. Some years before the Revolution, Franklin was widely known as Richard Saunders, the "Poor Richard" of the Almanac from 1732 downwards. In later times, Dietrick Knickerbocker, historian of New Amsterdam, *i.e.*, New York, became a quasi-actuality, whilst the second assumed name of the same author, Geoffry Crayon, became a familiar expression throughout England as well as the United States, and was regarded by many as almost a real cognomen. In late years, Mr. Hosea Biglow has nearly equalled Geoffry Crayon in extent and degree of reputation. Numerous other appellations of this class have likewise become household words, throughout the United States at least; for example, Ik. Marvel (Donald Mitchell), Jack Downing (Seba Smith), Gail Hamilton (a lady, Miss Dodge), Mark Twain (T. L. Clemens), Petroleum J. Nasby (D. R. Locke), &c. The supposed United States characteristic practice of citing only the initial of an intermediate Christian name, as here, has given rise to the not very elegant *nom-de-plume* of Orpheus C. Kerr (R. H. Newell), intended to be a bit of satire on carpet-baggers and other hungry parasites of the several governments and municipalities.

Now, our Canadian literature has something to shew analogous to these developments in the literatures of older communities. Our Canadian literature, indeed, in what may be called its more infantile stage, has consisted, in great measure, of productions to which, for reasons arising out of the times, were affixed fictitious signatures. And I have thought that it might be a matter of some interest, and even of some utility, to collect the more important of these feigned names, giving at the same time samples of the writings to which they

are appended, and naming their authors where possible or proper to do so. I do not pretend to give a list of the innumerable Agricolas, Justitias, Catos, Pro-bono-publicos, &c., that from time to time have abounded in our Canadian papers and periodicals, as in all papers and periodicals, each treating, fitly doubtless, and reasonably, of a topic of the moment just once, and then emerging to the view no more, and so passing into complete oblivion. This would be an endless task, and to identify the respective writers would be a matter perhaps of not much moment. But there have appeared from time to time amongst us, under fictitious signatures, during our short history, especially in what seems to us now a rather remote past, writings which deserved and have acquired more than an ephemeral repute, and which have exerted over our mixed yet plastic Canadian society, an influence that may be said, in some sense, to continue to the present time. It is the authors of such productions as these that I am to trace and put on record, as contributors in some sort to our nascent Canadian literature, and perhaps to the formation of our Canadian national character.

On subjects then that may be roughly classed as follows, I find writings of the kind described:

1. Our Politics: our politics while Canada was yet known as the two Canadas, Upper and Lower; and our politics just after the re-union of the two provinces into one. 2. The promotion of emigration. 3. The question of education. 4. Miscellaneous subjects; as, for example, the fostering of patriotism towards Canada, and love and reverence for the mother country, the cultivation of literature and taste in general. And these writings divide themselves into prose and verse.

On the prose side we have, in relation to the politics of the first-named period, the writings of Veritas and Nerva. In relation to the second, those of Patrick Swift and Legion. On the subject of emigration we have the Backwoodsman, the Pioneer of the Wilderness. On the educational question there are Graduate, Scotus, British Canadian. Under the general head of the inculcation of taste in art and literature, the promotion of patriotism, loyalty, attachment to the mother country, we have Guy Pollock, Alan Fairford, Solomon of Streetsville, Maple Knot, Maple Leaf, The Whistler at the Plough, and Libertas.

On the poetical side, touching of course lightly and gracefully on

subjects more or less identical with those just enumerated, we have Rosecharp, Cinna, Isidore, Plinius Secundus, Claud Halcro, Zadig.

I exclude with regret, from a kind of necessity, Lower Canadian French *noms-de-plume*, not having convenient access to the early journals and other publications which from time to time have appeared in what is now the Province of Quebec; but I know there are several which are duly honoured by literary men there. I also exclude the writings of Mr. Samuel Slick, the famous clock-maker of Slickville, the decease of their author having occurred before his native province, Nova Scotia, was comprised within the Canadian boundaries.

I begin with the prose writers; and of these I dispose first of those whom I have classed as miscellaneous.

In the periodicals of 1833 and of several successive years, published at Toronto, appeared many communications on miscellaneous subjects, signed Guy Pollock. They attracted general attention, being marked by an elevation of thought and culture beyond the ordinary, and by a good style. I give a passage from a description of the Falls of Niagara, by Guy Pollock, in the *Canadian Literary Magazine* for April, 1833, in which he offers some strictures on the great cataract thus: "Were I to write a criticism on nature—which, by the way, would be something like presumption—I would say," Guy Pollock writes, "that for producing a grand emotion, the cascade is too low when compared with its extent across the river. The architectural proportions, as builders express the idea, are not preserved, the river even grows broader immediately above the Falls—a circumstance which gives the cascade too much the appearance of an immense mill dam—an appearance which excites a very ordinary, although, no doubt, a very useful idea. The Falls of Niagara are great," he continues, "and therefore in some measure grand; but, unless for their magnitude, which in that respect gives them a decided superiority, they are, in respect of sublimity of aspect and grandeur of surrounding scenery, far inferior to the Falls of Clyde, round which the jackdaws are screaming, above the goshawks are soaring, and under the overhanging groves the bat flies at noon. Compared with the Falls of Clyde, those of Niagara have a lifeless appearance."

The following is from a chapter on craniology in the same periodical, by the same writer, under the same signature: "The common

reproach of wanting brains, a round head, and a thick skull, are mere colloquial expressions, often spoken at random, to suit the humour of the moment," Guy Pollock says; "but on inquiry they are found to be strictly philosophical expressions, sanctioned by the experience of ages. This physical deficiency in the position and quantity of the brain, explains, on philosophical principles, the grand secret why the Ethiopians have so long been retained in a state of slavery. That knowledge is power is an undisputed aphorism, which applies well to the present condition of the Ethiopian species; they want knowledge to discover and appreciate their own power, otherwise they would have broken the gyves of slavery in pieces long before this evil hour: for the first use that every man makes of knowledge is to turn it to his own advantage. It is the same want of knowledge, in a still greater degree, which constitutes what we call docility in the horse or elephant. The strength of either of these animals is far beyond that of a man: but they know it not; they cannot avail themselves of their natural superiority in this respect, therefore they are confounded by the commanding skill of their drivers, and tamely submit to their dominion."

Guy Pollock is understood to have been Robert Douglas Hamilton, a Scottish M.D., who had seen service as a surgeon in the army and navy. He emigrated to Canada in 1830, and died in Scarborough, near Toronto, in 1857. Before his emigration Dr. Hamilton was known in Scotland and England as the author of works of fiction, and of essays on medical and other subjects.

The *Canadian Literary Magazine*, published at Toronto in 1834, was edited by a gentleman afterwards well known in the literary world of Canada by the *nom-de-plume* of Alan Fairford. Under this signature appeared in a widely-circulated Canadian periodical a series entitled "The English Layman." The subjects handled therein were such as the following: The connection between Democracy and Infidelity, Duties of the Laity, Plain Reasons for Loyalty, the Press, Sacrilege, &c. In all the productions of Alan Fairford there is noticeable a fine, manly sentiment expressed in remarkably vigorous and pure English. I quote from the introduction to his paper entitled, "Plain Reasons for Loyalty." The scene is Cobourg, on Lake Ontario. We are reminded of the style, now of Paley, now of Washington Irving. "I sit," Alan Fairford says, "while I write, beneath one of those lofty, drooping elms which, having been spared

from the general havoc of their sylvan brethren, are to be found here and there, erect in single beauty, relieving the eye after it has been wearied in gazing on extended masses of unbroken foliage. It stands on a ridge in the midst of an open country, and when seen from a distance on a summer's evening, with a sky as yet glowing with a thousand inimitable tints, it displays so minutely all its tracery, branches, and even leaves, that it appears as if it would be no difficult task to count them. But the day is as yet in all its meridian splendour. The shrill, cheerful chorus of the grasshoppers rings in my ears. The echoes of the flail mingle with the softer murmur of the breeze that wantons with the leaves over my head; and every sound and sight proclaims that the sand has still some hours to run before the hum of industry and the voice of creation will be mute. Rich, various and beautiful is the landscape on which I gaze. At my feet the country descends into a gentle slope; to this succeeds a narrow, fertile valley, with a stream winding through it that waters the meadow, turns the wheel of the mill, and contributes alike to the sustenance and health of man, the cool refreshment of the panting cattle, the growth of manufactures, and the promotion of agriculture. Beyond the valley the ground ascends into a gentle undulation. Fields that have consigned their produce to the barn, lie denuded of their wealth, but dotted here and there with browsing cattle. A range of woods, with many a crested eminence wrapped in the blue haze of an autumnal day, terminates my view. The frost has not yet scattered the colours of the rainbow over the forest, but there is nothing like sameness in the glorious landscape. Orchards laden with reddening fruit, the white farm house with its commodious outbuildings, the country inn, flanked by a long line of Lombardy poplars, which here need not droop for want of Italian skies, the towering mill with its pointed angles, and the broad Ontario stretching to the right, are objects that successively attract the eye as it travels with human restlessness in search of novelty and variety. Now I turn my head, and perceive that the picture is incomplete, for I have not yet introduced into it a pleasing scene of the unfinished harvest—the sheaves that you cannot look upon without thanking God for your daily bread, and the rising stack on which they will shortly be piled. Alongside of the gathered and gathering treasures of the present year, the husbandman is committing to the rich fallow the promise of the next; and my mind is at once regaled

with the sight of a present plenty and the prospect of its undiminished succession. To whom do these woods and meadows, these streams and valleys, these smiling homesteads, these flocks and herds, belong? Does their possessor reside in some baronial hall—the rural king of his surrounding tenantry? Or is the soil the property of a few, while the many rise up early and lie down late, and eat the bread of carefulness? The inequalities of condition and wealth—the characteristics of an old and densely-peopled country—are not as yet known in Upper Canada."

The following has reference to the Duke of Wellington: "We are prepared to view him meditating gigantic schemes and laying down the plans by which they are to be accomplished. We find no more than we expected when he compresses a life of truth and experience into a single hour, and with an intuitive glance foretells the catastrophes of the various dramas enacting on the world's wide stage before him. We perceive no cause for special wonderment in his untiring sagacity, in his combination of the aggressive vigour of Marcellus with the defensive caution of Fabius, in his unrivalled practical sense, his unshaken magnanimity, and his lofty disinterestedness. These, it must be confessed, are signal and noble qualities, but they fill us with esteem rather than with affection; they dazzle rather than fascinate our eyes; and their combination is not a novel feature in the character of the world's foremost men. The traits which these Despatches exhibit to us for the first time, and which previously were not in general accorded to the Duke of Wellington, are those which add love to admiration, and heighten national gratitude into personal attachment. It is ennobling to our species, and delightful to our feelings, to find that the highest excellences of private station are not irreconcilable with the stern career of the victorious warrior, and that the household virtues and the peace-loving humanities of life may be found among the demoralization of camps and the carnage-covered fields of battle."

I select one more passage from this excellent master of English style. It is from a paper in a humorous strain, entitled, "A Defence of Little Men," and it professes to be, not by Alan Fairford this time, but by Sir Minimus Pigmy. "Perhaps some tall gentleman is laughing at what I have written," Sir Minimus says, "but he had better take care not to laugh in my face. Little men are as choleric as Celts; and Sir Jefferey Hudson (a name ever to be venerated by

me) has shown that little men are not to be insulted with impunity. On the breaking out of the troubles in England, the pigmy knight was made a captain in the Royal Army, and in 1644 attended the Queen to France, where he received a provocation from Mr. Crofts, a young man of family, which he took so deeply to heart that a challenge ensued. Mr. Crofts appeared on the ground armed with a syringe. This ludicrous weapon roused the indignation of the magnanimous little hero to the highest pitch. A real duel ensued, in which the antagonists were mounted on horseback, and Sir Jefferey, with the first fire of his pistol, killed Mr. Crofts on the spot. I cannot refrain from lingering on the history of the gallant Hudson. Sir Walter Scott, in his novel of 'Peveril of the Peak,' has immortalized the chivalrous little knight, and I humbly wish to lend my feeble aid in making known to the Canadian public the deeds of departed littleness."

These remarkable papers were from the pen of Mr. John Kent, chief secretary for a time to Sir George Arthur, one of the Lieut.-Governors of Upper Canada, and afterwards private tutor and confidential secretary to the present Earl of Carnarvon. The influence of Mr. Kent's character and writings on the minds of many of his contemporaries during his sojourn in Canada was very marked.

Between 1848–58, our Canadian Streetsville acquired great distinction and *éclat* as being the scene of the publication of the *Streetsville Review*, a periodical which managed to gain for itself a reputation altogether beyond the average for originality and spirit. Its editor occasionally spoke of himself as Solomon in the columns of this journal, and under this sobriquet, innumerable oracular utterances of the Review were quoted and circulated in most of the newspapers of Canada. Dry Scotticisms and quaintly-formed words and expressions gave a kind of pungency to Solomon's observations on current events. The following will serve as specimens:

From the *Weekly Review* of June 17th, 1854. "Lyrical Lunacy. Solomon has ever regarded it as a leading feature of his mission to check, by judicious application of the taws, that itch for engendering idiotical rhymes which so calamitously characterizes this cranky age. The latest escapade of this description, calling for stripes, appears in the *Commercial Advertiser* of Montreal on Tuesday," &c. He then transcribes and remarks on the doggerel referred to. Again: "Solomon in his slippers. It is a common superstition among the

million that editors are fashioned out of cast-iron, and that they can engender articles from the primary day of January to the final ditto of December without experiencing lassitude or performing the muscular action of a yawn. Never was there a more monstrous fallacy. Solomon at least can speak for himself, that he is subject to all the weaknesses of our common humanity, and desiderates an occasional modicum of repose quite as much as the balance of Adam's multitudinous family." Again: "The rival settlements of Hamilton and Toronto being witnesses, Streetsville is progressing at railroad speed. Like the fabled bearer of the mythical Jack, a sharp-eyed observer can twig the perpetual motion of its growth. Our grist and saw-mills are too numerous to be recapitulated without drawing sundry breaths; our stores emulate the dollar-coining emporiums of King Street (Toronto); and before long, the magic wand of an act of incorporation will call into being crops of civic fathers, wise as Solon, and inflexible as Brutus senior. In these circumstances, we are patriotically desirous that our beloved sucking city should put her best foot foremost, and exhibit to an admiring universe smooth-kempt hair and a shining well-washed face. Now, nothing would tend so much to improve the frontispiece of Streetsville as a sprinkling of trees judiciously emplanted before her churches, marts and villas. Stern truth compels us to admit that the village does not possess an overly inviting appearance to the stranger who, whirled past in the accommodating machine of Squire Harris, snatches a passing glance at her charms. Tardily doth the plasterer and bricklayer repair the dilapidations which accident or senility makes in her dwellings; and too frequently doth the stocking or superannuated Kilmarnock night-cowl usurp the place of plate or crown glass in the windows of her sons. If all these flaws were redressed, most assuredly we would rise in the scale of cityhood so far as appearance went. But chiefly and above all would the arborical immigration which we advocate heighten the witcheries of our far-famed clachan. Let the sceptic on this head pay a visit to the neighbouring republic, and he will frankly admit that we have got the legitimate sow by the ear." Kossuth's avoidance of the British side of the Lakes in 1852 is thus spoken of: "We esteem it as a high compliment that Kossuth has not visited Canada. We thank him for the tacit admission that the spurious metal which so tickled the vulgar taste of our republican neighbours would be altogether thrown away upon the denizens of

British North America. There is, there must be, a lingering fragment of shame about the man after all. It is a redeeming feature in Kossuth's character that he lacked assurance to preach to a free people, like the subjects of Queen Victoria, about freedom, after coming from the land of bondage, redolent with the foul kisses of the tyrant, and gorged with money earned by the toil of the slave."

This Solomon, under another guise, edited the *Anglo-American Magazine*, a valuable periodical published for several years in Toronto by Mr. Maclear. One conspicuous feature of this monthly was a department in which, after the pattern of *Blackwood* of old, a group of friends discuss matters in a free and familiar manner. The personage who figures as the editor in these "Sederunts," as they are called, is "Culpepper Crabtree, Esq.," major in the militia, at whose shanty events and books are made to pass under review; the other interlocutors are the Doctor, the Laird, the Squireen, and Mrs. Grundy. The shanty itself is on the banks of the Humber. It is thus spoken of: "On a gentle slope, some four miles to the westward of the 'Muddy clearing,' as Solomon of Streetsville delighteth to call our city, *i.e.*, Toronto, may be seen one of those primitive fabrics, yclept in Cannuckian vernacular a 'shanty.'" It is further described. The conversation then proceeds in a natural, chatty way, with a plentiful intermixture of anecdote and humour. Thus in the year of the Duke of Wellington's death (1852), we have:—

"LAIRD.—Ha'e ye read, Crabtree, the vidimus which the *Times* gives of the great Duke's life and character?

MAJOR.—I have, and with unmixed enjoyment. It is one of the most masterly essays which has graced the periodical press for many a long day, far surpassing, in my humble opinion, the highest flights of that showy but intensely superficial writer, Thomas Babington Macaulay.

LAIRD.—You are a thocht too hard on Tummus, Major. His sangs o' auld Rome rouse my blood like the blast o' a border trumpet.

MAJOR.—By your leave, Laird, you are creating a man of straw for the mere purpose of demolishing your handicraft. I said nothing against Macaulay as a poet, but merely demurred to his pretensions as a historian.

DOCTOR.—The less a fossil such as you are, Crabtree, says respecting a Whig historian, the better. You know that I, as a Whig, can

never agree with your opinion. We are wandering, however, from the point in hand. What a wonderful establishment the *Times* must be, which, almost at an hour's notice, can turn out such an article as that to which I referred."

Again, in 1852, thus closes a discussion on Cooper, the United States novelist. The Major, or editor, thus speaks of the book before him, viz., a "Memorial of Cooper," as a pleasingly compiled record of certain proceedings which have recently taken place in New York, with the view of giving expression to the public sentiment on the death of that illustrious novelist. On the Doctor's observing that "Cooper's Leatherstocking" is a *chef-d'œuvre*, the Laird rejoins: "I like his writings weel eneuch; but ah, man, he's no to compare wi' Walter Scott," &c. The peroration of a eulogy by W. C. Bryant is quoted, of which the language is somewhat high-flown. This draws from the Squireen the observation: "Ah! how swately the dew of praise must fall on the sensibilities of departed genius, if the spiritual essence be cognizant of the incense of corporeal votaries at its shrine and susceptible of its influence." To which the Laird gruffly replies: "Nane o' your poetical flights o' fancy! Dinna forget we ha'e four miles o' limestone to hirple o'er afore the sma' hours come ringing frae the St. Lawrence Ha'. Guid nicht, Major." (*Exeunt.*) Thus the sederunt closes.

Solomon of Streetsville was the Rev. J. MacGeorge. Mr. MacGeorge, prior to his emigration to Canada, was an experienced litterateur, a contributor to *Fraser* and other English periodicals. In his graver moods, Mr. MacGeorge was a poet of no mean grade, as we shall perhaps hereafter see.

I observe in Morgan's *Bibliotheca Canadensis* that in 1858 a work of fiction, highly spoken of, appeared in Montreal, entitled "The Life and Adventures of Simon Seek; or, Canada in all Shapes," by Maple Knot. I regret that I have it not in my power to give a sample of Maple Knot, who was Mr. Ebenezer Clemo, now deceased. The nom-de-plume Maple Knot suggests to me the mention here of "Maple Leaf," or rather "The Maple Leaf," a very handsome Christmas or New Year's gift book, which was published in Toronto in 1847, and in several successive years. The "Maple Leaf" introduced to the Canadian public a goodly company of creditable local writers, who, without the stimulus afforded by this publication, would perhaps never have ventured to try their hand at such

work. The "Maple Leaf" thus contributed much to the genesis of a high-class Canadian literature. It were to be wished that the editor of this volume had identified himself with Maple Leaf as a nom-de-plume instead of resigning it altogether to the volumes of which he superintended the issue. The papers in that book are all anonymous. If none of them are from his own facile and elegant pen, it is certain that the prefaces are his handwork. From these accordingly I venture to make an excerpt or two, treating them as though they had appeared under the signature of Maple Leaf.

First, I give a pleasant account of our Canadian London as it was in 1848, with some remarks on the Canadian habit of transplanting local names from the "Old Country." "The good custom," Maple Leaf says, "of naming places, as they spring into existence in this new world, after the old localities with which the early associations of the settlers are connected, at once attests the affectionate remembrance of the fatherland, and preserves unimpaired the sweet ties which bind us to 'home,' as we still fondly call the far-distant land of our birth. In the present case the town of London, the county of which it is the capital is Middlesex, the stream the banks of which it graces bears that name so closely associated with the most thrilling events of English history, the Thames. The toll-gate on the right of our view opens on another Westminster Bridge; and a second Blackfriars would meet the eye if we could but see a little more to the left."

> "Procedo et parvam Trojam, simulataque magnis
> Pergama, et arentem Xanthi cognomine rivum
> Agnosco, Scææque amplector limina portæ."

"Nor is the Canadian stream," Maple Leaf continues, "wholly wanting in historic interest; for in a battle in its neighbourhood fell the noblest Indian warrior that ever drew bow, or raised rifle, in defence of the 'White Father' of the tribes. It was at the battle of the Thames that the gallant *Tecumseth* was lost to his brother warriors, and to his country; but this, however, was at a distance from the scene more immediately under our notice. Elevated on a pleasant bank, which looks down upon the junction of two streams, stands our Canadian London. As it stretches itself towards the waters that flow on either side of it, it seems as if fondling them into that amity with which they embrace and flow on united, ere they leave the reconciler of their variance. From this 'meeting of the

waters'—ah! how unlike that sweet valley in our own dear isle, with

'Her purest of crystal and brightest of green!'

—the rapid river hastens on through a fertile country, until it pours its tribute into the lap of St. Clair, some miles below Chatham. Long previous to the foundation of the town, the surrounding country was well settled, and contained many wealthy farmers, and the spot was called by the uncouth familiar appellation of 'The Forks.'"

In another place, we have a reference to the University of Toronto, or, as it was called in 1848, the University of King's College. At that time the work of the University was carried on in the Parliament Buildings, the Government having been removed, when the two Canadas were united, from Toronto to Montreal. A flagstaff is also spoken of in Government House grounds, whereon, when the Governor was here, a flag used to be displayed. After numerous vicissitudes of local history, it is pleasant in 1876 to have our Parliament Buildings at Toronto again put to their proper use; and to see the symbol of a Governor's presence amongst us again floating over the same Government House grounds, which had been for a time deserted. A humorous allusion occurs to the fact that while the University was in occupation of the central Parliament Building, one of the wings of the same building was made a receptacle for lunatics. It is singular that it has been the fate of the University, since its removal to its present magnificent quarters, to have again become a close neighbour to a receptacle for lunatics. "The long ranges of red brick, towards the left of the view," Maple Leaf says, speaking of an engraving of Toronto, "were once tuneful with the eloquence of our legislators, but are now the peaceful retreat of learning. In the main structure and west wing are the temporary halls and lecture rooms of our noble university, while the building on the east is at present occupied by the Lunatic Asylum, a playful illustration of the poetic adage,

'Great Wit to Madness nearly is allied.'"

"A little in the rear," the account of the engraving goes on to say, "above a thick plantation, may be seen the staff which, in days gone by, was wont to bear the flag that indicated to the lieges of Toronto the presence of the Lieutenant-Governor, in the official residence embosomed by those dark trees."

Maple Leaf, who thus in 1848, and ten years earlier it may be said, was the first to call forth with sensible effect, and mould into

respectable form, a higher Canadian literature, was the Rev. Dr. McCaul, still among us, engaged in the same work; not now single-handed, so to speak, but surrounded by compeers of the first class, all "minding the same thing," seconded, too, more or less, by a younger generation scattered throughout Canada, who, having received from such hands the sacred torch of learning and light, are ambitious, it is hoped, to pass it on, trimmed and brilliant, to their successors.

I next make an extract from a volume of a very miscellaneous character, published in Montreal in 1860, bearing on its title page, in addition to the real name of the author, the *nom-de-plume* by which he had previously been extensively known, viz., "One who has whistled at the Plough!" This work is entitled, "The Conservative Science of Nations; being the first complete narrative of Somerville's Diligent Life in the Service of Public Safety in Britain." The mass of the book consists of matter with which Canada has little concern, but the passage which I quote relates to Canadian affairs. It criticises, it will be seen, the tone adopted by the editor of the *Quebec Mercury* towards the Canadian French, and hints that the politics of that paper are, in his opinion, "small," *i.e.*, somewhat narrow in their range. He also gives his views on the Science of Political Economy.

"Of difficulties in governing Canada, on which you remark with emphasis, I do not," the Whistler says to the editor of the *Quebec Mercury*, "as a stranger, presume to speak beyond this, that the unenfranchised working class of Britain does not inherit an enmity of race, language and religion, against the throne, church, laws and constitution. If you see no difference between the French Canadians who are enfranchised here and the unenfranchised men of Britain, I do. You date the difficulties of Canadian Government from the advent of the Whigs to power at the Reform era, 1830, 1831, 1832, and rail at me for being their ally, while I call myself a Conservative. Sir," he then shrewdly observes, "the difficulty in governing Canada dates from the 13th of September, 1759. Difficulty of government is a penalty of conquest everywhere. Not all the wisest or sternest Tories ever born to the inheritance of power, could govern Canada by a compulsory sword and proscription of race, as you seem to desire, in presence of the United States and of free institutions in Britain. As for Radicals, Whigs, Tories and

any such party alliances, I never was of them. Mine has not been a life of small politics. Much of my literary life has been spent, and my brain worn to even incapacity for literary labour, in rescuing the science of Political Economy from the soulless materialism which had made it, in mouths of Whigs and Radicals, odious to the People. It has been my self-imposed task to humanize and Christianize Political Economy. I assert man to be the primary element in national wealth."

The Whistler, Mr. Somerville, still, I believe, resides in Canada, and occasionally addresses a communication to Canadian journals. It was his intention, at one time, to identify himself with a periodical on Canadian Agriculture. In the preface to "The Diligent Life," he thus speaks of himself: "Having been bred in the toils and joys of agricultural and rural life, its associations have for me a charm beyond all other objects of literature."

By right of subsequent intimate association with our country, we may fairly claim as a Canadian writer, Libertas, the author of a book entitled, "The Fame and Glory of England Vindicated," which appeared at New York in 1842, with that *nom-de-plume* on its title-page. It was a review and a refutation in detail of the work of a United States writer named Lister, who, after a visit to England of a few weeks, in 1840, undertook to pronounce judgment on what he saw and heard there, and to give the pre-eminence in most things to the United States. The book was entitled, "The Glory and Shame of England." Libertas exposes the mode in which Lister's book was manufactured, and the numerous misstatements and unwarrantable inferences it contained respecting England and her institutions; and in the course of the discussion he is led to give his views—which are enlightened and broad—on the English Corn Laws, the Poor Laws, British and American Tariffs, Taxation, Education, Church and State, Slavery, and other interesting questions; and "in reversing," Libertas says, "the low position in which Lister has placed Britain and her institutions, and the high elevation he has assigned to the United States, we conceive that we have done no more than justice requires, and which, we feel assured, impartial history will award to the two countries, when the transactions of the present generation shall be placed on record. * * * The author will think his time well bestowed," Libertas continues, "if he shall succeed in

shewing the impossibility of such works as 'The Glory and Shame of England' being published without risk of detection and exposure, or in throwing any additional light on those questions which are now *agitating* the public on both sides of the Atlantic." I give a passage from the thirteenth chapter as a specimen of the writer's clear and vigorous style. Lister had asserted that "English liberty had its broadest foundations during," as he chose to call it, "Cromwell's splendid administration." Libertas then proceeds: "Now, we never knew any man who was a genuine friend of liberty, who admired Oliver Cromwell. With such persons you will invariably find that it is republicanism, not liberty, that they admire. It is not tyranny that they dislike, but monarchy. Cromwell was, like many republicans, a seeker of power. Republicanism was with him, as with Napoleon Bonaparte, the ladder by which he reached that power. Both kicked away the ladder when the power was attained. Will our author say," asks Libertas, "what stone was ever laid on the temple of freedom by Cromwell after he reached his elevation? He broke up the remains of the Rump Parliament with a military force, crying out as the last vestige of popular power disappeared, 'Take away that bauble.' He summoned another Parliament, consisting of his own creatures, who went such lengths in folly that even their master was ashamed of them." Then a little further on: "We have often been astonished to hear men, styling themselves democratical republicans, praising Napoleon Bonaparte. That unprincipled man went farther lengths than Cromwell; and yet because he was not born to royalty, and because he overturned ancient dynasties, he is still looked on with respect by republicans, and all his tyranny and ambition are forgotten. The splendid administration and splendid talents of these ambitious men, only rendered them more dangerous to the liberties and independence of nations. The solution of such strange inconsistency is plainly this: that many republicans are not favourable to liberty, and many understand nothing of its *genuine* principles. It is too readily assumed that republicanism is synonymous with freedom, but such is not necessarily the case. Oppression by a majority is just as much oppression as by a king or aristocracy; and the oppression becomes truly fearful, when that majority delegates its power to wicked and selfish men, and is so ignorant that it is not aware when that power is abused."

Lister, the very unfair, and in fact ignorant criticiser of old England and her ways, was an American clergyman. Hence the motto from Burns on the title-page of the "Fame and Glory of England:"

"Some books are lies frae end to end,
And some great lies were never penn'd;
E'en *ministers*, they ha'e been kenn'd,
In holy rapture,
A rousing whid at times to vend,
And nail't wi' Scripture."

Libertas is known to have been the late Peter Brown, Esq., the founder of the *Globe* journal in Toronto; a Scottish gentleman, freshly remembered in our community for his eminent talents as a journalist, for his high literary attainments and skill, and for many estimable traits of character, as a genial and benevolent member of society.

MONTHLY METEOROLOGICAL REGISTER, AT THE MAGNETICAL OBSERVATORY, TORONTO, ONTARIO—JUNE, 1876.

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 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'tant.	6 A.M.	2 P.M.	10 P.M.	Res'tant.	MEAN.		
					°	°	°	°													°							
1	29.607	29.496	29.455	29.5148	67.1	67.7	61.8	62.43	+ 4.93	.397	.470	.469	.444	85	69	85	79	S	E	N E	S 78 E	2.8	11.0	0.6	3.88	5.00	...	...
2	.416	.380	.432	.4095	68.6	71.2	63.6	64.93	+ 7.13	.432	.621	.433	.505	88	81	74	81	S E	S	N	S 59 W	1.6	6.0	1.2	0.65	3.98	...	...
3	.458	.413	.426	.4355	58.9	57.5	57.5	58.30	+ 0.67	.362	.429	.453	.425	72	91	95	86	N W	N E	E	N 45 E	6.6	10.0	1.4	3.66	5.33	.550	...
4	.415	.410	.460	.4333	61.0	68.0	67.0	58.50	+ 0.05	—	—	—	—	—	—	—	—	S E	S W	W	S 57 W	3.8	14.3	3.6	5.08	7.02	...	...
5	.524	.539	.598	.5588	52.4	57.8	49.2	53.72	— 5.05	.308	.319	.294	.303	78	67	84	74	W	W	W	W	8.0	15.6	3.0	6.59	7.42	...	...
6	.653	.654	.662	.6557	47.0	62.9	55.7	55.32	— 3.77	.254	.276	.359	.306	78	48	81	71	N W	S	S	S 33 W	4.8	7.5	0.8	3.91	6.09	.080	...
7	.698	.711	.672	.6918	53.5	61.4	56.0	58.15	— 1.25	.333	.389	.321	.352	81	71	71	72	N W	E	N E	N 81 E	3.4	9.0	6.0	4.16	5.91	...	...
8	.648	.673	.625	.6728	53.9	67.7	64.3	62.48	+ 2.75	.344	.477	.474	.440	82	70	78	77	N E	S E	S	S 41 E	1.8	7.4	5.0	2.78	5.32	R	...
9	.516	.470	.506	.5260	66.1	74.4	61.8	67.08	+ 7.02	.479	.549	.495	.516	74	64	89	78	S W	S W	S	S 26 W	11.0	16.0	2.0	9.75	9.83	.350	...
10	.641	.651	.669	.6568	62.5	76.4	62.2	68.12	+ 7.75	.504	.647	.515	.552	89	71	92	82	S W	S E	N E	S 23 E	3.0	7.5	2.5	2.59	4.22	...	...
11	.710	.720	.735	.7275	62.0	75.0	64.0	66.83	+ 6.14	—	—	—	—	—	—	—	—	S W	E	N E	S 80 E	1.4	8.0	3.8	4.32	5.92	...	...
12	.744	.735	.699	.7205	63.2	75.5	67.6	69.32	+ 8.32	.489	.621	.538	.566	84	70	80	79	E	E	N E	N 76 E	5.6	8.0	6.4	4.97	5.63	...	...
13	.665	.619	.623	.6347	62.9	77.3	66.8	68.55	+ 7.22	.548	.735	.561	.602	95	78	86	86	E	E	W	S 89 E	6.7	9.0	5.2	4.54	5.63	...	...
14	.631	.594	.630	.6208	62.9	78.0	69.7	70.87	+ 9.20	.533	.723	.566	.610	93	76	77	81	E	S E	N E	S 80 E	0.4	7.0	8.0	2.86	4.28	...	...
15	.664	.660	.649	.6552	66.1	71.9	65.8	68.65	+ 6.67	.586	.610	.548	.582	91	78	86	83	N E	E	N E	N 78 E	6.0	11.0	5.3	6.47	7.01	...	...
16	.607	.536	.481	.5308	68.3	75.5	66.8	70.33	+ 8.03	.598	.606	.549	.578	86	69	83	78	S E	E	E	S 72 E	5.0	8.0	5.6	4.81	5.12	...	...
17	.470	.415	.371	.4112	66.0	68.7	62.5	66.05	+ 3.45	.566	.625	.532	.576	88	89	94	90	E	E	E	S 78 E	7.8	11.6	8.0	7.73	8.54	.460	...
18	.370	.410	.490	.4283	61.0	70.0	62.0	64.33	+ 1.34	—	—	—	—	—	—	—	—	S E	E	E	S 53 E	9.2	8.0	1.8	5.48	6.60	...	...
19	.554	.613	.507	.5228	58.6	69 0	58.9	63.05	— 0.15	.425	.398	.410	.425	80	56	83	73	E	S	E	S 33 E	5.4	9.5	4.8	5.12	5.86	...	...
20	.494	.459	.490	.4893	60.7	68.5	59.6	63.13	— 0.38	.447	.368	.412	.409	84	63	81	72	S	S W	S W	S 33 W	4.8	15.0	2.6	7.25	8.20	.020	...
21	.529	.546	.588	.5500	57.8	66.5	60.7	60.83	— 2.97	.426	.448	.484	.428	88	69	91	81	W	S W	W	S 78 W	6.8	7.4	7.6	5.47	6.22	.120	...
22	.634	.626	.609	.6258	56.4	69.4	62.2	63.25	— 0.85	.395	.421	.412	.405	83	58	74	71	W	S	N W	S 48 W	4.8	9.0	4.2	3.79	5.35	...	...
23	.685	.472	.381	.4657	59.0	75.2	67.2	68.57	+ 3.98	.412	.603	.606	.551	81	60	91	79	W	S W	S W	S 40 W	2.6	12.5	4.0	5.46	5.98	...	...
24	.409	.358	.348	.3703	66.1	85.6	68.6	74.17	+ 9.66	.571	.339	.511	.472	89	28	73	61	S W	W	S W	S 82 W	8.0	24.5	5.4	9.01	9.55	...	...
25	.316	.270	.310	.2958	67.0	86.0	73.0	75.22	+10.33	—	—	—	—	—	—	—	—	S W	W	N	W	4.0	18.8	9.0	6.09	7.98	.010	...
26	.405	.403	.356	.3880	64.7	73.7	64.7	68.83	+ 3.70	.443	.470	.498	.491	72	56	81	70	N E	E	E	S 85 E	3.2	7.6	3.8	3.84	5.35	...	...
27	.325	.370	.404	.4082	65.4	85.6	70.6	73.83	+ 8.45	.554	.594	.615	.593	89	48	82	73	N	W	W	S 79 W	0.2	20.0	7.6	7.56	8.29	...	...
28	.609	.640	.644	.6368	65.0	74.1	65.8	67.45	+ 1.89	.408	.470	.441	.443	65	56	69	66	W	W	N W	S 57 W	3.8	9.6	4.8	2.99	5.03	...	...
29	.649	.692	.574	.6055	61.1	75.9	63.2	67.16	+ 1.28	.436	.482	.469	.470	81	54	81	72	N W	S E	V	S 7 E	2.4	12.0	2.2	3.47	5.74	...	...
30	.613	.637	.690	.6505	60.7	74.8	60.7	66.12	0.00	.447	.362	.398	.386	84	42	75	62	N W	W	E	N 59 W	4.6	9.0	2.6	6.44	7.20	...	...
	29.5519	29.5291	29.5378	29.5402	60.55	72.04	62.98	65.53	+ 3.52	.450	.502	.476	.478	83	65	82	76	.....	.....	.....	.....	4.65	10.99	4.29	.....	6.32	1.590	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR JUNE, 1876.

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.....29.763 at 7 a.m. on 11th } Monthly range=
Lowest Barometer .....29.237 at 4 p.m. on 25th } 0.526.

Solar Thermometer.
- Maximum temperature.....87°2 on 27th } Monthly range=
- Minimum temperature .....44.2 on 6th } 43°0
- Mean maximum temperature .....74°39 } Mean daily range=
- Mean minimum temperature .....56°30 } 18°09
- Greatest daily range.....29°2 from p.m. of 25th to a.m. of 26th.
- Least daily range .....9°9 from a.m. to p.m. of 17th.

Warmest day ..... 25th; mean temperature 75°22 } Difference=21°50.
Coldest day ..... 6th; mean temperature 53°72 }

Maximum { Solar .....147°0 on 25th } Monthly range=
Radiation { Terrestrial..... 31.0 on 6th } 116°0.

No Aurora observed.

Possible to see Aurora on 18 nights; impossible on 12 nights.

Raining on 8 days; depth, 1.690 inches; duration of fall, 18.1 hours.

Mean of Cloudiness, 0.68.

WIND.

Resultant direction, S. 7° W.; Resultant Velocity, 1.61 miles.

Mean Velocity, 6.32 miles per hour.

Maximum Velocity, 24.5 miles from 2 to 3 p.m. of 24th.

Most Windy day, 9th; Mean Velocity, 9.83 miles per hour.

Least Windy day, 2nd; Mean Velocity, 3.98 miles per hour.

Most Windy hour, 2 p.m.; Mean Velocity, 10.99 miles per hour.

Least Windy hour, 5 a.m.; Mean Velocity, 3.07 miles per hour.

Fog on 2nd, 4th, 13th and 19th.

Solar halo on 28th.

Lunar halo on 2nd.

Thunder on 1st, 2nd, 6th, 9th, 17th and 25th.

Lightning on 6th, 9th, 12th, 13th, 14th, 17th, 24th and 26th.

COMPARATIVE TABLE FOR JUNE.

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.
	°	°	°	°	°					°		
1848	62.9	+ 1.2	92.0	37 4	54.6	8	1.810	...	...	N 61 W	1.90	4.51
1849	63.2	+ 1.5	84.4	35.2	49.2	7	2.020	...	...	S 71 E	0.49	3.32
1850	64.3	+ 2.6	85.6	34.2	51.4	10	3.345	...	...	S 60 W	0.38	4.54
1851	59.2	— 2.5	79.2	37.0	42.2	11	2.695	...	...	S 2 W	1.26	4.42
1852	60.8	— 0.9	86.1	37.2	48.9	10	4.165	...	...	S 76 W	1 49	4.09
1853	65.5	+ 3.8	89.5	39.2	50.3	9	1.550	...	...	N 1 W	0.10	3.73
1854	64.1	+ 2.1	92.6	35.2	57.3	9	1.460	...	...	N 24 E	0.71	4.15
1855	59.9	— 1.8	91.5	36.2	55.3	17	4.070	...	...	N 69 W	1.33	5.70
1856	62.1	+ 0.4	89.2	42.0	47.2	13	3.200	...	...	S 21 W	0.99	5.30
1857	56.9	— 4.8	76.0	35.0	41.0	21	5.060	...	...	N 49 W	1.15	7.60
1858	66.2	+ 4.5	90.2	42.5	47.7	12	2.943	...	...	S 20 E	0.25	5.53
1859	58.3	— 3.4	80.4	32.2	54.2	16	4.085	2	Inap.	N 77 E	1.95	7.19
1860	63.2	— 1.5	81.6	42.2	32.4	14	2.130	...	...	N 44 W	3.13	7.61
1861	61.3	— 0.4	87.8	41.6	46.2	13	2.820	...	...	N 39 W	2.29	6.11
1862	60.5	— 1.2	85.8	39.4	46.4	10	1.007	...	...	N 26 W	1.77	5.98
1863	60.1	— 1.6	84.8	37.4	47.4	13	1.662	...	...	N 50 W	2.26	5.24
1864	63.0	+ 1.3	93.4	34.8	58.6	5	0.570	...	...	N 55 W	1.72	4.53
1865	64.5	+ 2.8	90.2	43.0	47.2	7	2.005	...	...	S 39 W	0.60	4.06
1866	60.2	— 1.5	90.5	40.0	50.5	15	2.720	...	...	S 15 W	0.71	5.09
1867	64.3	+ 2.6	88.6	44.0	44.6	8	0.885	...	...	S 84 E	0.48	4.13
1868	62.0	+ 0.3	84.2	38.0	46.2	11	2.217	...	...	N 16 E	0.85	5.26
1869	58.4	— 3.3	81.4	36.4	45.0	22	4.375	...	...	N 80 W	1.77	5.23
1870	67.3	+ 5.6	88.4	50.0	38.4	16	3.090	...	...	N 17 E	0.40	5.14
1871	61.4	— 0.3	83.0	41.8	41.2	13	3.340	...	...	N 80 W	2.04	6.57
1872	63.7	+ 2.0	88.0	41.8	46.2	8	3.148	...	...	N 69 W	0.76	3.80
1873	63.7	+ 2.0	89.5	40.0	49.5	10	0.680	...	...	N 18 E	1.09	6.43
1874	62.6	+ 0.8	88.0	44.2	43.8	13	1.705	...	...	N 44 W	1.68	6.52
1875	61.0	— 0.7	86.8	37.4	49.4	7	1.825	...	...	N 69 W	1.05	7.35
1876	65.5	+ 3.8	87.2	44.2	43.0	8	1.690	...	...	S 7 W	1.61	6.32
Results to 1875	61.73	.....	86.05	39.37	47.68	11.64	2.854	...	...	N 60 W	0.84	5.33
Excess for 1876	+ 3.80	.....	— 0.25	+ 4.83	— 4.68	3.64	1.264	...	...	...	...	+ 0.99

MONTHLY METEOROLOGICAL REGISTER, AT THE MAGNETICAL OBSERVATORY, TORONTO, ONTARIO—JULY, 1876.

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

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of Mean above Average	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	29.668	29.660	29.602	29.5647	67.8	80.4	60.0	69.10	— 2.22	.366	.488	.618	.482	76	93	100	89	N E	E	N	N 50 E	3.7	10.8	1.8	5.00	6.79	.090	...
2	.484	.440	.375	.4247	62.0	68.0	66.0	65.33	— 1.19	—	—	—	—	—	—	—	—	W	E	S	N 83 E	2.0	10.2	8.7	3.48	5.61	.260	...
3	.313	.435	.487	.4257	67.6	78.8	69.4	72.63	+ 5.03	.607	.618	.583	.671	91	52	81	73	S W	W	S W	S 47 W	10.5	22.5	4.2	10.99	11.48	.150	...
4	.496	.520	.695	.5395	65.0	65.0	60 4	64.45	— 2.43	.559	.559	.488	.542	91	91	93	89	S W	N W	S W	S 39 W	7.4	1.0	2.0	3.39	4.17	.230	...
5	.581	.261	.491	.4327	61.4	65.4	65.1	64.50	— 2.57	.542	.608	.479	.527	99	97	77	87	S	S	W	S 67 W	3.6	8.0	12.0	5.12	11.52	.420	...
6	.648	.660	.650	.6548	60.0	76.6	61.8	66.62	— 0.11	.432	.577	.457	.483	83	63	83	76	W	S E	S E	S 17 W	4.0	6 3	0.6	3.13	5.22	...	...
7	.670	.617	.698	.6165	62.6	71.9	65.0	67.83	— 0.03	.501	.685	.588	.592	88	86	95	86	N E	S E	E	S 68 E	0.6	3.4	6.4	2.05	2.44	.260	...
8	.630	.663	.675	.6692	70.2	87.4	77.0	80.63	+13.10	.760	.859	.768	.77.	84	66	82	76	S W	S W	W	S 67 W	3.3	6.2	2.0	3.91	5.71	...	...
9	.590	.630	.650	.6567	76.0	91.0	79.0	82.67	+ 5.01	—	—	—	—	—	—	—	—	N W	S	W	S 55 W	7.6	5.4	1.6	4.32	5.49	...	...
10	.604	.657	.694	.6585	77.0	80.6	71.6	76.52	+ 8.72	.811	.883	.643	.746	88	85	83	81	W	N E	N	N 61	4.6	4.2	7.5	2.63	5.42	.310	...
11	.645	.657	.647	.6463	67.6	75.3	67.0	71.17	+ 3.27	.654	.766	.628	.668	97	80	92	88	C	S	S W	S 36 W	0.0	4.5	3.4	0.85	3.77	.570	...
12	.658	.637	.613	.6366	65.0	86.0	76.1	74.50	+ 6.90	.600	.856	.826	.768	97	68	94	89	N W	S E	N W	S 14 W	1.2	8.6	4.0	1.96	2.90	.450	...
13	.646	.620	.610	.6125	74.1	83.1	69.6	76.33	+ 8.29	.670	.712	.661	.673	79	63	92	78	N W	S W	S W	S 51 W	1.4	6.9	2.5	2.38	4.03	.150	...
14	.656	.616	.661	.6433	70.8	84.2	63.4	73.28	+ 5.10	.564	.648	.442	.498	75	55	75	62	N W	S	W	N 53 W	1.6	6.6	2.0	4.37	5.48	...	...
15	.695	.642	.695	.6488	63.6	77.7	68.6	70.30	+ 2.10	.446	.469	.445	.460	76	48	63	61	N W	S	N W	N 21 W	8.4	6.2	5.3	1.68	5.66	...	...
16	.780	.740	.760	.7667	62.0	80.0	67.0	70.17	+ 1.88	—	—	—	—	—	—	—	—	W	S	N	S 25 W	2.0	7.2	2.0	1.53	3.70	...	...
17	.761	.664	.616	.6642	64.3	81.5	72.8	73.80	+ 5.45	.490	.649	.600	.588	81	60	76	70	E	S E	S W	S 27 E	0.2	7.0	2.8	2.72	4.15	...	...
18	.635	.649	.678	.6558	72.3	77.7	67.9	73.66	+ 5.27	.649	.801	.635	.688	82	85	93	83	W	S W	S W	S 53 W	3.0	4.8	3.0	2.28	3.21	.020	...
19	.686	.653	.603	.6063	67.6	81.3	72.0	75.02	+ 6.60	.686	.569	.552	.613	87	52	81	72	N W	S	S E	S 6 E	0.5	7.2	1.0	2.63	3.67	...	...
20	.396	.392	.547	.4397	71.0	80.9	65.1	72.23	+ 3.78	.682	.677	.479	.608	90	64	77	75	S W	W	W	N 88 W	8 0	13.5	6.2	11.07	13.10	.020	...
21	.636	.761	.784	.7302	60.7	71.9	59.6	64.07	— 3.50	.387	.295	.242	.326	73	38	47	54	N W	S W	N W	N 32 W	2.0	7.2	5.4	6.58	8.44	...	...
22	.740	.663	.514	.6143	64.6	64.0	59.6	61.02	— 7.45	.362	.507	.486	.457	85	84	95	85	N	E	N	N 42 E	1.8	6.5	0.6	2.17	4.31	.130	...
23	.550	.620	.600	.5907	57.0	70.0	59.0	61.67	— 6.78	—	—	—	—	—	—	—	—	N	N W	N W	N 16 W	13.5	11.0	9.5	11.86	12.32	...	...
24	.580	.548	.618	.5835	54.2	66.8	56.4	59.76	— 8.70	.324	.341	.316	.328	77	52	69	66	N W	N W	N W	N 51 W	9.5	22.0	6.2	11.10	11.49	...	...
25	.643	.625	.657	.6410	51.7	62.9	56.4	57.78	—10.68	.317	.346	.328	.332	83	60	71	70	W	N E	N	N 47 W	4.4	3.5	5.0	1.21	4.75	...	...
26	.780	.809	.813	.8045	50.1	64.7	57.1	58.50	— 9.87	.313	.394	.397	.334	86	64	84	75	N W	S	S W	S 3 W	4.0	11.0	0.4	2.11	6.09	...	...
27	.767	.618	.486	.6113	55.3	65.0	64.3	62.82	— 5.55	.364	.439	.568	.479	53	71	94	83	N E	E	S E	N 83 E	3.3	12.0	5.2	5.91	6.58	.030	...
28	.384	.417	.549	.4695	65.2	76.2	61.6	67.30	— 1.00	.616	.605	.445	.600	99	58	80	76	S W	N W	N W	N 75 W	6.2	18.0	5.0	8.52	10.73	.160	...
29	.010	.627	.637	.6292	60.7	72.1	62.5	65.86	— 2.38	.441	.491	.435	.456	83	62	77	72	N	S	N W	S 44 W	4.6	8.6	3.2	1.67	5.06	...	...
30	.645	.640	.660	.6225	61.0	76.0	66.0	68.33	+ 0.14	—	—	—	—	—	—	—	—	N	S E	N	N 48 E	9.2	8.8	2.2	2.80	5.39	...	...
31	.673	.589	.616	.6093	64.7	77.7	70.1	71.37	+ 3.25	.456	.416	.397	.429	75	44	54	57	N	S E	N	N 14 E	9.0	6.5	9.1	4.75	6.76	...	...
	29.6116	29.6860	29.5984	29.6976	63.86	74.81	65.73	68.78	+ 0.67	.519	.576	.519	.536	85	67	81	76	...	...	...	...	4.66	8.75	4.03	...	6.31	3.290	...

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.....29.813 at 10 p.m. on 26th. } Monthly range
Lowest Barometer.....29.343 at 6 a.m. on 3rd. } 0.470.

Self-registering Ther.
- Maximum temperature .....92°9 on 8th. } Monthly range
- Minimum temperature.....46°2 on 26th } 46°7.
- Mean maximum temperature .....78°30. } Mean daily range
- Mean minimum temperature .....68°76. } 19°55.
- Greatest daily range.....31°4 from a.m. to p.m. of 8th.
- Least daily range.....10°4 from a.m. to p.m. of 2nd.

Warmest day ..... 9th; mean temperature .....82°67 } Difference=24°89.
Coldest day.....25th; mean temperature .....57°78 }

Maximum Solar .....144°5 on 10th. } Monthly range
Radiation Terrestrial ..... 33°4 on 26th. } 111.1.

Aurora observed on 3 nights, viz., 16th, 18th, 19th.
Possible to see Aurora on 24 nights; impossible on 7 nights.
Raining on 16 days; depth, 3.290 inches; duration of fall 35:8 hours.
Mean of cloudiness, 0.50.

WIND.

Resultant direction N. 78° W.; resultant velocity 1.03 miles.
Mean velocity 0.31 miles per hour.
Maximum velocity 31.5 miles, from 5 to 6 p.m. of 5th.
Most windy day 20th; mean velocity 13.10 miles per hour.
Least windy day 7th; mean velocity 3.44 miles per hour.
Most windy hour noon; mean velocity 0.25 miles per hour.
Least windy hour 10 p.m.; mean velocity 4.03 miles per hour.

Fog on 1st, 2nd, 4th, 5th, 12th, 22nd and 28th.
Thunder on 2nd, 5th, 6th, 10th, 12th, 13th, 18th and 20th.
Lightning on 1st, 3rd, 6th, 9th, 10th, 12th, 13th, 17th, 18th, 19th, 20th, 22nd, 25th, 30th.
Solar halo on 31st.
Lunar halo on 29th.
Dew on 12 mornings.
Rainbow on 3rd.

COMPARATIVE TABLE FOR JULY.

YEAR.	TEMPERATURE. Mean.	Excess above aver'ge	Maximum.	Minimum	Range.	RAIN. No. of days.	Inches	SNOW. No. of days.	Inches.	WIND. Resultant. Direction.	Vel'y	Mean Velocity. Miles.
	°	°	°	°	°					°		
1848	65.6	— 1.9	82.2	44.1	38.1	10	1.890	...	...	N 74 W	0.18	4.94
1849	68.4	+ 1.0	88.6	45.2	43.4	4	3.415	...	...	S 5 W	0.78	3.52
1850	68.2	+ 1.5	86.2	51.6	34.6	12	5.270	...	...	N 81 E	0.59	4.56
1851	65.0	— 2.0	82.7	46.5	36.2	12	3.625	...	...	N 60 W	0.88	4.13
1852	66.8	— 0.6	90.1	48.5	41.6	8	4.025	...	...	N 43 W	0.93	3.33
1853	65.6	— 1.8	91.3	41.6	49.7	10	0.916	...	...	S 58 E	0.24	3.69
1854	72.5	+ 5.1	98.0	42.5	55.5	9	4.805	...	...	S 49 W	0.37	4.03
1855	67.9	+ 0.5	92.8	49.2	43.6	13	3.245	...	...	S 19 W	0.73	6.47
1856	69.9	+ 2.5	96.6	49.5	47.1	8	1.120	...	...	N 79 W	1.57	5.84
1857	67.8	+ 0.4	86.6	47.0	39.6	6	3.475	...	...	S 68 E	0.81	4.74
1858	67.9	+ 0.5	85.0	62.0	33.0	13	3.072	...	...	N 15 E	1.13	5.76
1859	66.9	— 0.5	88.0	44.7	43.3	12	2.611	...	...	N 56 W	1.48	5.81
1860	63.9	— 3.5	88.0	43.8	44.2	13	4.356	...	...	N 60 W	2.16	7.29
1861	65.4	— 2.0	84.6	47.0	37.6	16	2.635	...	...	N 74 W	1.43	4.65
1862	66.7	— 0.7	95.6	48.2	47.3	15	5.344	...	...	S 89 W	1.42	5.80
1863	67.6	+ 0.2	83.5	48.0	35.5	15	3.408	...	...	N 18 W	0.40	3.89
1864	69.7	+ 2.3	90.2	49.0	41.2	8	1.332	...	...	N 01 W	2.23	6.00
1865	65.0	— 2.4	83.0	45.8	37.2	11	2.470	...	...	N 86 W	2.28	6.34
1866	70.4	+ 3.0	94.0	47.8	46.2	16	5.390	...	...	S 79 W	0.94	4.17
1867	68.2	+ 0.8	91.0	48.2	45.8	12	1.965	...	...	N 48 W	1.40	5.45
1868	76.8	+ 8.4	93.4	59.0	34.4	5	0.610	...	...	S 87 E	0.72	4.66
1869	64.6	— 2.9	84.9	49.8	35.1	13	4.610	...	...	S 67 W	2.01	5.07
1870	68.8	+ 1.4	87.4	48.0	39.4	16	1.890	...	...	S 78 W	1.69	4.82
1871	66.0	— 1.4	88.4	47.8	40.6	11	1.255	...	...	N 88 W	1.55	5.67
1872	70.2	+ 2.8	96.0	52.2	43.8	13	2.297	...	...	N 67 W	1.19	3.56
1873	68.4	+ 1.0	87.5	47.5	40.0	11	1.913	...	...	S 76 W	1.71	6.11
1874	67.9	+ 0.5	83.5	44.4	39.1	11	3.350	...	...	N 68 W	1.26	6.55
1875	66.6	— 0.8	88.0	46.4	41.6	6	1.810	...	...	S 88 W	1.09	6.78
1876	68.8	+ 1.4	92.9	46.2	46.7	16	3.290	...	...	N 78 W	1.03	6.31
Results to 1875.	67.39	...	88.72	47.09	41.23	10.61	3.148	...	...	N 78 W	0.86	5.09
Excess for '76	+ 1.39	...	+ 4.18	— 1.49	+ 5.47	+ 4.39	— 0.142	...	...	...	...	+ 1.22

MONTHLY METEOROLOGICAL REGISTER, AT THE MAGNETICAL OBSERVATORY, TORONTO, ONTARIO—AUGUST, 1876.

Latitude—43° 39′4 *North*. *Longitude*—5*h*. 15*m*. 33*s*. *West*. *Elevation above Lake Ontario, 108 feet.*

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of Mean above Average.	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 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.	Resultant.	6 A.M.	2 P.M.	10 P.M.	Result't	MEAN		
					°	°	°	°													°						
1	29.722	29.766	29.809	29.7735	60.5	76.6	65.6	69.90	+ 1.83	.369	.385	.322	.362	57	43	51	49	N	S E	N E	N 70 E	3.0	7.8	8.0	4.86	7.20	...	...
2	.853	.845	.802	.8347	62.9	77.3	69.0	71.05	+ 3.03	.309	.450	.422	.413	55	48	60	55	N E	E	N E	N 73 E	6.3	12.0	4.4	6.36	7.32	...	...
3	.707	.761	.721	.7582	67.6	74.4	69.0	70.22	+ 2.30	.551	.691	.561	.558	82	69	79	76	N E	E	N	S 80 E	2.4	9.5	1.8	4.32	5.59	...	...
4	.734	.692	.677	.6973	67.6	80.4	71.0	73.73	+ 5.88	.545	.692	.673	.653	80	60	89	79	N	S E	N E	S 68 E	1.8	9.0	4.7	3.22	4.99	...	...
5	.711	.687	.705	.6980	68.6	84.5	75.0	77.62	+ 9.85	.640	.744	.744	.734	92	63	83	78	N E	S E	N W	S 47 E	0.2	9.5	4.5	2.77	4.53	...	...
6	.744	.720	.710	.7240	73.0	84.5	76.0	77.75	+10.08	—	—	—	—	—	—	—	—	S	S	S W	S 19 W	3.6	10.8	4.0	5.69	6.56	...	...
7	.721	.677	.733	.7137	71.6	84.6	62.5	73.28	+ 5.73	.736	.471	.381	.532	95	39	67	66	S W	N W	N W	W	4.0	19.0	2.8	6.12	7.94	...	...
8	.770	.765	.698	.7403	67.1	77.7	67.0	68.63	+ 1.20	.374	.518	.576	.676	80	55	84	69	W	S	S	S 5 W	1.6	9.4	1.2	3.70	4.72	...	...
9	.747	.729	.702	.7263	69.8	81.3	69.4	71.93	+ 4.67	.434	.442	.542	.487	84	41	76	64	N W	S E	E	S 33 E	2.2	8.0	3.6	2.09	4.58	...	...
10	.756	.735	.740	.7420	66.1	82.9	71.2	73.95	+ 6.78	.479	.576	.635	.691	74	51	82	71	N E	S E	N E	N 79 E	5.5	6.6	2.4	3.84	5.26	...	...
11	.765	.716	.699	.7223	66.8	81.3	73.7	75.45	+ 8.40	.549	.803	.754	.738	83	75	91	83	N	S E	E	S 66 E	2.6	4.4	4.0	2.66	4.63	...	...
12	.733	.738	.746	.7288	71.2	82.9	74.1	76.00	+ 9.10	.740	.795	.769	.749	97	73	91	84	S	S	E	S 27 E	1.8	7.0	3.6	4.03	5.78	...	...
13	.770	.740	.710	.7350	71.0	84.5	72.0	76.42	+ 9.67	—	—	—	—	—	—	—	—	N E	S E	E	S 61 E	1.6	8.2	1.0	3.94	4.71	...	...
14	.697	.619	.638	.6068	69.6	86.7	71.9	75.83	+10.25	.619	.664	.700	.663	92	52	89	75	N E	S	S W	S 31 E	1.6	9.4	1.6	3.00	5.01	...	...
15	.601	.528	.633	.5610	67.0	79.1	64.3	70.45	+ 4.02	.587	.500	.434	.509	88	50	72	69	W	N W	N	N 44 W	2.6	20.0	5.2	9.40	10.06	...	...
16	.691	.675	.675	.6835	68.2	78.3	65.2	70.00	— 0.25	.328	.408	.455	.405	67	50	73	64	N E	S E	N E	N 89 E	6.2	10.5	4.5	2.67	5.77	...	...
17	.686	.658	.636	.6618	63.6	74.8	67.0	69.85	+ 3.78	.406	.416	.481	.495	84	48	70	69	N E	S 2	E	S 76 E	3.6	6.5	2.9	3.35	4.13	R	...
18	.593	.493	.361	.4585	66.6	73.7	69.4	70.52	+ 4.60	.549	.558	.658	.582	83	67	92	78	N E	E	E	S 88 E	3.5	9.5	2.2	5.66	6.94	R	...
19	.346	.334	.429	.3776	65.8	82.0	67.8	72.77	+ 7.08	.548	.572	.609	.639	86	52	74	68	W	N	N	N 50 W	1.8	10.4	8.0	3.93	6.08	...	...
20	.580	.740	.820	.7383	56.0	69.0	59.0	61.33	— 4.16	—	—	—	—	—	—	—	—	N W	N	N	N 19 W	10.6	12.0	10.2	12.73	13.25	...	...
21	.878	.762	.727	.7822	60.6	69.4	55.0	59.42	— 5.87	.276	.261	.282	.286	76	36	65	59	N	S	N W	S 4 W	0.2	12.6	1.4	1.30	7.49	...	...
22	.725	.668	.614	.6627	49.2	73.3	63.3	64.45	— 0.60	.254	.382	.508	.354	73	46	74	58	W	S	W	S 28 W	2.6	9.6	4.2	2.45	5.01	...	...
23	.657	.663	.677	.6622	65.8	77.7	68.6	70.71	+ 5.02	.360	.445	.580	.462	68	47	83	62	N	S	S E	S 42 E	2.2	6.6	7.0	2.37	4.96	...	...
24	.701	.650	.592	.6435	65.0	75.5	67.0	69.56	+ 4.93	.679	.853	.603	.525	84	40	89	74	N E	E	E	S 85 E	4.4	8.0	1.0	4.51	4.79	...	...
25	.517	.476	.540	.5498	70.1	82.7	68.9	69.45	+ 5.10	.694	.510	.300	.499	94	46	60	68	S W	N W	N W	S 81 W	4.5	20.5	4.6	7.51	10.67	...	...
26	.670	.671	.655	.6365	60.3	73.0	59.3	61.63	— 2.47	.300	.213	.290	.280	82	26	57	55	W	W	N W	N 79 W	3.2	25.2	16.2	13.25	13.54	...	...
27	.700	.690	.720	.7093	48.0	76.0	68.0	60.67	— 3.17	—	—	—	—	—	—	—	—	W	N W	N W	N 64 W	10.0	15.0	3.4	10.57	10.64	...	...
28	.773	.706	.694	.7203	46.1	73.3	64.7	63.58	+ 0.02	.239	.279	.262	.276	77	34	42	49	W	S	N	S 37 W	2.6	9.0	6.0	2.33	6.16	...	...
29	.730	.669	.638	.6717	52.1	73.2	67.9	67.73	+ 4.43	.297	.408	.455	.410	76	50	60	61	Calm.	S	N W	S 20 W	0.0	6.3	6.4	2.01	5.25	...	...
30	.609	.545	.545	.5637	65.0	78.7	68.6	71.12	+ 8.05	.494	.323	.552	.465	80	32	79	63	N W	S	S W	S 2 W	1.2	5.5	3.8	1.64	4.37	...	...
31	.539	.474	.443	.4893	65.1	80.9	76.2	76.18	+12.38	.544	.677	.671	.604	88	64	77	70	S W	S	S W	S 14 W	2.4	10.4	2.0	4.78	6.05	...	...
	29.6912	29.6605	29.6617	29.6704	62.68	78.14	67.59	70.24	+ 4.28	.476	.498	.523	.508	80	50	76	67	.....	.....	.....	.....	3.41	10.58	4.41	.....	6.57	R	.....

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR AUGUST, 1876.

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., 9 A.M., 3 P.M., 4 P.M., 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest barometer .....29·889 at 8 a.m. on 21st } Monthly range=
Lowest barometer .....29·334 at 2 p.m. on 19th } 0.555.

Solar Register. Thermometer.
- Maximum temperature .....88°8 on 14th } Monthly range=
- Minimum temperature .....46°0 on 28th } 43°8.
- Mean maximum temperature .....80°39 } Mean daily range=
- Mean minimum temperature .....59°06 } 20°73.
- Greatest daily range .....32°2 from a.m. to p.m. of 25th.
- Least daily range .....10°8 from a.m. to p.m. of 3rd.

Warmest day ..... 6th; mean temperature.....77°075 } Difference=18°33.
Coldest day .....21st; mean temperature.....59°042 }

Maximum Solar .....153°0 on 15th } Monthly Range=
Radiation Terrestrial .....31°6 on 28th } 121°4.

Aurora observed on 2 nights, viz., 12th and 26th.

Possible to see Aurora on 24 nights; impossible on 7 nights.

Rain on 2 days; depth inappreciable; duration of fall, 0.2 hours.

Mean of cloudiness, 0.46.

WIND.

Resultant direction, S 31° W.; resultant velocity, 0.23 miles.

Mean velocity, 6.57 miles per hour.

Maximum velocity, 25.7 miles, from 4 to 5 p.m. of 26th.

Most windy day, 26th; mean velocity, 13.54 miles per hour.

Least windy day, 17th; mean velocity, 4.13 miles per hour.

Most windy hour, 2 p.m.; mean velocity, 10.58 miles per hour.

Least windy hour, 2 a.m.; mean velocity, 4.14 miles per hour.

Lightning on 5th, 11th, 18th, 19th and 31st.

Thunder on 11th and 31st.

Fog on 7th.

It will be seen from the Comparative Table that this month was the driest August during the past 37 years, only a few drops having fallen since the morning of 28th July.

COMPARATIVE TABLE FOR AUGUST.

YEAR.	TEMPERATURE. Mean.	Excess above aver'ge	Maximum.	Minimum.	Range.	RAIN. No. of days.	Inches.	SNOW. No. of days.	Inches.	WIND. Resultant. Direction.	Velo'y	Mean Velocity.
	°	°	°	°	°						°	
1848	69.2	+ 3.0	87.0	48.7	38.3	8	0.855	...	...	S 21 E	0.98	4.55
1849	66.3	+ 0.1	79.0	49.0	30.0	10	4.970	...	...	N 71 W	0.60	3.76
1850	66.8	+ 0.6	85.0	41.0	44.0	13	4.355	...	...	N 15 W	0.35	4.46
1851	63.6	— 2.6	79.8	42.0	37.8	10	1.360	...	...	N 63 W	0.40	4.63
1852	65.9	— 0.3	81.2	45.8	35.4	9	2.695	...	...	N 70 E	0.56	3.30
1853	68.6	+ 2.4	94.9	42.5	52.4	11	2.576	...	...	S 36 E	0.30	4.26
1854	68.0	+ 1.8	99.2	45.6	53.6	5	0.455	...	...	N 64 W	1.76	4.60
1855	64.1	— 2.1	83.5	40.0	43.5	7	1.455	...	...	N 63 W	1.04	6.97
1856	63.0	— 2.6	82.7	41.5	41.2	12	1.680	...	...	N 50 W	2.88	7.03
1857	65.3	— 0.9	88.2	46.0	42.2	13	5.265	...	...	N 77 W	1.51	6.36
1858	67.6	+ 1.4	84.0	44.0	40.0	11	3.830	...	...	N 69 W	1.57	6.50
1859	66.6	+ 0.4	82.2	45.8	36.4	11	3.900	...	...	N 36 W	1.62	5.96
1860	64.6	— 1.7	87.0	46.8	40.2	14	3.405	...	...	N 70 W	1.83	5.80
1861	65.5	— 0.7	85.2	47.0	38.2	15	2.953	...	...	N 8 E	0.46	4.21
1862	67.6	+ 1.4	89.6	42.8	46.7	15	3.483	...	...	N 78 W	1.67	5.96
1863	66.6	+ 0.4	88.0	42.4	45.6	12	2.208	...	...	S 61 W	1.80	4.89
1864	68.6	+ 2.4	94.0	47.0	47.0	16	5.060	...	...	N 70 W	1.38	4.75
1865	65.2	— 1.0	87.8	44.4	43.4	8	1.990	...	...	N 60 W	1.55	5.07
1866	60.8	— 5.4	77.0	42.4	34.6	14	4.457	...	...	N 59 W	2.58	5.16
1867	68.1	+ 1.9	95.2	42.2	53.0	10	2.440	...	...	N 76 W	1.25	4.52
1868	67.2	+ 1.0	84.4	46.8	37.6	13	1.562	...	...	S 68 W	1.01	6.15
1869	63.6	— 2.6	89.0	43.5	45.5	11	4.273	...	...	N 42 W	1.98	5.13
1870	67.1	+ 0.9	84.0	40.0	44.0	14	3.422	...	...	N 75 W	1.80	5.92
1871	67.4	+ 1.2	89.5	46.0	43.5	8	2.800	...	...	N 52 W	1.09	6.86
1872	69.6	+ 3.3	91.8	51.0	40.8	19	2.405	...	...	N 51 W	1.43	3.73
1873	66.6	+ 0.4	85.0	46.4	38.6	12	1.913	...	...	N 84 E	1.35	5.56
1874	67.1	+ 0.9	95.0	48.0	47.0	4	0.380	...	...	N 23 E	0.70	6.16
1875	65.2	— 1.0	81.9	48.0	33.9	14	1.880	...	...	S 56 E	1.58	6.70
1876	70.2	+ 4.0	88.8	45.0	43.8	2	R	...	...	S 31 W	0.23	6.57
Res'ts to 1875.	66.20	...	86.82	44.88	41.94	10.97	2.864	...	...	N 61 W	0.90	5.32
Excess for '76.	+ 4.04	...	+ 1.98	+ 0.12	+ 1.86	8.97	2.864	...	...	...	...	+ 1.25

CONTENTS.

*** The Annual Subscription, due in January, Country Members, $3; in Toronto, $4.

N. B.—The article on the "Flora of the St. Lawrence Valley," &c., is deferred until January, 1877.