TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD

AT PHILADELPHIA,

FOR

PROMOTING USEFUL KNOWLEDGE.

VOL. III.—NEW SERIES.

PUBLISHED BY THE SOCIETY.

Philadelphia:

PRINTED BY JAMES KAY, JUN. & CO.

PRINTERS TO THE SOCIETY.

1830.

RULES

FOR

THE GOVERNMENT OF COMMITTEES OF PUBLICATION.

First.—" That the grounds of the Committee's choice of papers for the press, should always be the importance or singularity of the subjects, or the advantageous manner of treating them, without pretending to answer, or to make the Society answerable, for the certainty of the facts, or propriety of the reasonings, contained in the several papers so published, which must still rest on the credit or judgment of their respective authors."

Second.—" That neither the Society nor the Committee of the press do ever give their opinion as a body upon any paper they may publish, or upon any subject of art or nature that comes before them."

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PREFATORY NOTICE.

Various circumstances have retarded the publication of this volume, which was intended to have appeared in the preceding year. Measures have been taken to prevent a similar delay in future. The Society have materials on hand with which they hope soon to begin the publication of the fourth volume of this series.

Since the publication of our catalogue in 1824, the library of the society has been considerably increased: so much so, that an additional catalogue has been ordered to be made, which is now in preparation. Our cabinet also has been enlarged by numerous contributions, some of which are very valuable. Among them may be particularized the collections of Mexican minerals and antiquities, for which we are indebted to the munificence of our fellow member, Mr Poinsett, late minister from this country to the United Mexican States,—the additions which have been made to those collections by another of our members, Mr William H. Keating,—and the complete series of the various earths and fossils developed in the great excavation of the Chesapeake and Delaware Canal, which we have received from Andrew Alfred Dexter, Esq., one of the engineers of that work.

In the course of the last five years, death has deprived the society of many of its most valuable members. At home we have to lament the loss of Thomas Jefferson, John Adams, and De Witt Clinton, three of the greatest men that this country has produced: next to them we must place our late venerated president William Tilghman, Dr Adam Seybert, Mr François Adrian Vanderkemp, Mr Charles Wilson Peale, Dr Samuel Brown, Dr Stephen Elliott, the founder of the Philosophical Society of Charleston, South Carolina, and Professor John D. Godman; whose deaths have left a void in this society which will with difficulty be filled.

Among those of our foreign members, of whom death has deprived the learned world as well as ourselves, we particularly notice that illustrious friend and patron of science, Count Nicholas Romanzoff, Nicholas Fuss, Sir Humphry Davy, Count Lanjuinais, Duke de Liancourt, Bishop Munter of Copenhagen, Thunberg, Vater; whose names are celebrated throughout America as well as Europe. We have also lost Salazar of Colombia, Stockler of Lisbon, and Torombert of Lyons,—all more or less distinguished in the literary and scientific world. At the same time, other names have been added to our list, of men whom the society are proud to reckon among their associates.

The contents of this volume partly belong to the physical and partly to the moral sciences. In this the society has followed the example of several learned societies in Europe, and particularly of the Royal Academy of Berlin.

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APPARATUS USED BY M. BULL IN HIS EXPERIMENTS ON FUEL.

TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY.

NEW SERIES.

No. I.

Experiments to determine the comparative quantities of Heat evolved in the combustion of the principal varieties of Wood and Coal used in the United States, for Fuel; and, also, to determine the comparative quantities of Heat lost by the ordinary apparatus made use of for their combustion. By Marcus Bull.—*Read April* 7, 1826.

The experiments on fuel detailed in the following paper, were commenced in November, 1823, and were prosecuted with very little cessation, until June, 1824; when, in consequence of absence, together with subsequent ill health, they were suspended until May, 1825, when they were again resumed with undiminished interest, and have been continued, as circumstances would permit, from that period to the present.

During the latter of these periods, I was under the necessity of repeating those experiments which had been previously made, in consequence of a defect discovered in a part of the apparatus, the removal of which, was found to change the results; still, it was very satisfactory to find that the variation was, in every instance, directly proportional to the results which had been formerly obtained.

The experiments to determine the comparative loss of heat sustained by using apparatus of different constructions for the combustion of fuel, appeared to be equally necessary with those to determine its comparative efficiency.

To Professors Hare and Patterson of the University of Pennsylvania, I am under obligations for their kind assistance in my experiments, and it gives me great pleasure to have an opportunity thus publicly to tender them my acknowledgments.

The importance of those experiments, which have for their object the promotion of the useful arts and sciences, or an improvement in the domestic economy of society, by which our comforts may be increased, is generally admitted.

In a climate like that of the United States, where, during two-thirds of the year, fires are indispensable to human comfort, and where, consequently, the savings of a large portion of the poor, during the summer, are often inadequate to purchase a sufficient supply of fuel for the winter; it must, obviously, be highly important to ascertain, the comparative efficiency of different kinds of fuel; as, without this knowledge, those who are desirous of economising, may be prodigal through ignorance.

The knowledge of the comparative heat disengaged in the combustion of the different varieties of wood and coal, is also important in various processes in the arts, and it is believed that the results of my experiments will be found worthy of attention, in a philosophical point of view.

Previous to describing my apparatus or experiments, it will be proper to notice those of some of my predecessors, as, in the investigation of this subject, no small degree of inaccuracy appears to have prevailed, even among experimenters of high character.

My remarks cannot be better prefaced, than by making use of the following extract from Dr. Ure, on the subject of combustion.

"Lavoisier, Crawford, Dalton, and Rumford, in succession, made experiments to determine the quantity of heat evolved in the combustion of various bodies. The apparatus used by the last was perfectly simple, and perhaps the most precise of the whole. The heat was conducted by flattened pipes of metal, into the heart of a body of water, and was measured by the temperature imparted."

From the general table of results, it is only necessary for me to extract two, to show the force of the succeeding remark.

Substances burned, one pound.	Ice melted in pounds.			
	Lavoisier.	Crawford.	Dalton.	Rumford.
Olive oil.	149	89	104	94.07
Charcoal.	96.5	69	40	

"The discrepancies in the preceding table, are sufficient to show the necessity of new experiments on the subject."

As the experiments of M. Lavoisier, Dr. Crawford, and Mr. Dalton, did not comprise any article of fuel except charcoal, a more particular notice of them would be irrelevant to my purpose.

The experiments of Count Rumford, to determine the quantity of heat evolved in the combustion of different woods, will alone be examined. In his very just remarks, he says, "Many persons have already endeavoured to determine the relative quantities of heat furnished by wood and charcoal in their combustion; but the results of their inquiries have not been satisfactory.

Their apparatus has been too imperfect, not to leave vast incertitude in the conclusions drawn from their investigations. Indeed, the subject is so intricate in itself, that with the best instruments, the utmost care is requisite, lest, after much labour, the inquirer should be forced to content himself with approximations instead of accurate results, and valuations, strictly determined.

All woods contain much moisture, even when apparently very dry; and, as the persons alluded to have neglected to determine the quantities of absolutely dry wood, burned by them, much uncertainty prevails in the results of all their experiments. Another source of uncertainty, lies in the great quantity of heat suffered to escape with the smoke and other products of the combustion."* Again,† "attempts have been long ago made, to measure the heat that is developed in the combustion of inflammable substances; but the results of the experiments have been so contradictory, and the methods employed so little calculated to inspire confidence, that the undertaking is justly considered as very little advanced. I had attempted it at three different times within these twenty years, but without success. After having made a great number of experiments with the most scrupulous care, with apparatus on which I had long reflected, and afterwards caused to be executed by skilful workmen, I had found nothing, however, that appeared to me sufficiently decisive to deserve to be made public. A large apparatus in copper, more than twelve feet long, which I had made at Munich fifteen years ago, and another scarcely less expensive, made at Paris four years ago, which I have still in my laboratory, attest the desire I have long entertained, of finding the means of elucidating a question that has always appeared to me of great importance, both with regard to the sciences and to the arts. At length, however, I have the satisfaction of announcing to the class, that, after all my fruitless attempts, I have discovered a very simple method of measuring the heat manifested in combustion, and, this even with such precision, as leaves nothing to be desired."

It will not be necessary to describe the *Calorimeter* used by Count Rumford, more particularly, than to say, that it consists of a small copper receiver containing water. In the inside is a flat worm, also made of copper, bent so as to pass horizontally three times from one end of the receiver to the other. This worm passes down through an aperture in the bottom,

* Nicholson's Journal, XXXV. 105.
† Ibid. XXXII. 105.

near one end of the receiver, to which it is soldered; and the other extremity of the worm passes through the opposite end of the receiver. A thermometer is introduced into the water contained in the receiver; the woods, in thick shavings, and other combustible bodies, are consumed in the mouth or bottom of the worm, and the heat evolved in the combustion, is imparted to the water during its passage through the worm.

The experiments consisted in elevating the temperature of the water in the receiver 10°, commencing at 5° below, and finishing at 5° above the temperature of the room; and the comparison was made between the weights of different articles required to be consumed to produce this effect, *without regard to time.*

The quantity of wood consumed, varied from 59 to 111 grains in each experiment.

Upon these experiments it is necessary to remark, that the passage of the mercury from 1 to 10° on the scale of the thermometer, can scarcely be supposed to have been performed in all the experiments *in equal periods of time;* and, since the water would require unequal increments of heat in equal times, to counterbalance its unequal decrements, and, possessing, as it does, different capacities for heat at different temperatures, consequently, a very slight inequality in point of time, in elevating the mercury between the several degrees, would materially affect the results of experiments in which only a few grains of the combustible were consumed.

To these causes, and the absence of proper means to take advantage of the heat produced in the combustion of the carbon contained in the woods, may be attributed the inaccuracy of Count Rumford's results; as he states some of the woods to evolve, by the combustion of equal weights, 64 per cent. more heat than others; whereas, the results of my experiments on forty-six varieties of wood, in equal weights, give the extremes of difference as only 11 per cent.

The result from charcoal is not given in the table, but the says, that "The dry vegetable flesh of wood, produces more heat in its combustion, than an equal weight of dry charcoal."*

By the expression "dry vegetable flesh," the count means to indicate that portion of dry wood which is inflammable, or that part which is independent of the charcoal. Now I find, by the most favourable comparison for this portion of the wood, that an equal weight of dry charcoal, produces 286 per cent. more heat than the former, and by the least favourable comparison, 314 per cent. more, giving a mean difference of 300 per cent. in favour of the charcoal.

It will be proper to state what has been considered as essential requisites to the perfection of the apparatus, that, as the description proceeds, the degree of accuracy which it is likely to possess, may, with greater facility be determined; and this will be done under three heads, with explanatory remarks.

1st. *That the apparatus in which the combustion is produced, be so constructed, that all, or an equal proportion of all the heat generated, may be measured by some unchanging standard.*

This is effected in a manner to be hereafter more particularly described, but it may now be sufficiently understood, by referring to the plate, in which the apparatus and the interior of the room, constructed for performing the experiments, are shown in perspective. At E is a thermometer, the bulb of which is in the centre of the stove-pipe, and another, Fig. 6, is suspended from the side wall of the room.

When articles are submitted to combustion in the stove, the heat is so completely given out by the pipe, that these two thermometers, indicate *exactly* the same degree of temperature.

Strictly speaking, we cannot say even in this case, that *all* the heat generated is imparted to the air of the room. That small portion which is included in the air of the pipe, and passes off into the chimney, does not impart its heat to the air of the room, both being of the same temperature, consequently, no

* Nicholson's Journal, XXXV. 112.

interchange of heat can take place between them. We may consider this escape of heat, however, in the same point of light as we do that which is conducted off by the surface of every other part of the room, with this difference—that *this particular surface of two inches diameter, conveys more heat in a given time, than any other equal surface;* but as this difference is uniform in all the experiments, we may say, *comparatively*, that there is *no loss* of heat, as it is the *ratio*, and not the *positive* quantity of heat disengaged, which we wish to discover.

2d. *That the recipient body be always affected equally by the communication of the same heat.*

Air has been selected as the recipient body, because we are enabled by a thermometer to measure with accuracy the heat communicated to it; and because it varies very little in its specific heat, under the ordinary changes of barometric pressure, and its hygrometric changes may be readily counteracted.

3. *That the surrounding refrigerating medium be permanent at any required temperature.*

In consequence of the variations in the temperature of the atmosphere, not only daily, but in different parts of the same day, to devise a plan which should strictly comply with this requisition, was a subject which caused me much reflection and perplexity. The room selected for my experiments, was well calculated, in every respect, (except the window,) to prevent an immediate influence being produced in its temperature, by the ordinary external changes. The window being large, I determined to close it entirely, and to perform my experiments by lamp light, and it was, accordingly, perfectly closed on the inside of the room, with boards, which were well seasoned, and grooved together, leaving a space of four inches between this barricade and the sashes of the window. This space being occupied with *confined air*, was a bad conductor of heat. Finding it inconvenient, and objectionable in other respects, to experiment with artificial light, a sash with four panes of glass was subsequently inserted in this barricade, for the admission of light. Every part of the room was then made as tight as possible, and to furnish the room with the necessary supply of air, of equal temperature, a pipe with a valve was inserted through a partition into an adjoining room; as its temperature was necessarily maintained very uniform, for the purposes to which it was applied. Having spent nearly four months of application in perfecting my apparatus, and removing difficulties which presented themselves at the threshold of every stage of the investigation, and feeling desirous to avail myself of any improvements which might be suggested to me, either in the apparatus, or the intended plan of conducting the experiments, I invited several gentlemen to examine it for that purpose, and among them, Dr. Hare, professor of chemistry in the University of Pennsylvania.

The method which had been adopted, as described, to comply with the last requisition, did not appear to Dr. Hare to possess that degree of accuracy which was necessary, nor did it equal that which every other part of the apparatus, together with the intended plan of conducting the experiments, as described to him, appeared to possess. Dr. Hare stated to me, that, "he had long been under the impression, that no accurate comparison could be made by means of the same single room heated at different times, with different fuel, on account of the varying temperature of the weather; nor by different rooms at the same time, from the difficulty of finding two rooms sufficiently alike, in form, aspect, size, and materials. It seemed to him indispensable, to have one room within another, so that, in the interval, a uniformity of temperature might be artificially sustained." As the method suggested by Dr. Hare, removed this difficulty with which I had unsuccessfully contended, no time was lost in making a practical application of his suggestion, and a room of smaller dimensions was in consequence constructed within the room originally intended for my experiments, in the best manner which my architect could devise; by which a free circulation of air is produced on all the exterior surfaces of the interior room, and this air may be sustained of a uniform temperature.

A description of the apparatus, plan of the experiments, and the manner of experimenting, will now be detailed.

In a room with a floor of about eleven feet by fourteen, and nine and a half feet in height, another room is constructed, eight feet square in the clear, its contents being 512 cubic feet. The plate represents the interior of this room in perspective, and as these rooms may now be considered as distinct, I shall, for convenience, designate them by the names of *interior* and *exterior*.

The frame of the interior room is composed of scantling, three inches by four. The ends of the posts, and top and bottom rails, have mortises, with tenons passing through them, of sufficient length to project about four inches, and, in the projecting part of the tenons, are transverse mortises for wedges, by which the frame is drawn firmly together. The floor is supported by two cross pieces of scantling, and the posts and rails are grooved through the centre, to receive boards one inch in the clear, with which the room is enclosed. The boards are also grooved together in the most perfect manner, so that the wedges (there being no nails used except about the door and window) will draw every part of the room tight, and correct, with great facility, any shrinking of the boards during the process of seasoning, which it was necessary to perfect, previous to any experiments being made.

The interior is supported by its four posts, six inches from the floor of the exterior room, there being the same distance between the ceilings, and a much greater between the side walls, the air therefore circulates freely between the two rooms. The internal surfaces of the interior room are made as white as possible with lime-wash, to produce equality in their power of conducting heat. The body of the stove, Fig. 1., is a cylinder, twelve inches in height, and four inches diameter; the ash pit is four inches deep, and four inches in diameter; both are made of common sheet iron, and separate, for the purpose of introducing between them, a chamber, or concave piece of sheet iron, of larger dimensions, perforated with holes half an inch in diameter; and on this chamber the body of the stove rests, as will be seen, by referring to the enlarged sectional view on the plate, Fig. 2. Three inches above this chamber is another, closely fitted within the body of the stove, and perforated with holes one quarter of an inch in diameter. The interior of the body of the stove above, is made to assume the conical shape which it presents, with the apex downwards, by coating it with fire clay, so as to expose only one and a half inches diameter of the surface of the chamber, and on which the fuel rests. The space between the chambers is necessary in experimenting on anthracite coals in small quantities, for the purpose of heating the air as much as possible before it comes in contact with the burning body, and the clay coating is also necessary in the same experiments, to act as a non-conductor. The stove, Fig. 1., is supplied with air through apertures just above the ash pit, or lower door, and to lessen, or close these apertures, a sliding sheet iron hoop, (not shown in the engraving,) is fitted with great accuracy. The middle door is necessary, to obtain access to the upper chamber when its apertures require clearing, during an experiment. For heating water, a tin vessel in the shape of a crescent, rests on cleats, between the upper and middle doors. This vessel is accurately fitted to the body of the stove, but may be removed to any required distance, at pleasure; and we may thereby lessen the evaporation of the water, its object being to regulate the hygrometric state of the air.

All the doors of the stove are represented as open. The upper door is to admit the fuel. The cone, leading from the body of the stove to the pipe, is ten inches long, and very accurately fitted to the former, but removable for the purpose of separating them, to take from the stove and ash pit, the unconsumed parts of any body, that may have been experimented upon. This is done with facility, as the pipe is supported from the ceiling, by wires which sustain it in its place, after the body of the stove is removed.

In the cone, three quarters of an inch above its junction with the body of the stove, (which in this place is made flat,) is an aperture one inch broad, and one and a quarter inches long, which is covered with a thin plate of mica, resting on a flange, or ledge, and kept in its place by a wire passing round the cone. Through this plate of mica, the fire may be seen, thereby avoiding the necessity of opening the upper door for the purpose of mere examination.

The pipe is two inches diameter, and made of extra thin *black* tin, to impart the heat to the air of the room with the least possible obstruction. The elbow joints are each nine inches long. The whole length of the pipe is forty-two feet; and this was found insufficient to impart to the air of the room all the heat generated, there being a loss of 3°, until the tin box, A, was attached to the pipe near its extremity. This box is fourteen inches long, ten inches broad, and $\frac{3}{8}$ths of an inch deep, and its interior and exterior surfaces are made black. In passing through this box, the warm air is exposed to a much larger surface than that presented by the pipe, and the few degrees of heat which it before contained, are by this means imparted to the air of the room.

The joints of the pipe are perfectly closed by clay lute, and its whole exterior surface is covered with a thin coat of dead black varnish, made to resist heat.

The valves B, C, D, to regulate the admission of air into the stove, are all of the same construction, being circular pieces of flat thick sheet iron, very accurately adjusted, to close the interior of the pipe. Fig. 3, represents a side view of the valve B, standing entirely open. The wire to which it is firmly riveted, crosses the centre of the valve, and passes through the pipe. This end of the wire serves as one of the pivots for the valve to turn upon, and the other end, being bent into a half circle, is used both as the handle to turn the valve, and as an index to regulate it. The point of this enters the graduated holes in the dial; Fig. 4, which is a front view, and is riveted to the exterior of the pipe, being the half of a circle of flat sheet iron, whose whole diameter is equal to that of the pipe. The handle is bent to correspond exactly with the flat surface of the valve, by which the situation of the handle indicates the position of the valve inside of the pipe, so that no mistake can occur in its use.

Being well aware that the experiments could not be accurately performed, unless the operator should at all times possess a perfect control over the burning body; it became necessary after attaching the box A, to insert the cross pipe with the valve D, by which the current of air through the stove may, in an instant, be placed at its maximum in quantity and velocity, if permitted to pass through this cross pipe, in place of passing through the shallow box A.

This passage is useful when igniting anthracite coal, in which process, the coal, as well as all other combustible bodies, require to be heated to a certain temperature before they will ignite, during which process, heat being absorbed, and not disengaged, if care be taken to close this valve in proper time, none is lost. As this required temperature differs not only in different bodies, and in the different component parts of some bodies, but is specific, for each, it may for convenience, be termed their *heat of ignition* or *accension.*

This passage is also useful in some experiments, to give a momentary impulse to the inflammation, of certain bodies, and cannot be dispensed with without great loss of time, in heating the room to its proper temperature, before commencing an experiment.

Considerable difficulty was experienced in getting the valves and their appendages made with sufficient accuracy, but when done, as half of the arc of each dial is divided into twenty equal parts, it will be perceived that the current of air to supply the body in combustion, can be regulated with great precision.

The valve B, is particularly useful to stop at a proper time the combustion of those bodies, which it is known cannot be wholly consumed in the stove, and this is done almost instantaneously by closing this valve, and sliding down the hoop which covers the apertures for the admission of air.

The pipe passes through the side wall into the chimney of the exterior room. Near the end of the pipe, within the interior room, is an aperture of sufficient size to admit the bulb of the thermometer E, and this aperture is closed by a tin plate closely fitted to the stem of the thermometer. This plate is curved to fit the pipe, and is of sufficient size to cover the aperture, and rest upon the pipe. The bulb of the thermometer is suspended in the centre of the pipe, by the brass scale being made shorter than usual, and resting on the tin plate, which is secured in its place by a small quantity of clay lute. This thermometer is used to measure the temperature of the air within the pipe, previous to its passing into the chimney; and as I have never found the bulb discoloured by the carbonaceous particles in the smoke, and thereby rendered more sensible, as it was feared would be the case, I am induced to think very little ever reaches it, being previously deposited in the pipe.

Fig. 6, is another mercurial thermometer, suspended from the side wall of the room. Both these were made expressly for my experiments, and to correspond in their scales (which are Fahrenheit's) with the greatest possible accuracy. The thermometer, Fig. 6, is used to measure the temperature of the air in the room, and is placed on a line with that in the pipe, at twelve inches distance. The bulb is screened by a piece of bright planished tin, to prevent the influence of heat radiated from any part of the stove or pipe, while it does not prevent a free access of the air in the room, to the bulb of the thermometer.

Fig. 7, is Mr. Leslie's differential thermometer, one half of which is passed through an aperture in the board partition into the exterior room, and is secured in its place by a divided cork, which encircles a part of the syphon at the bottom of the instrument, and closes the aperture. Both bulbs are perfectly screened by large pieces of bright planished tin, not shown in the engraving. This instrument, as its name denotes, measures only the *difference* of temperature in the two rooms, and as it does this with peculiar delicacy, it is admirably adapted to my purpose, the accuracy of my experiments depending in a great measure on the uniform difference of temperature in the two rooms; and I am under obligations to its inventor, and also, to Dr. Hare, as it was in consequence of the suggestion of the latter gentleman, that this instrument was added to my apparatus; its peculiar applicability to my experiments not having previously occurred to me.

The differential thermometer used in my experiments, indicated 20°, to 1° of the mercurial thermometers, and, as one of the bulbs is situated in the interior room, it can only be operated upon by the temperature of that room; the other bulb being in the exterior room, can only be operated upon by the temperature of the latter room; consequently, any change of temperature in either will be shown on the scale, the instrument having been adjusted with great care, so that the top of the tinged liquor will stand at 50°, when there is a difference of 10° between the mercurial thermometers placed in the two rooms; and from its superior sensibility in detecting incipient changes, the differential thermometer may almost be said to possess the power of *divination*, whereby the operator receives timely notice to avoid any essential error.

Fig. 5, is a tin supply pipe, two inches in diameter. This passes through the floor in a perpendicular direction, and has an elbow joint opening towards the stove. It has a valve to regulate the quantity of air found necessary to be admitted into the room for the purposes of respiration, and to support the combustion in the stove. This valve, when once adjusted, remained the same through all the experiments. Whether the precise quantity of air necessary for the respiration of the operator, and to support the combustion, is admitted by this pipe, *or an excess*, its temperature being the same, and the stove being supposed always to be supplied with air at the temperature of the interior room, and to require about the same quantity during any given period of two or more experiments, the air admitted being also of equal volume, its velocity will be the same under all changes of barometric pressure; consequently, the reduction of the temperature of the air in the room may be supposed to be the same during the time required to perform each experiment, with the exception of an immaterial variation in its specific heat, to be hereafter noticed; and, the results of the experiments cannot be affected by the admission of an excess of air, they being, as before stated, founded on the comparative, and not the positive quantity of heat evolved.

At Fig. 8, is a hygrometer made of the beard of the wild oat, enclosed in a small brass case, and covered with glass. This is used to measure the humidity of the air, which, like all other bodies, possesses different conducting powers as its hygrometric state varies, by which its specific heat or capacity for absorbing caloric is increased or diminished; those bodies which contain moisture being better conductors than the same bodies when dry. The comparative capacities of water and dry air, are, as 1.000 to .266, by the experiments of MM. Delaroche and Berard. From Sausseur's experiments, it appears, however, that the quantity of aqueous vapour attracted by the air of the atmosphere, when at 65° of Fahrenheit, is very small; a cubic foot of air requiring not more than eleven or twelve grains to bring it from the state of perfect dryness, to that of extreme moisture.

Now, as the various sides of the room are the conducting media by which the heat generated in the room is dissipated, and as these sides are in contact with the air of the room, and must in some degree be influenced by its hygrometric state, they will, consequently, become more or less powerful conductors, as this varies. To produce a uniformity in this respect, I have, by the aid of this instrument, and of the water contained in the tin vessel before described, taken care to keep the air of the interior room in the same hygrometric state, during the various experiments.

The barometer at Fig. 9, requires no description, and is not considered an essential appendage to my apparatus, although convenient as a check upon the valves; not, however, on the common supposition that the velocity of the current of air through the stove is greater under one pressure than another, *cæteris paribus*, but that its quantity varies with its density, more being contained in the same volume at one pressure than at another.

The results of MM. Clement and Desormes' experiments on gases, to determine their *specific heats*, at different densities, show that the specific heat of atmospheric air does not vary more than .02, between 29.5 and 30.5 inches of barometric pressure. These being the extremes during my experiments, the difference of heat required to maintain the temperature of the air between any two experiments, cannot materially affect their results, and for this variation no correction has been thought necessary.

Having described the construction of the interior room, and its apparatus, it remains to describe the exterior room, which has a capacity of 860 cubic feet, after deducting 542 feet for the space occupied by the interior room, and the materials of which it is composed. This room has a southern aspect, and is defended from the west winds by a building projecting beyond it ten feet south. It has one window, with blinds on the outside, to exclude, when necessary, the rays of the sun; the east and south walls are of brick, and are ten inches in thickness; the remaining two are partitions of lath and plaster, four and a half inches thick, and separate between a passage on the west, and a room on the north. The chimney is in the east wall. A small stove is placed in this room, the pipe of which passes through the fire-board. A mercurial thermometer, to measure the temperature of the air, is placed in a convenient situation, on a line with those in the interior room, and on a table an accurate balance is suspended, to weigh the articles which are to be subjected to experiment.

The plan of the experiments will next be described.

Equal quantities are taken of each article by weight, previously made absolutely dry; by which is to be understood, that state of deprivation of moisture manifested when no diminution in weight can be effected by the heat of a stove at 250° of Fahrenheit.

It is required to determine the period of *time* which the combustion of each article will maintain the temperature of the *interior* room 10° higher than the *exterior;* and the time that the interior room is thus maintained by any article, gives its true relative heat, when compared with the time which any other article has maintained the room at the same difference of temperature. As the temperature of the air in both rooms is supposed to remain *stationary*, the increments and decrements of heat will therefore be equal, in equal periods of time, in all the experiments, by which the objections made against the *plan* of Count Rumford's experiments are considered as obviated.

The manner of experimenting is as follows:

The first step to be taken by the operator, is to produce the required difference of 10° between the interior and exterior rooms, and to arrange the necessary coincident circumstances for its perpetuation.

As no artificial refrigerating means can, with convenience, be made use of to depress the temperature of the exterior room below that of the atmosphere, it becomes necessary that the temperature of this room shall, in the first instance, be higher than any elevation which will occur in the temperature of the atmosphere during an experiment, otherwise the experiment must fail.

During the many trials of the apparatus in order to become familiar with its use, and to lessen the great difficulty experienced in maintaining the uniform difference of temperature required between the interior and exterior rooms, the following incident occurred, by which this difficulty was entirely obviated.

In the month of June, an unusual depression in the temperature of the atmosphere had taken place during the night season, in consequence of which the temperature of the exterior room was found on the following morning to be 20° above that of the atmosphere. Having been previously obliged to experiment at very high and uncomfortable temperatures, in consequence of the heat of the weather, and presuming that this depression would be transient, and as my assistant, who attended to the exterior room, was absent, no increase was made in its temperature, as had formerly been done under similar circumstances. The temperature of the interior room was elevated, without previous calculation, 15° above that of the exterior room, at the period of commencement; during this operation, the thermometer in the exterior room had not been observed, but on examination, the difference was found to be precisely 10° between the two rooms; considering it, however, as a fortuitous occurrence, no investigation of the cause was at that time entered into. The trial experiment was commenced under a firm belief that the differential thermometer would give immediate notice that the temperature of the exterior room required correction, but, to my astonishment, the differential thermometer was found to vary less than usual, and after a lapse of three hours, although the temperature of the atmosphere was found to have been elevated 12°, the temperature of the exterior room remained *stationary*, and continued so until the completion of the experiment.

No time was then lost in attempting to discover the cause by which an effect so desirable had been produced, and when examined, it became a matter of surprise that it had not previously been discovered by calculation and experiment, rather than accident. It may be explained in the following manner:

The interior room contains 512, and the exterior 860 cubic feet of air. As the heat necessary to elevate 512 cubic feet of air 15°, is gradually transferred to 860 cubic feet, consequently, it must increase its temperature so long as its increments are greater than its decrements, and should, by calculation, *cæteris paribus*, augment it nearly 9°, instead of 5°, as was found to be the case; but as the exterior room presents very nearly double the conducting surface, this will account for the difference.

When the temperature of the interior room is thus elevated 15°, the exterior is consequently elevated 5°, by which the required difference of 10° is produced, and the temperature of the exterior room then becomes *stationary*, that being the precise point at which the increments and decrements of heat are equal in the air of *both rooms*.

The manner of producing this important result under known circumstances, being established, the operator has only to seek for the same result in a different place, under an unknown, or known difference of circumstances. As the surface of the window (the barricade having been removed) is the only part of the exterior room which can be speedily operated upon by the ordinary changes of the atmosphere, the temperature of the room, must therefore, from its situation, and the nature of its walls, change very little; if, however, during an experiment, any indication of an increase in its temperature is observed, the upper sash in the window, which is suspended with weights, is lowered the required distance to correct it; but if decreasing, a fire of wood can be immediately kindled in the stove, a lamp being kept burning in this room for the purpose, although never required but in two instances during my experiments.

The required difference of temperature between the two rooms being adjusted as described, it is maintained for about half an hour by burning dry charcoal. The article to be subjected to experiment is then accurately weighed, and if it is wood, the unconsumed charcoal is wholly removed from the stove by a small pair of tongs, and deposited in another room, and the wood which is used in pieces two inches long, and half to one quarter of an inch thick, is ignited by applying it to the flame of a lamp; but if it is any of the species of coal which cannot be ignited *per se*, the burning charcoal is taken from the stove and weighed, and its quantity either increased or diminished so as to make half an ounce, which is quickly returned to the stove, and on my notes, the name of the article, its quantity, and the time, by an accurate watch, are then set down, together with the state of the thermometers, the barometer, and hygrometer. The heights of the thermometers are noted every ten minutes during the experiment, that in the exterior room being always known by comparing the mercurial and differential thermometers of the interior room.

The last ten minutes of time which is entered to finish an experiment, is that to which it approaches the nearest; the difference therefore from the proper time, cannot be more, but will generally be less than five minutes, which is, in many cases, as near perhaps as it can be determined, and the greatest difference stated will not affect the mean of the results one per cent.

The anthracite coal cannot be wholly consumed, even in the improved state of the stove, the upper chamber having been introduced after its first construction, to provide a space for the purpose of heating the air as much as possible before coming in contact with the burning body, by which the quantity remaining unconsumed is reduced from two ounces to less than half an ounce. That portion which remains unconsumed after an experiment, including the small particles which drop through the apertures of the chambers into the ash pit, are washed upon a sieve to remove the ashes and any other foreign matter, and when thoroughly dried in a crucible, are weighed and deducted from the original weight.

In making up the results of experiments in which charcoal is used to ignite the body, from the resulting time is deducted so much as is known by previous experiment to have arisen from a portion of charcoal equal in weight to that used. Those bituminous coals which fuse and cake in the process of coaking, are the most troublesome to manage in small quantities, from the inconstant manner in which the bituminous part burns, and its tendency to become extinguished the moment that portion is consumed; the combustion of the bitumen not producing the heat of ignition required by the carbonaceous part to continue the process of combustion, and the surface being partially covered with the deposite from the pyrites, becomes more difficult to ignite, and requires to be broken asunder to present a fresh surface. To overcome this difficulty, it was found necessary to use the coal in very small pieces, and occasionally to take from the stove such parts as had coaked, break them in pieces, and return them to the stove as required, which, when ignited, will burn permanently, and the heat required to coak the remaining part of the coal is thereby produced. During tedious experiments, the operator is sometimes under the necessity of passing from the interior to the exterior room, but if done with proper caution, the differential thermometer is never affected thereby.

The animal heat imparted to the air of the room by the operator, must be noticed. This, under ordinary exertion of the muscles, being equal both in temperature and quantity, as determined by Dr. Crawford, and being the same during the period of each experiment, the results will not be affected thereby.

The accuracy with which the experiments have been performed, is a delicate subject for me to expatiate upon, but I shall be permitted to say, that all means within my power have been used to render the results as accurate as the difficult nature of the subject will admit. These results will be found in the general table.

From the diversity in these results, it is apparent, that equal weights of different combustible bodies vary materially in the quantity of heat disengaged in their combustion. The woods differ less perhaps in *equal weights* than has been generally supposed, and that difference will be found to correspond very nearly with the different quantities of carbon they contain; they are however of very different value in *equal quantities by measure*, in consequence of the great disparity in their *weight*. This remark is also applicable to those coals which are sold by measure and not by weight, from which circumstance, it becomes necessary to *caution* those who would attempt to ascertain the value of different articles of fuel by merely comparing their different results of heat in the table, without regard to their different weights. The results being comparisons between articles in equal weights, cannot be compared with quantities by measure alone; hence the necessity of determining the weights of a given bulk of those articles sold in this manner, which will be found in the table in their respective columns, the manner of obtaining which will be hereafter detailed. The object of my experiments being practical utility, rather than scientific research, to facilitate the accomplishment of that desirable object, I have estimated the comparative values of the different articles. These will be found in the last column of the table, and are equally applicable not only to every market, but for every change in the prices that can take place.

The standard taken is shell-bark hickory, that being of greater weight than a cord of any other wood in the table, and disengaging in its combustion an equal quantity of heat from any given weight.

The comparative numbers express the value of one cord of each of the woods, one ton of the anthracite coals, and one hundred bushels of the bituminous coals, charcoal and coak, and although no one market is supposed to furnish for fuel every kind of wood contained in the table, yet the principal part will probably be found, and in markets where the woods are much mixed, averages may easily be made adapted to those markets. The column of comparative values was found in the following manner.

The value of a given quantity of fuel is directly proportional to the *time* that a given weight of it maintained the air of the room at a given temperature, and also to its *weight*. Hence assuming shell-bark hickory for a standard, since one pound of this wood maintained the air of the room at the given temperature 400 minutes, this being multiplied by 4469, the weight of a cord of this wood, we obtain 1787600 minutes as the time which the air of the room would have been maintained at the given temperature, by consuming one cord of this wood.

We then have the following proportion. As the product in time corresponding to one cord of shell-bark hickory, (1787600) is to its assumed value (100) so is the product of the weight of a given quantity of any other article into the time that one pound of it would maintain the air of the room at the given temperature, to the value of the given quantity of this article.

Thus for a cord of white ash wood:

As 1787600 : 100 :: 3450×400=138000000 : 77

For a ton of Lehigh coal, of 2240 pounds:

As 1787600 : 100 :: 2240×790=176960000 : 99

For 100 bushels of cannel coal weighing 6525 pounds:

As 1787600 : 100 :: 6525×630=411075000 : 230

A few examples will be sufficient to show the facility with which the comparisons may be made. For this purpose, we will assume the price of shell-bark hickory wood as at six dollars for a cord of 128 cubic feet, this being the average price in this market, and compare it with a cord of red-heart hickory. The comparative value of the former is 100, and of the latter 81. We then have the following statement. As 100 : 600 : : 81 : 486. Four dollars and eighty-six cents being the comparative value of a cord of red-heart hickory, and the difference between the price of this wood and its comparative value thus ascertained, shows how much dearer or cheaper it is than the wood with which it has been compared. We will suppose the price of red-heart hickory to be 5.75 and that of chesnut white oak to be 5 dollars. Then 81 : 575 : : 86 : 610, is the value of the latter, which being sold at 5 dollars, is cheaper by one dollar and ten cents, than the red-heart hickory. If we take the mean of the comparative numbers for the eleven different species of oaks, which is 69, and compare them at 5 dollars, with shell-bark hickory at 6 dollars, 100 : 600 : : 69 : 414, is the average value of those oaks, and at the prices specified, the hickory is the cheapest by nearly one dollar.

A mere examination of the comparative numbers, will show that a cord of white birch is 52 pr. ct. less in value than a cord of shell-bark hickory, and the difference *per cent.* may be calculated from the comparative numbers between any two articles sold at the same price.

We will now extend the comparison to some of the coals: and take for this purpose one cord of shell-bark hickory, at 6 dollars, and determine the comparative value of one ton of Lehigh Coal. As 100 : 600 :: 99 : 594, which shows them to be of nearly the same value, supposing each article to be consumed under the same circumstances; but as this is not the case, and as this objection has been frequently stated to me by those who have confounded two distinct subjects, a momentary digression will be excused, to show the futility and irrelevancy of this objection. It is admitted that there may be greater disparity between the manner of consuming different kinds of fuel, than actually exists in their comparative value as usually sold; but this difference does not enhance or depress the value of the different articles, provided it is practicable to consume them in the same manner, which, with very few exceptions, may be done. The intrinsic value of the different kinds of fuel, and the loss or gain experienced by the different constructions of the apparatus used for their combustion, are distinct subjects of inquiry, and although both are necessary to be known, to effect any valuable improvement in the selection of the one and the construction of the other, yet it does not follow as a consequence, because the construction of a grate used for the combustion of Lehigh coal, is more economical than an open fire-place, that, therefore, one ton of the coal possesses greater intrinsic value than one cord of shell-bark hickory wood, as it would be equally relevant, to say, that the coal is intrinsically of less value, because the wood may be consumed in a sheet iron stove, which is a much more economical apparatus than the grate.

We will resume the subject by comparing one ton of Lehigh coal, at seven dollars, with one hundred bushels of Newcastle coal, at thirty-five dollars, which are the present prices in this market. As 99 : 700 :: 198 : 1400, from which, it appears that fifty bushels of this coal are precisely equal in value to one ton of Lehigh coal, but as the Newcastle coal will cost seventeen dollars and fifty cents, and the Lehigh coal costs only seven dollars, the latter is the cheaper article of fuel by 150 per cent.

If the value of a chaldron or bushel of the bituminous coal is required, the manner of obtaining a solution of either question, is obvious.

It will be apparent, that although shell-bark hickory has been taken, for convenience, as the standard, to construct the column of comparative values, the economist should take the cheapest article of fuel in the market, as his standard of comparison.

The experiments on the Lehigh, Schuylkill, Susquehanna, and Lackawaxen coals were repeated a number of times in different quantities, but the results were found to be uniformly the same. Considerable difference was found in the results of pine charcoal, when taken promiscuously from different parcels as brought to market, in consequence of the imperfect manner in which the charring process had been conducted, but as these coals are sold by measure, and not by weight, and as the bulk is not materially diminished in perfecting the process, the loss sustained from this circumstance being in part compensated by the heat disengaged in expelling the remaining inflammable matter, we may consider this defect, in ordinary cases, as unimportant; the result, however, is given for perfect charcoal.

The coak used to experiment upon was produced in the large way, and that which was most free from earthy, or other foreign matter, as well as most perfect in other respects, was selected. The result is less than was anticipated, and shows that the commonly received opinion that it contains as much carbonaceous matter as charcoal, in equal weights, is erroneous, and what is still more erroneous is, the opinion that any given quantity of coak, by *measure*, will in its combustion disengage as much heat as an equal quantity of the coal from which it is produced. One bushel of bituminous coal produces in retorts about one and a half bushels of coak, in consequence of swelling during the process, and yet its specific gravity is stated, in some tables, as nearly equal to the coal.

The composition balls of Lehigh coal, charcoal, and fire clay, were made for the purpose of ascertaining whether a very economical fuel might not be formed of the culm or fine portions of the two former, by combining them with the latter article, as they possess very little value, and the same practice having been adopted with considerable advantage in various parts of Europe.

The fire produced by these balls was found to be very clean and beautiful in its appearance; its superior cleanliness is in consequence of the ashes being retained by the clay, and the balls were found to retain their original shape, after they were deprived of the combustible materials. The beauty of the fire is enhanced by the shape and equality in the size of the balls, which, during the combustion, present uniform luminous faces. No difficulty was found in igniting or perfectly consuming the combustible materials of the balls, and the loss in heat, when compared with the combustion of the same quantity of each article, in their usual states of aggregation, was found to be only three per cent.

It is proper to state that the experiments were made with the best quality of every article that could be procured, and as some slight difference may exist between wood of different ages, the medium sizes were selected. Those woods and coals which are peculiar to the New England States, were obtained from thence. The Rhode-Island and Worcester coals were procured for me by an obliging friend in Boston, who stated that the coals were selected with care, but, that the Worcester coal being a recent discovery, and the parcel sent having been taken from the surface of the bed, could not be considered as a fair sample of the coal which may be supposed to exist in lower strata.

Many and insuperable difficulties presented themselves, in attempting to ascertain by common methods the weight of dry wood in a cord of each kind. The plan adopted, and which appeared most likely to produce satisfactory results, was as follows. From a pile of swamp white oak of medium size, which had been cut the preceding winter, and weather seasoned during the interval, (this being the state in which the largest portion of wood is sold,) a half cord, or sixty-four cubic feet, was accurately measured, and its weight was found to be 1928 avoirdupois pounds. From this half cord was taken in various sizes, a sufficient number of sticks to allow one piece to be sawn from each, twelve inches long, to produce $\frac{1}{64}$ part of the whole weight, which being done, the pieces of wood were placed in a foot "*corder*," or space twelve inches square, made by nailing four pieces of board together at the ends; but the wood not being found to fill it equally in the first instance, other pieces were substituted, of *equal weight*, until the interstices between the sticks presented a similar appearance to that of wood, as ordinarily piled up for sale.

This parcel of wood was then perfectly dried in an oven, and its solid content ascertained by the quantity of water which it displaced. To perform this operation, a tin box was used, fifteen inches deep, and six inches wide at the open top, which was set into a large tin funnel, and the water displaced by the wood was conveyed by the latter into an earthen vessel placed underneath for its reception. The pieces of wood were taken separately, and into one end of each, a small awl was inserted a sufficient distance to sustain the weight of the stick, and by which it could be accurately and expeditiously immersed in the water. As the surface of the wood could not be made impervious to water without a change in its bulk, it became necessary to perform the operation with as much dexterity as possible; the wood, however, being perfectly dry, its surface was covered with dust, which caused it to *repel* the water in the first instance, and I found it could be immersed steadily, and yet with such facility, as to be left nearly dry if shaken immediately on being withdrawn from the water, and this was determined by the very slight addition which was found to have been made to its weight by the immersion. For this addition to the weight of the wood, the water used being at 55° Fahrenheit, a correction was made and added to the quantity of water displaced, although a partial compensation may be considered to have taken place by the expansion produced in the wood in consequence of the absorption of this portion of the water.

The water displaced was measured in a deep narrow vessel, provided with a sliding scale, fitted to its interior, for the purpose, and found to be 965 cubic inches, from which the quantity of *plenum*, or solid dry wood, in a cord taken under the circumstances described, was found to be $71\frac{1}{2}$ cubic feet, leaving a deficiency for the interstices and diminution in volume by drying of $56\frac{1}{2}$ cubic feet. Thus,

$$1 : 965 :: 128 : 123520, \text{ which } \div 1728 = 71.\tfrac{832}{1728} \text{ cubic feet.}$$

The method taken, it is supposed, will give the average quantity of *combustible matter*, in a cord of wood, as usually sold, it being impossible for me to give a scale adapted to every change in volume produced by the different degrees of humidity, of which the woods are susceptible.

The solid content of a cord of wood being known, if the specific gravity of any wood is correctly ascertained, its absolute weight may be determined thereby.

The usual method of ascertaining the specific gravity of wood, as laid down in the books, is manifestly incorrect, as the absorption of water, during its immersion, produces an enlargement in the *magnitude* of the body, not compensated for by adding to the water weight, if the body is lighter, (or deducting, if heavier than water,) the weight of water found to have been absorbed, and this absorption must constitute complete saturation before the water weight can be accurately ascertained, because, during this process of absorption, the air being constantly expelled from the body, part of it adheres to it in small globules, and renders it more buoyant, in proportion as this bulk of air is lighter than the same bulk of the body; consequently, the body weighs less than it should do, and this cause of error cannot be counteracted by an attempt to weigh the body "*expeditiously*," as is recommended. During this necessary process of saturating the body with water, the wood increases in magnitude, and its specific gravity will be found less than it should be; and the difference will be seen to be very considerable, when it is stated that the specific gravity of a piece of dry wood, weighing in air 11.15 grains, was, by the common method found to be .556, and the same piece of wood being then dried with great care to its former weight, its specific gravity found by a process free from this objection, (hereafter to be described,) was .619, the difference in which would be 282 lbs. in one cord of wood.

The specific gravity of those bodies which do not change in their *magnitude* by the absorption of water, and which have no *fissures*, may be correctly obtained by the common method, as the water absorbed is *retained* in the body, and can thereby be ascertained, as it will be of the exact weight by which the water weight had been increased or diminished in consequence of the expulsion of an equal bulk of air from the body.

Our object in ascertaining the specific gravities of bodies, is to find the proportion of their weights under the same volume. Now, by the volume of a body, is to be understood the entire space enclosed within its exterior surface, including its pores and fissures. It is necessary, therefore, in determining the sp. gr. by the usual method of the hydrostatic balance, to use some means for preventing the water from insinuating itself into the pores and fissures of such bodies as are not of a perfectly compact texture. If the article employed for this purpose be of a sp. gr. different from water, and if (as will almost always be the case) it protrude beyond the surface of the body so as to enlarge the bulk, it will be necessary not only to know its weight in air, but its specific gravity; and even then it is difficult to make a satisfactory correction of the water weight in consequence of the change which the article made use of may sustain in its specific gravity by pressure in applying it to the body, and also, from the different specific gravity of different parts of articles not expressly prepared for the purpose.

As it was necessary for me to determine with great accuracy the specific gravities of dry wood, charcoal, and the mineral coals, all of which absorb water and present more or less fissures, and as I wished to relieve myself from liability to inaccuracies from the sources which have been detailed, I determined to make a compound which should be convenient to use, and whose specific gravity should be precisely that of water at 60° Fahrenheit.

This was effected with white wax and yellow rosin; the specific gravity of the former was .967, and of the latter 1.079. The compound was of the best possible consistence, and whether compressed by mechanical means at a low temperature, or expanded by the temperature of water at 120°, it would in either case be unity when brought to the temperature of 60°, and the whole mass was perfectly uniform.

The difficulty of producing this compound was much greater than had been anticipated, and will be apparent, when it is stated that the mass weighed at the commencement about two ounces, taken by arithmetical calculation in the proportions supposed to be necessary, which were 46 grains of rosin to 100 grains of wax, and although the smallest additions supposed necessary, were made at each time to this mass, from two other masses of the same articles compounded, whose specific gravities were known to be about .995 and 1.005, the mass weighed when finished more than thirty ounces, and required seven days to accomplish the undertaking, and the proportions of the ingredients found to have been used, were about 22 grains of rosin to 100 grains of wax. Having had occasion to use some of this compound within a short time, I regret to say, that the lapse of two years since it was made, has produced a change in its specific gravity, it being now 1.004 in water at the temperature of 60° Fahrenheit.

The pieces of wood being made positively dry, in the manner described for drying those experimented upon, they were covered with the compound described without regard to its weight, and their specific gravities being ascertained, the absolute weight of dry wood in a cord of each was found in the following manner, and will be seen in the table.

The weight of a cubic foot of any substance, whose specific gravity is 1, is known to be very nearly 1000 ounces, or $62\frac{1}{2}$ pounds avoirdupois. Hence, to find the weight of a cord of wood, or $71\frac{1}{2}$ cubic feet of *plenum*, of specific gravity 1, (for example, shell-bark hickory) we have only to multiply 71.5 by 62.5, which gives us 4468.75. Now, to find the weight of a cord of wood, of any other specific gravity, we say, As *unity* is to (4468.75) the weight of a cord at specific gravity 1, so is the given specific gravity, to the weight of a cord at that specific gravity. Thus, for white ash; 1 : 4468.75 : : .772 : 3449.87 pounds. In fact, we have, in any case, merely to multiply 4468.75 by the specific gravity of any other wood, to obtain the weight of a cord of this wood, in pounds and decimals avoirdupois.

The quantity of charcoal which can, by the best conducted process, be obtained from the different woods, was deemed an inquiry of considerable importance, there being great discrepancies in the results of different experimenters on this subject, and from the vast importance and consumption of this article in the arts generally, and particularly in the process of smelting iron ore. For this purpose all attempts hitherto made in this country to substitute anthracite coals, have proved nugatory; and, as equally unsuccessful results have attended the numerous and well conducted experiments, which have been made in England, Ireland, and Wales, to substitute anthracite coals for coak, in the same important process, it becomes a matter of national interest, that our forests, intended for this purpose, should not be unnecessarily wasted by conducting the charring process in an improper manner, and this can only be ascertained by first knowing the positive quantity of carbon contained in the different woods, from which we shall be able to determine whether any improvements can be made in the process.

Various methods have been adopted by different experimenters on this subject; that most generally used appears to have been charring the woods in dry sand; but I found this objectionable, as the finer portions of the sand were liable to enter the interior of the coal, if it had any fissures, and the weight of the product was too large, while on the other hand, the interstices between the particles of sand were found to admit sufficient air to consume part of the coal, and the product in consequence of this combustion was liable to be found too small. To obviate both these objections, pulverized charcoal, known to have been perfectly charred and dry, was substituted for sand, having ascertained that it could be almost entirely shaken out of the fissures in the coal, and that, should any remain, the error would be immaterial. The pieces of wood were closely packed in it, and presented an inch in thickness of powdered coal between the sides and bottom of the crucible and the wood, and about three inches of powdered coal on the top of the wood, the whole being covered by an inverted crucible luted down. In this latter crucible a small orifice only being made, any air, therefore, which should enter through the pores of the crucible or the aperture at top, would be decomposed before it could reach the wood in the interior, and the air which may be supposed to have existed between the interstices of the powdered coal, or in the coal itself in the first instance, would also be decomposed and rendered inert, before the wood could be charred. The whole of the woods, which had been previously filed into oblong solids, presenting sharp edges, to detect any loss by fracture, each being designated by notation letters, made by incision, were thus surrounded and exposed in the first instance to a moderate heat in an air furnace, which was increased to a white heat, and so remained for about two hours, during which time additional quantities of powdered coal were introduced through the aperture at the top of the inverted crucible.

The product of charcoal from the several woods obtained in this manner, will be found in the table.

Among the many experiments made to discover the best manner of ascertaining the weight of charcoal product from the different woods, and to satisfy myself whether any loss could take place in a solid piece of coal surrounded by powdered charcoal, a piece of box wood coal without fissures was taken, weighing 23.7 grains, and after having been exposed to a white heat for three hours, was found to weigh 23.1 grains; the loss of $\frac{6}{10}$ of a grain, was, however, undoubtedly, produced by the air contained in the piece of coal, or conjointly with that in the interstices between the powdered coal, contiguous to the piece when first ignited.

A similar experiment was made in clean dry white sand, upon a piece of maple coal without fissures, which had been previously exposed in powdered charcoal to a white heat, and known to be perfectly charred and dry. This piece of coal weighed 26 grains, and lost by the process 6 grains; the surface was found entirely changed from its original hard texture, having become soft, and the colour was changed from slate to jet black, which is often found to be the case in charcoal obtained in the large way, and is always objectionable, as it produces loss both to the collier and consumer.

The charcoal produced by surrounding the wood with powdered coal was found of a slate colour on its surface, dense, sonorous, brittle and equal in all respects to that made in cylinders or retorts for gunpowder, which is known to be much superior to that produced by the ordinary method, even for common purposes, from its greater durability, although, for these purposes, no particular necessity exists that the pyroligneous acid and tar should be perfectly expelled. From the preceding experiment in sand, it occurred to me that an important improvement might be made in the common process, by filling the interstices between the sticks of wood with the culm or fine coal left on the ground after the large coal has been drawn from the pit, and by covering the wood more perfectly than is usually done. In this way we may more perfectly prevent the access of the air, which is not only destructive in many cases to a large portion of the coal, but also renders what remains, less valuable.

That my remarks on this subject may not be considered entirely theoretical, it is proper to state, that an intelligent collier in New Jersey applied in a partial manner the plan proposed, and found the product to be about 10 per cent. more in quantity by measure, than he had ever before obtained from the same kind and quantity of wood, and I found the coal when brought to market nearly 20 per cent. heavier than usual, and as an evidence that the coal had been well charred, a circumstance which is too often neglected, the hydrogen gas appeared to have been almost entirely expelled, and it lost very little in weight by exposing it to a red heat in powdered charcoal.

The quality of this coal was considered by competent judges to be superior to any other ever offered in this market, and was as cleanly to handle as the anthracite coals, and sold readily at an advanced price.

From an examination made during the last summer, of the common manner of piling and covering wood which is to be converted into charcoal, the practice of piling it two and three tiers in height, appears to be objectionable for two reasons; the first is, that the second and third tiers cannot be so well defended from the air as the first, which rests upon the ground, this being a better barrier against the air, than the former can be made to present; and the second is, that this disposition of the wood is not favourable for producing the ignition of the whole mass at one and the same time, the usual practice being either to commence the ignition in the centre of the upper tier, or, in other cases, to drop the fire into a hole, or chimney, left in the centre of the pile which extends to the bottom, or ground; and by giving air holes at the sides of the pit, to use the language of the colliers, the fire is said to be "drawn to the sides of the pit."

It is very true, that the fire does eventually extend to the sides of the pit; but a much more uniform and speedy process, and by which less loss would be sustained, would be to place the fire in the first instance in a number of holes at the sides, near the bottom, leaving an opening at the top by which the heat generated at the sides would be communicated to the wood in the interior, and facilitate the uniform ignition of the whole mass, and the moment this is effected, let the holes at the sides be closed, and that at the top may be lessened, but should not be wholly closed, until the extrication of hydrogen gas has nearly ceased, which, from its prodigious expansion, sometimes bursts the pits, and as this generally occurs when the wood is well covered, and sometimes produces very injurious effects, by firing the adjacent woods, (as the column of flame has been known to extend from twenty to thirty feet,) it has probably led many colliers into the belief that the proper remedy is to give the wood a slight covering, by which numerous escapes are allowed for the gas; but in effecting this object, as the holes at the sides are left open, a very strong current is produced through the pit by the slight covering, and another evil is produced, that of burning through the sides of the pit.

In those instances where pits have been known to burst, when well covered, the cause may probably be traced to having closed the chimney at the top too soon, this being generally done in about fifteen minutes, and having left those open at the sides too long, as the gas will make its escape in some manner, which should be provided for, and this provision is as necessary to a coal pit, as the safety valve is to a steam boiler.

Both the objections which have been alluded to against piling the wood two or three tiers high, may in part be remedied by changing the manner of igniting the wood as proposed, and if clay can be procured, (with sand on the top, to fill the cracks as it dries,) as a covering, which should be preferred in all cases, the evils may be reduced; but the best manner is, undoubtedly, to pile the wood in single lengths, and if the fine coal is used to fill the interstices, and can be made subservient in its combustion to produce the required heat or any portion of the heat necessary to char the wood, that portion which can be so used is as effectual as the combustion of an equal portion of the char. The process being, when conducted in retorts, similar to that of distillation, the qualities of the wood necessary to be expelled being volatile, no necessity exists that any combustion should take place either in the wood or char; yet this cannot be entirely prevented, in the common process, unless some means are devised to burn the hydrogen gas which escapes, and make it applicable to produce the heat necessary to char the wood as is done when the process is conducted in retorts. The hard texture of the coal will be in proportion to the heat given it, and the exclusion of air; the advantage therefore of using clay will be obvious from its being a bad conductor of heat, and a good barrier to exclude the air.

I have been informed by a gentleman well acquainted with the iron works in this state, that in consequence of the slow growth of the extensive forests belonging to the same, not being sufficient to furnish a constant supply of charcoal, many of the works are obliged to suspend their operations, about three months in each year, by which very great loss is sustained. If an improvement can be made in the manner of producing the charcoal required, by which these works, and all others similarly situated shall be enabled, from their present forests. to continue their operations without interruption, such an improvement must be considered as important, not only to individuals, but to the community generally.

A series of experiments was made on a large number of woods, to determine the difference, if any existed, in the product of charcoal from green and dry wood; and these being taken from the same sticks in equal weights when green, they would both contain the same quantity of ligneous matter. The product was not found to be essentially different, but, invariably, rather larger from the dry than from the green wood, and the specific gravity of the former was also greater; I have no hesitation, however, in saying that there will be less loss in charring wood in the large way by using dry wood, as it can be ignited more equally, and with greater facility.

It is my intention, so soon as my other avocations will permit, to make some experiments in the charring process in the large way, and to use the fine coal as suggested, for which purpose a number of cords of wood have been cut for a considerable period of time.

Dead wood was found to produce the same quantity of charcoal as the same wood in a living state, and the limbs of trees produced coal of much greater density than the trunk. Among the most dense woods, stove dry ebony, sp. gr. 1.090, gave a product of charcoal from 100 parts of wood, of 33.82, which is larger than was obtained from any other wood, and its specific gravity was also greater, being .888; its fracture so much resembles that of some of the mineral coals, that it is difficult to say in what respects they differ. Stove dry live oak, sp. gr. .942, gave 32.43, sp. gr. .591. Tortoise-shell wood, sp. gr. 1.212, gave 30.31, sp. gr. .866. Cocoa, sp. gr. 1.231, gave 28.53, sp. gr. .742. Turkey box, sp. gr. .933, gave 27.24, sp. gr. .622.

A piece of box wood polished, lost very little of its lustre by charring in powdered coal, and the beautiful variations in the grain of the wood were as apparent in the coal as in the wood, and this experiment may be considered as conclusive, as to the complete exclusion of air by this process.

It does not appear from the products of charcoal from the different woods, that their density or durability is to be attributed to the quantity of carbon they contain. As the woods differ materially in the quantity of charcoal product by measure, it appeared necessary to give the product from a cord of each in bushels, and as the value of these can only be determined by their weight, this also appeared necessary, both of which will be found in the table.

The bushel generally used in this country contains 2150.4 cubic inches, but as coals are sold by what is termed "*rounded measure*," or partially heaped, it became necessary to ascertain the cubical content of a body of coal thus measured. For this purpose one bushel of charcoal was made perfectly dry, and the mean specific gravity of a large number of pieces was found to be .285, and the weight of the bushel of coal was fifteen pounds avoirdupois, or 105000 grains, and the absolute weight of a cubic foot of coal whose specific gravity is .285, is 124687 grains, and a cubic foot being 1728 cubic inches, then we have the following statement: As 124687 : 1728 : : 105000 : 1455 solid inches of coal in the bushel, which being known, the absolute weight of a bushel of each of the coals was calculated from their specific gravities, in the following manner:

The weight of a cubic foot, or 1728 cubic inches of any substance, whose specific gravity is 1, being 1000 ounces, consequently the weight in ounces of a bushel containing 1455 cubic inches of any substance, of the same specific gravity, will be found by the following proportion:

As 1728 : 1000 : : 1455 : 842 = 52.62 pounds.

Now to find the weight of a bushel of a substance of any other specific gravity, we say; As *unity* is to (52.62) the weight of a bushel at specific gravity 1, so is the given specific gravity, to the weight of a bushel at that specific gravity. Thus for white ash charcoal, we have, As 1 : 52.62 : : .547 : 28.78 pounds.

From a number of comparisons, made by actual measurement, of different mineral coals, it is believed the weights expressed in the table will be found sufficiently correct in every instance.

The hydrostatic balance made use of to ascertain the specific gravities of the different bodies expressed in the table, is sensibly affected by $\frac{1}{100}$ part of a grain, when not loaded, and the weights were made to twentieth parts of a grain in every instance.

From experiments made to ascertain the weight of moisture absorbed by the different woods, which had previously been made perfectly dry, and afterwards exposed in a room in which no fire was made during a period of twelve months, the average absorption by weight, for this period, was found to be 10 per cent. in forty six different woods, and 8 per cent. in the driest states of the atmosphere, and an unexpected coincidence was found to exist in the absorption by weight of forty six pieces of charcoal made from the same kinds of wood, and similarly exposed, the latter being also 8 per cent.

The quantity of moisture absorbed by the woods individually, was not found to diminish with their increase in density; while it was found that the green woods, in drying, uniformly lost less in weight in proportion to their greater density. Hickory wood taken green, and made absolutely dry, experienced a diminution in its weight of 37½ per cent., white oak, 41 per cent. and soft maple, 48 per cent.; a cord of the latter will therefore weigh nearly twice as much when green as when dry.

If we assume the mean quantity of moisture in the woods, when green, as 42 per cent., the great disadvantage of attempting to burn wood in this state must be obvious, as in every 100 pounds of this compound of wood and water, 42 pounds of aqueous matter must be expelled from the wood, and as the capacity of water for absorbing heat is nearly as 4 to 1, when compared with air, and probably greater during its conversion into vapour, which must be effected before it can escape, the loss of heat must consequently be very great.

The necessity of speaking thus theoretically on this point, is regretted; but, it will be apparent, that this question of loss cannot be solved by my apparatus, as the vapour would be condensed in the pipe of the stove, and the heat would thereby be imparted to the room, which, under ordinary circumstances, escapes into the chimney.

The average weight of moisture in different woods which have been weather seasoned from eight to twelve months, will not be found to vary materially from 25 per cent. of their weight; every economist, therefore, will see the propriety of keeping his wood under cover in all cases where this is practicable.

Numerous experiments have been made to determine the law which obtains in the cooling of heated bodies. Although my apparatus did not admit of making experiments on this subject at high temperatures, yet it appears in one respect better adapted for the purpose than any other which has, to my knowledge, been made use of, as we are enabled to maintain both the heated body and the refrigerating medium at the same *difference* of temperature, for a sufficient period of time, to determine the question with accuracy. My experiments consisted in maintaining the temperature of the interior room 10°, 20°, 30°, and 40° above the temperature of the exterior room for the same period of time, and the quantity of fuel required was found to be directly proportional to the increased difference in temperature. These results are in agreement with the assumption of Newton, the geometrical law of Richmann, and also correspond at these differences of temperature with the experiments of MM. Dulong and Petit, although the latter gentlemen found very different results at higher temperatures.

The usual method which has been adopted to determine this question, by finding the period which fluids require, when heated, to cool through a given number of degrees in different parts of the scale of a thermometer, appears liable to some objections, which it becomes me, however, to notice with deference. The shape or size of the containing vessel is not, perhaps, material, but as spheres have been most generally used, my remarks will be confined to that shape.

We will, for illustration, assume the containing vessel to be the bulb of a thermometer two inches in diameter, and filled with mercury. This we will suppose to be heated to 300° of Fahrenheit, and placed *in vacuo*, in which case it is said to lose its heat by radiation only. Now, as the stratum of mercury in contact with the bulb, parts with its heat, it contracts and occupies less space in the bulb, which causes a portion of that within the tube to sink into the bulb in order to supply the deficiency. This exterior stratum must then be supposed, from its loss of heat, to have acquired greater density, and to leave the sides of the bulb; hence, *motion* in the fluid commences, and in proportion to its heat will be its fluidity, and consequently, the velocity with which the change will be made, and as the strata lessen in volume as they approach the centre of the bulb, their heat must either be transmitted through the exterior intervening strata, or be subject to the necessary delay in coming in contact with the bulb, in consequence of the decreasing velocity with which the changes are made; and, in either case, the cooling process will be retarded. If we suppose the fluid, under the circumstances described, incapable of locomotion, it will not be denied that the interior strata will require more time to impart the same heat than the exterior, consequently, proportional to the cooling of the body must be the increased time required to deprive it of any given number of degrees.

Experiments upon this subject would be much more satisfactory, and would probably give different results from those hitherto obtained at *high* temperatures, by using an apparatus which should admit of maintaining the heat at fixed points upon the scale of the thermometer; in which case motion in the fluid would be immaterial, and an equally heated surface would always be exposed to the refrigerating medium.

Experiments to determine the comparative loss of Heat sustained by different constructions of apparatus ordinarily used for the combustion of Fuel.

The comparative loss of heat which arises from the different manner in which fuel is consumed, is a subject intimately connected with the question of economy in its use, but it is a distinct subject of inquiry from the former investigation, which was to determine the comparative heat disengaged in the combustion of the various kinds of fuel. It is presumed the remarks which have already been made, in anticipation, on this point, in detailing the first course of experiments, (at page 23,) will be considered conclusive.

For the purpose of performing these experiments, a slight alteration, only, of the interior room, was required.

The chimney of the exterior room being situate within twelve inches of the board partition on the east side of the interior room, an opening was made through the partition of a sufficient size fairly to expose the fire-place of the chimney to the interior room; the sides, top, and bottom of this aperture were then closed by boards perfectly tight, and may now be considered as forming part of the interior room.

All the apparatus, with the exception of the stove, remained the same, and was made use of as has been before described.

Those constructions of apparatus in most common use, and of proper size for the room were selected. The experiments could not, without great inconvenience, be extended so as to embrace all the inventions which have been presented to the public as improvements upon these constructions, but it is believed those selected will be sufficient for the object of the inquiry.

This course of experiments was conducted on the same plan as the former, namely, by determining the period of *time* which the air of the interior room could be maintained 10° of temperature above that of the exterior room, in the combustion of equal quantities of fuel, by weight, in each apparatus. In some cases, indeed, it was necessary to use larger quantities of fuel than in others, in order to make satisfactory experiments, yet the results are given for equal weights, and exhibit the time which the air of the room was thus maintained by each apparatus, and are compared with the time which the same weight and kind of fuel had maintained the same difference of temperature in using apparatus No. 9, in the former state of the room; a correction having been made for the slight increase in its size, in consequence of the alteration which has been described. The fuel used in all the experiments was shell-bark hickory wood, of the same quality, and absolutely dry.

It had been apprehended that considerable difficulty would be experienced in producing the required equality in the temperature of the interior room, from the absence of proper means, in some of the apparatus experimented upon, to regulate the combustion; but from very few trials with each, it was found less difficult than had been anticipated, and that the difficulty could be entirely avoided by making the quantity of fuel administered to the fire, the regulator of the rapidity and extent of combustion necessary to be produced, which was effected by using the wood in small pieces.

The results have been thrown into a tabular form, and exhibit, as before stated, the comparison of each apparatus with No. 9, in which it is assumed that no loss of heat is sustained, this assumption being necessary, for the purpose of determining the comparative *loss* of heat sustained by each apparatus, which is the object of the experiments.

The manner of obtaining the results in *time*, having been stated, it is evident, that, as the same quantity of fuel was consumed in every experiment, consequently the same quantity of heat must have been generated. In all the experiments, (except the standard experiment No. 9,) we find part of the heat escaped by the pipe or flue of the grate and fire-place into the chimney, and was lost, and proportional to this loss must have been the quantity of the fuel required to be consumed in a given time, to maintain the temperature of the room, and, consequently, the duration of each experiment was proportionally affected thereby. The numbers, therefore, which express the duration of each experiment, are proportional to the heat *saved*, and assuming the positive quantity of heat generated as 100, this being the result of apparatus No. 9, if the time occupied in any other experiment is deducted from 100, the remainder gives the positive *loss* sustained in every hundred parts of heat generated by using this apparatus, and by which we determine that in using No. 1, as only 10 parts in every hundred parts of heat generated are saved, consequently we lose 90 per cent of heat.

As the important difference which exists in the quantity of fuel required to be consumed in different apparatus to produce the same effect, might not in all instances be obvious by a cursory inspection of the numbers in the first column of the table, the second column of numbers has been inserted to facilitate these comparisons, and the great disparity in the quantity of fuel required to produce the same effect in No. 1 and No. 2, may, at first view, appear paradoxical, if compared with the quantity of heat saved by each, from 100 parts generated, as only 8 parts more heat are saved by No. 2, than is saved by No. 1, and yet the positive saving in fuel by using No. 2, is nearly 45 per cent.

To find the numbers in the second column, we assume the fuel used in all the experiments as 100; and for the facility of comparison, we will say this quantity of fuel maintained the temperature of the room 100 minutes when consumed in apparatus No. 9. In experiment No. 1, we find this quantity of fuel maintained the temperature of the room only 10 minutes, and, consequently, it would have required 10 times as much fuel as apparatus No. 9, (or 1000,) to maintain the room at the same temperature for 100 minutes. In the same manner the other numbers are found.

The proportion for the experiments will be clearly explained in the following manner: As the time of the experiment is to the quantity of fuel consumed, so is the assumed time of comparison, to the fuel that would be required for that time. Thus for experiment No. 2: As 18 : 100 : : 100 : 555.

By an examination of the numbers in the second column of the table, it will be seen that one dollar expended in fuel consumed in apparatus No. 9, is as effective as ten dollars expended in the same kind of fuel consumed in No. 1, the same quantity of heat being imparted to the room in both cases. The comparison may be extended in the same manner between any two experiments inserted in the table, and the figures in the second column will be found to express the relative value of fuel for each apparatus, in dollars and cents, by adding a decimal point at the left hand of the two last figures.

Experiments No. 6, 7, and 8, were made with the same stove for the purpose of determining the difference in the loss of heat by different constructions and positions of pipe of the *same length*, which in all other respects were similar. From these experiments it will be seen, that the same length of pipe in elbow joints is much more efficacious in imparting heat to the room than straight pipe, and as the length of pipe producing a *descending* current, was nearly equal in experiments No. 6 and No. 8, the great advantage which has been supposed to be derived from the descending current, does not appear to exist, although it is undoubtedly more efficacious than the same length and position of pipe producing an *ascending* current, as the velocity of the current in the former is diminished by the increased resistance which must necessarily be overcome in its descent, while the latter gives greater facility for the heated air to escape than is given by any other position in which the pipe can be placed. Experiment No. 7 shows that pipe placed horizontally is more efficacious in imparting heat, than when placed in a vertical position either for an ascending or descending current.

The causes which operate to render the same length of pipe in elbow joints more efficacious than any other construction, may be satisfactorily explained. The shape of the pipe forces the current of heated air to make abrupt turns, in doing which it impinges against the elbows with sufficient force to invert its internal arrangement, by which change from its former relative situation with the sides of the pipe, a new stratum of hot air from the interior of the current, is brought more frequently in contact with the sides of the pipe, which facilitates the process of imparting heat, particularly by being brought in contact with the lower half of the horizontal part of the pipe, which is necessarily the coldest from various causes, and is of very little service in imparting heat to the room without the aid of elbow joints.

From experiment No. 8, an important inference may be drawn; that the advantage gained under ordinary circumstanes, by increasing the length of the pipe, has a limit very far short of that which is found to be necessary to impart *all* the heat generated to the air of the room, as in this experiment, only five parts of the heat were lost in using $13\frac{1}{2}$ feet of pipe, consisting of nine elbow joints; whereas, in apparatus No. 9, eight additional elbow joints, with sixteen and a half feet of straight pipe, amounting together to 28½ feet of pipe, were required to save these five parts of the heat which would otherwise have escaped into the chimney. The reason for this limitation will appear evident, by reflecting that a heated body loses less in equal periods of time, as its temperature approaches that of the surrounding refrigerating medium, and that the loss of heat will be in the proportion which the volume of air in the pipe bears to the volume of air in the room; and, also, proportional to their difference of temperature.

It must not, however, be inferred from this experiment, that 13½ feet of pipe of any *diameter*, and thickness of iron, made into elbow joints, will produce the same effect; as the length will require to be increased with the increase in its diameter, and this will appear obvious, from the fact, that the surface of the pipe does not increase in the ratio of its area or contents of heated air, and as this surface is the medium by which the heat is imparted to the room, and that being effected principally by contact with the sides of the pipe, greater length will be required to produce this necessary contact.

The great advantage of sheet iron stoves, is obvious, from the slight obstruction which they present to the rapid communication of the heat generated, to the air of the room.

From experiment No. 2, the advantage gained by lessening the current of air into the chimney is clearly demonstrated; this being the principal cause why this apparatus is more efficacious in warming the room than No. 1; and this advantage does not arise so much from the excess of heat which enters the room by using No. 2, as from the diminished quantity of cold air necessary to be admitted to supply the place of the air that *has been heated*, and of which, by using No. 1, the room is constantly deprived in much larger volume than by No. 2. The advantage derived from using stove pipe of small diameter, arises from the same cause, and whether the velocity of the current of heated air is diminished by the construction, position, or length of the pipe, or its volume is diminished by reducing the diameter, the same effect is produced in every case.

I am not in possession of the results of any experiments, if such have ever been made, to determine the ratio of friction experienced by air, when compared with water, in their passage through pipes, under the same pressure. That air does, however, experience a diminution in its velocity from this cause, will not, it is supposed, be doubted, and this must affect, very materially, the current of air through pipes and chimneys.

In practical hydraulics, it is well known, that, without altering the column of pressure, the quantity of water discharged is greatly diminished, by merely lengthening the conduit-pipe. "Comparing the experiments on the flow of water through conduit-pipes, as recited in Bossuet's *Hydrodynamique*, I find, after making the proper reductions, that the velocity of projection from the bottom of a cistern, is diminished about five times in the passage through an horizontal tube of one inch in diameter, and fifteen feet long. Consequently, while one part of the actuating force is discharged from the orifice, twenty-four parts are consumed in gliding against the sides of the pipe. Every particle contained must hence have repeated its contact no less than twenty-four times, before it made its escape; that is, the whole column of fluid must have inverted its internal arrangement at each interval of $7\frac{1}{2}$ inches."*

The principal article of fuel used in the United States, is forest wood, which, from necessity, or choice, will continue to be so in many sections of the country, notwithstanding the abundant supply of anthracite and bituminous coals already discovered in some of the States.

The difficulty of consuming small quantities of anthracite coal in open grates, must operate to prevent its general introduction into use, unless this difficulty can be removed; any suggestions, therefore, which may possibly tend to lessen this objection to an article of such vast importance to the community, will not be considered irrelevant to my subject.

It is very well known, that no particular difficulty is experienced, under ordinary circumstances, in consuming small

* Mr. Leslie on Heat, 308.

quantities of this coal in sheet iron cylinder stoves lined with fire brick; and it is as well known, that an equally small quantity of this coal cannot be consumed in an open grate. The inference, therefore, which should be drawn from the knowledge of these facts, is, that the open grate is an improperly constructed apparatus to obtain the desired object, independent of the deleterious gas which it imparts to the room. The question which then presents itself, is, what are the qualities possessed by the former apparatus in which the latter is deficient?

In the former, the coal is known to be completely surrounded by a thick substance, which, when heated, retains it with great tenacity. The air admitted is in small quantity, and, from the construction of the stove, it is necessarily considerably elevated in its temperature, before it comes in contact with the burning body. We infer from these facts, that anthracite coal requires a very high temperature to produce ignition, and, as we know that combustion cannot take place without this prerequisite, the necessary means to effect it, are, consequently, indispensable. We also infer, that the commonly received opinion, that this coal requires a very large quantity of air, or "strong draught," to carry on its combustion, is not correct; the converse of this opinion being nearer true; and this may in part be demonstrated by an examination of a single piece of this coal which has been ignited. If we break the piece of coal, the interior will present its original black colour and lustre, with the exception of an inconsiderable portion near the surface; the body of the coal being sufficiently dense to exclude the access of air, no combustion of its interior can take place, and, consequently, the quantity of air necessary to be admitted to the coals, is nearly proportional to the quantity of coal contained in *their surfaces*, but not in proportion to their positive quantity, as would be nearer the case, if this article were as pervious to air as charcoal. Any excess of air, therefore, is injurious in proportion as the quantity exceeds that which can unite with what is termed the combustible or base, inasmuch as it tends to reduce its temperature, and thereby renders it less capable of rapid union with the air, to produce the combustion; and as each successive portion of air in excess robs the combustible of its heat, we see the fire languish for a short period, and then expire.

Although atmospheric air is generally necessary to support combustion, an excess of it, it is well known, will, in some cases, extinguish a burning body, as expeditiously as water; and from this circumstance it may be inferred that, for ignition, the air requires to be heated as well as the combustible body. We may also infer, that the intensity of heat produced by the union of the two bodies will be proportional to the excess with which their united heats exceed their mean heat of ignition.

Having had occasion, during the past winter, to warm two warehouses, of different sizes, and it being necessary that the temperature should be permanent during the night season, two cylinder sheet iron stoves, of ordinary construction, lined with fire brick, were procured, of different sizes, which were supplied with Lehigh coal.

The construction of the stoves being favourable to apply on a large scale what I had found so advantageous in my experiment stove, there being considerable space between the grate and the bottom of the ash pan, this space was converted into a reservoir for heating the air, by closing the apertures usually made for its admission in the front of the ash pan. During the igniting process, the ash pan was drawn out, but when this was effected, it was closed as perfectly as its construction would admit, leaving only the small crevices at its junction with the body of the stove for the admission of air, and although the largest stove usually contained more than half a bushel of coal, this supply of air was found ample for producing intense combustion, and the quantity of coal remaining on the grate unconsumed, was found to be much less than when the stove was supplied with a larger quantity of air, and a very important saving was made in the heat by the diminished quantity and velocity with which the current of heated air passed into the chimney. Very important improvements may be made in the construction of sheet iron stoves, for burning anthracite coal, and if provision is made for supplying the burning body with *intensely heated air*, any required quantity of coal may be consumed, and the present manner of lining them with thick brick may be entirely dispensed with, by substituting either thin tiles, or a thin coating of clay lute, sufficient to preserve the iron from fusion or oxidation, and as this would present less obstruction to the speedy communication of the heat generated to the air of the room, consequently less would escape into the chimney.

In examining the construction of the open parlour grate, we do not find in it one entire quality possessed by the close stove; the only one which bears any approach to similarity, is that three sides of the grate are lined with fire brick, but as the fourth is almost wholly exposed, its utility is thereby defeated.

It is admitted that the combustion is very perfect and rapid, when the sheet iron door, or "*blower*," as it is technically termed, is applied to close the front of the grate; and this must be a necessary consequence, as its application transforms the open grate into a powerful *air furnace*, by which the space for the admission of air is very much reduced, and the air is also, probably, reduced in quantity, this not being compensated by its increased velocity, and as the blower defends the body of coal in front from the cold air, to which it was before exposed, the required elevation in temperature is effected and maintained without difficulty.

It is only by radiation that any heat is imparted to the room from coal consumed in open grates, and as the radiated heat is known to be very small from the surface of that portion of coal which is exposed to the front or open part of the grate, the amount of heat imparted to the room would not probably be diminished, but rather increased, by using a thin plate of cast iron for the front of the grate, by which the difficulty of consuming small quantities of coal would be very much diminished; and this would not be less agreeable in its appearance than the equally *sombre* aspect presented by the unignited coal in the front of the generality of small grates, and particularly as the top of the coal would be exposed to view, and present a more luminous appearance.

Although iron is a good conductor of heat, the plate suggested would become sufficiently heated to maintain the necessary temperature of the coal to carry on the combustion of the surface exposed to it, with the exception of the points actually in contact with it, which would be unimportant; and this being the case, its conducting power would, in other respects, be obviously advantageous, and no danger of melting the iron, in this situation, need be apprehended. If, however, danger from melting or oxidation of the iron is feared, as a flat plate of iron could not be permanently covered with any composition of clay, it should be made circular, and defended at the top and bottom by a flange projecting on the inside, the required thickness of the clay. In addition to the plate suggested to cover the front of the grate, a still further improvement might be made by enclosing the ash pit also, both of which might be done with one plate of iron, and the grate for sustaining the coal might rest upon cleats projecting from the interior, taking care to give sufficient room for the expansion of the grate, to prevent its being pressed outwards. A door for the removal of ashes and the admission of air would be required, by which the necessary quantity of air could be admitted without an excess. This construction would also be favourable for heating the air which is to supply the combustible body, the advantage of which must be obvious, when we reflect on the necessity of cooling the burning body as little as possible. By the greater expansion of the air, the quantity which comes in contact with the burning body would be less in excess, at any one time, and better adapted to attain the object; the contact being more frequent, from its increased velocity, the quantity actually united in any given time, would probably be greater, and more heat would consequently be produced. This construction, besides the advantages already stated, would be more cleanly than the open grate, would not require the blower, and could also be made use of for culinary purposes, which is a very desirable object to be attained.

The construction of many grates is very objectionable, in an important particular not yet noticed, which is, making the receptacle for the coal of greater length than it has breadth or depth, by which the body of coal is not as much heated, and requires to be replenished more frequently to maintain the relative position of the coal, necessary to continue the combustion. A much better shape, and which would require less coal at any one time, would be in the proportions of twelve inches deep, to eight inches square at the top, and gradually diminished to six inches at the bottom, by which the heat generated in the combustion of the coal at the lower part of the grate, in its passage to escape into the chimney, would come in contact with nearly the whole body of coal, and keep it heated, which cannot be the case in the former shape, supposing the contents of the two grates, and the coal in each to be equal; and if we suppose them to be only *half filled* with coal, the position of that in the deep grate, will be very favourable for combustion, although less in quantity; while that in the shallow grate, from the unfavourable situation in which it is placed, would scarcely burn at all. The advantage of placing the body of coal in a deep grate, as described, may be illustrated by the well known fact, that a stick of wood burns much more rapidly in a vertical, than in a horizontal position, and for the reason already described.

Being well aware of the strong predilection in favour of those constructions which will permit the burning body to be seen, which, with other reasons, prevents the use of close stoves in many instances, and particularly where elegance is required, the necessity is apparent, that some new construction should be devised, which can be substituted for the open grate, that will obviate the difficulty, not only of consuming anthracite coal in small quantities, for rooms of small dimensions, but, what is a still greater objection made to its use generally, that the quantity cannot be varied to meet the changes in the temperature of the atmosphere.

In the plan which I will venture to suggest, a partial compromise must be made in the first particular stated, but all the others may be realized.

In those instances where simplicity of construction is required, take a cylinder, or rather, an inverted conical frustum, of cast iron, of any required thickness and diameter, and of sufficient height to form the receptacle for the coal and ashes; insert a grate at a sufficient height from the bottom to leave the required room for the ash pit, which should be provided with a door to remove the ashes and unconsumed coal, as usual in close stoves, and, also, to regulate the admission of air, which may be heated as in those stoves. This cylinder may be bricked in the ordinary manner on the outside; and this can be done with greater facility than for the grate, and the cylinder will remain more permanently fixed, as it will rest on the hearth. From the satisfactory experiments which have been made in double cylinder stoves, in which the interior cylinder is made of cast iron, without any coating of clay, it is not probable that this construction would require it. In those instances in which beauty of construction must be consulted, the ornamental parts or appendages to the open grates may be added; the only change suggested, being the substitution of a cylinder, or other shape more desirable, of cast iron, in place of the open grate.

The particular requisites necessary to be attended to in the construction of any apparatus intended for the combustion of anthracite coal, in small quantities, having been sufficiently, and, perhaps, tediously expatiated upon, those whose business it is to construct, will apply any suggestions which may be considered as valuable.

Before closing my paper, I cannot forbear making a few desultory remarks; and, first, on the commonly received opinion, that the "draught" of a chimney, or, more properly, the current of air through it, has greater velocity under one degree of barometric pressure than another, and that this is the cause why a combustible body burns better at one time than another.

That the velocity of the current cannot be greater under one degree of atmospheric pressure than another, *cæteris paribus*, may be satisfactorily shown, by supposing a room, with one window open, in which is a fire-place and chimney, and, that the temperature of the air in the room, and that within the chimney, is the same as the temperature of the atmosphere. No current of air would be found to pass either up or down the chimney, because the pressure of the column of air in the room would be counterbalanced by the equal pressure of the column of air within the chimney, and, consequently, both must remain stationary. If the temperature of the air within the chimney be elevated by any means, it expands, and becomes specifically lighter, and an ascending current will be produced: and if the same elevation of temperature remain, and we suppose any change, however great, in the pressure of the atmosphere, as that change must, of necessity, operate on both columns of air, consequently, the velocity of the current must remain the same. The current of air through a chimney, being wholly an artificial production, its velocity will always be proportional to its *temperature* above that of the exterior air, whereby the column of air in the chimney being rendered lighter than the exterior column, yields to its superior pressure, and thus the current is established.

If the air in the room is warmer than that in the chimney, a descending current will be produced; which shows the propriety of closing, during the winter season, those fire-places not used, to prevent the descent of cold air and smoke from the adjoining flues; and the advantage of leaving them open during the hot season, when the exterior air is known to be at a lower temperature than the rooms with which they are connected.

The existence of counter currents in a chimney, when in use, and properly supplied with air, spoken of by some writers on this subject, appears to be an illusion, produced by eddies in the air, at the sides of the chimney, as it enters from the room, as it would be difficult to assign any satisfactory cause for such an effect under the circumstances described.

In tight rooms, where fire-places are left open, and are not in use, counter currents will exist, so long as difference in temperature exists between the air of the room and the external atmosphere.

In those instances where the room is too tight to admit air in sufficient quantity to supply the current necessary to take off the smoke, a descending current is produced, and the smoke is driven into the room as a necessary consequence. The passage of the external air through the small crevices of the room, is not only diminished by the increased friction which it sustains in passing through a large number of crevices, instead of only one of equal capacity, but the pressure is absolutely prevented from exerting its full influence in raising the column of air within the chimney, by which the smoke is made to ascend. If we open a window, the air within the chimney, which before was the heavier column, will become the lighter, and consequently the current will be inverted, and the evil thereby instantly corrected.

It is not my intention to notice the various causes which operate to produce what are termed "bad draughts" to chimneys; there is one cause however of considerable importance, which will be noticed. Chimneys which are new, are found very frequently, if not invariably, to smoke, when an attempt is made to use them before they become perfectly dry. This being attributed to their bad construction in many cases, alterations are consequently made, without knowing the true cause, which will generally be found to be entirely owing to their not being dry. The materials of which they are composed being damp, they are consequently good conductors of heat, and unless very large fires are made, it is difficult to elevate the temperature of the air, throughout the chimney, sufficiently, to produce an ascending current; but when the chimney becomes dry, and covered with carbonaceous matter, it presents a bad conducting surface, and, if then found to smoke, this may be attributed to its bad construction, for which, however, no necessity exists in any case, save that the highly important class of artisans, who wield the trowel, have, too generally, discarded science from their craft.

A sufficient quantity of air must be admitted into every room to supply the demands of respiration and combustion, but any excess is injurious. The usual manner of admitting air for these purposes, through the joints or crevices of the doors, windows, and other parts of the room, appears very objectionable, as the cold air, thus admitted, is very annoying in its passage to the fire-place, and particularly to those seated near the doors or windows. Now, these inconveniences may be entirely avoided, and all parts of the room rendered equally comfortable, by furnishing the room, as is now done in some instances, with a supply-pipe, near the fire-place, for the admission of air. In this pipe there should be a valve, to regulate the quantity of air necessary to be admitted, by which the pressure of the external air, at the joints, or crevices, may not only be wholly taken off, but an outward current produced, through the crevices at the higher parts of the room.

The objection which has been made to this manner of admitting the air, that it does not change the air in the room sufficiently for respiration, appears to be gratuitous, and has been disproved by experience, in rooms of ordinary size, when not unusually crowded.

An additional improvement, to obviate the inconvenience experienced by over-heated or crowded rooms, would be to furnish a ventilator in the chimney, near the ceiling; but the most rational plan, in these cases, would be to remove the cause, by diminishing the fire.

Having shown very clearly, during the preceding remarks, that the reason why a combustible burns better at one time than another, cannot be owing to any change in the velocity of the current within a chimney, in consequence of changes in the pressure of the atmosphere, it becomes obligatory on me, as an objector to this opinion, to assign a more satisfactory cause.

The fact that combustible bodies generally burn better, when the barometer is at 30, than when it is at 28 inches, other things being equal, is admitted. The principal cause of this, appears to be, that the air is generally drier, and better adapted to produce rapid combustion, having less aqueous vapour mechanically mixed with it. Now moist air retards combustion, and cools the burning body, more than dry air, because it possesses a greater capacity for heat, and, consequently, requires more from the burning body to raise its temperature to the point of ignition. In chimney fire-places, it is generally observed, that wood fires burn most rapidly in cold weather; and, even while the air of the room is quite cold, they are known to burn very well. This fact will probably be urged, to disprove the necessity of heating the air, to produce more complete combustion in anthracite coal. It should be recollected, however, that wood ignites at a much lower temperature, and, that in very cold weather, a much larger quantity is required to be in combustion at one time, than in moderate weather; and, consequently, that the air within a few feet of the fire, and before it comes in contact with it, is more heated than it is at the same distance in moderate weather, when less fire is required.

The intense heat produced by an air furnace, does not appear to be in consequence of an increase in the volume of air, as those furnaces which are said to have the strongest "draught," will be found to have the most contracted throats. But, by thus contracting the throat, the friction of the air is increased, and its velocity being also increased, the sound which is said to denote a strong "draught," follows, as a necessary consequence. The air being very much expanded from its increase in temperature, and its rapid escape in large volume, being prevented by the contraction of the throat, the contact with the combustible is not only prolonged, but the real quantity in contact, at any one time, may be supposed to be considerably diminished; yet, this being more frequent and rapid, the union is more perfect, and, consequently, more intense heat is produced.

The superior light of an Argand lamp, is, probably, in consequence of surrounding the burner with a glass chimney, by which the current of air is considerably elevated in its temperature, and the volume admitted is diminished, and not increased, as is generally supposed. Whether its increased velocity through the chimney is advantageous in the process of combustion, when abstractly considered, may be questionable; but, it is evidently advantageous in dissipating the products of combustion, or rather, imperfect combustion, which would otherwise remain longer in contact with the flame. If the chimney be removed from the burner, the flame will be increased to double its former length, yet the light is pale, and the quantity emitted is much less. When the burner is surrounded by the glass chimney, if the wick remain at the same height, the strength of light required can be better regulated by the quantity of air admitted, than in any other manner; and for this purpose, these lamps should be furnished with delicate valves, and the most intense light will not be found, when the largest quantity of air is admitted.

The advantage of elevating the temperature of the air, is demonstrated by the increased intensity of light, which is produced by the button sometimes used in these lamps.

GENERAL TABLE.

Common Names of Woods and Coals.	Botanical Names.	Specific Gravities of dry Wood.	Avoirdupois pounds of dry Wood in one cord.	Product of Charcoal from 100 parts of dry Wood by weight.	Specific Gravities of dry Coal.	Pounds of dry Coal in one bushel.	Pounds of Charcoal from one cord of dry Wood.	Bushels of Charcoal from one cord of dry Wood.	Time 10° of Heat were maintained in the room, by the combustion of one pound of each article.	Value of specified quantities of each article, compared with Shell-bark Hickory as the standard.
									H. M.	Cord.
WHITE ASH,	*Fraxinus americana,*	.772	3450	25.74	.547	28.78	888	31	6 40	77
APPLE TREE,	*Pyrus malus,*	.697	3115	25	.445	23.41	779	33	6 40	70
WHITE BEECH,	*Fagus sylvestris,*	.724	3236	19.62	.518	27.26	635	23	6	65
BLACK BIRCH,	*Betula lenta,*	.697	3115	19.40	.428	22.52	604	27	6	63
WHITE BIRCH,	*Betula populifolia,*	.530	2369	19	.364	19.15	450	24	6	48
BUTTER-NUT,	*Juglans cathartica,*	.567	2534	20.79	.237	12.47	527	42	6	51
RED CEDAR,	*Juniperus virginiana,*	.565	2525	24.72	.238	12.52	624	50	6 40	56
AMERICAN CHESNUT,	*Castanea vesca,*	.522	2333	25.29	.379	19.94	590	30	6 40	52
WILD CHERRY,	*Cerasus virginiana,*	.597	2668	21.70	.411	21.63	579	27	6 10	55
DOG WOOD,	*Cornus florida,*	.815	3643	21	.550	28.94	765	26	6 10	75
WHITE ELM,	*Ulmus americana,*	.580	2592	24.85	.357	18.79	644	34	6 40	58
SOUR GUM,	*Nyssa sylvatica,*	.703	3142	22.16	.400	21.05	696	33	6 20	67
SWEET GUM,	*Liquidambar styraciflua,*	.634	2834	19.69	.413	21.73	558	26	6	57
SHELL-BARK HICKORY,	*Juglans squamosa,*	1.000	4469	26.22	.625	32.89	1172	36	6 40	100
PIG-NUT HICKORY,	*Juglans porcina,*	.949	4241	25.22	.637	33.52	1070	32	6 40	95
RED-HEART HICKORY,	*Juglans laciniata?*	.829	3705	22.90	.509	26.78	848	32	6 50	81
WITCH-HAZEL,	*Hamamelis virginica,*	.784	3505	21.40	.368	19.36	750	39	6 10	72
AMERICAN HOLLY,	*Ilex opaca,*	.602	2691	22.77	.374	19.68	613	31	6 20	57
AMERICAN HORNBEAN,	*Carpinus americana,*	.720	3218	19	.455	23.94	611	25	6	65
MOUNTAIN LAUREL,	*Kalmia latifolia,*	.663	2963	24.02	.457	24.05	712	30	6 40	66
HARD MAPLE,	*Acer saccharinum,*	.644	2878	21.43	.431	22.68	617	27	6 10	60
SOFT MAPLE,	*Acer rubrum,*	.597	2668	20.64	.370	19.47	551	28	6	54
LARGE MAGNOLIA,	*Magnolia grandiflora,*	.605	2704	21.59	.406	21.36	584	27	6 10	56
CHESNUT WHITE OAK,	*Quercus prinus palustris,*	.885	3955	22.76	.481	25.31	900	36	6 30	86
WHITE OAK,	*Quercus alba,*	.855	3821	21.62	.401	21.10	826	39	6 20	81
SHELL-BARK WHITE OAK,	*Quercus obtusiloba?*	.775	3464	21.50	.437	22.99	745	32	6 20	74
BARREN SCRUB OAK,	*Quercus catesbæi,*	.747	3339	23.17	.392	20.63	774	38	6 30	73
PIN OAK,	*Quercus palustris,*	.747	3339	22.22	.436	22.94	742	32	6 20	71
SCRUB BLACK OAK,	*Quercus banisteri,*	.728	3254	23.80	.387	20.36	774	38	6 30	71
RED OAK,	*Quercus rubra,*	.728	3254	22.43	.400	21.05	630	30	6 20	69
BARREN OAK,	*Quercus ferruginea,*	.694	3102	22.37	.447	23.52	694	29	6 20	66
ROCK CHESNUT OAK,	*Quercus prinus monticola,*	.678	3030	20.86	.436	22.94	632	28	6	61
YELLOW OAK,	*Quercus prinus acuminata,*	.653	2919	21.60	.295	15.52	631	41	6 10	60
SPANISH OAK,	*Quercus falcata,*	.548	2449	22.95	.362	19.05	562	30	6 20	52
PERSIMON,	*Diospyros virginiana,*	.711	3178	23.44	.469	24.68	745	30	6 30	69

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									H. M.	Cord.
YELLOW PINE, (SOFT,) ...	*Pinus mitis,*	.551	2463	23.75	.333	17.52	585	33	6 30	54
JERSEY PINE, ...	*Pinus inops,*	.478	2137	24.88	.385	20.26	532	26	6 40	48
PITCH PINE, ...	*Pinus rigida,*	.426	1904	26.76	.298	15.68	510	33	6 40	43
WHITE PINE, ...	*Pinus strobus,*	.418	1868	24.35	.293	15.42	455	30	6 40	42
YELLOW POPLAR, ...	*Lyriodendron tulipifera,* .	.563	2516	21.81	.383	20.15	549	27	6 10	52
LOMBARDY POPLAR, ...	*Populus dilatata,*	.397	1774	25	.245	12.89	444	34	6 40	40
SASSAFRAS, ...	*Laurus sassafras,*	.618	2762	22.58	.427	22.47	624	28	6 20	59
WILD SERVICE, ...	*Aronia arborea,*	.887	3964	22.62	.594	31.26	897	29	6 20	84
SYCAMORE, ...	*Acer pseudo-platanus,* ..	.535	2391	23.60	.374	19.68	564	29	6 30	52
BLACK WALNUT, ...	*Juglans nigra,*	.681	3044	22.56	.418	22	687	31	6 20	65
SWAMP WHORTLE-BERRY,	*Vaccinium corymbosum,* .	.752	3361	23.30	.505	26.57	783	29	6 30	73
										Ton.
LEHIGH COAL, ...	. . . .	. .	. . .	. .	1.494	78.61	. .	. .	13 10	99
LACKAWAXEN COAL, ...	. . . .	. .	. . .	. .	1.400	73.67	. .	. .	13 10	99
RHODE-ISLAND COAL, ...	. . . .	. .	. . .	. .	1.438	75.67	. .	. .	9 30	71
SCHUYLKILL COAL, ...	. . . .	. .	. . .	. .	1.453	76.46	. .	. .	13 40	103
SUSQUEHANNA COAL, ...	. . . .	. .	. . .	. .	1.373	72.25	. .	. .	13 10	99
SWATARA COAL, ...	. . . .	. .	. . .	. .	1.459	76.77	. .	. .	11 20	85
WORCESTER COAL, ...	. . . .	. .	. . .	. .	2.104	110.71	. .	. .	7 50	59
										100 Bushels.
CANNEL COAL, ...	. . . .	. .	. . .	. .	1.240	65.25	. .	. .	10 30	230
LIVERPOOL COAL, ...	. . . .	. .	. . .	. .	1.331	70.04	. .	. .	9 10	215
NEWCASTLE COAL, ...	. . . .	. .	. . .	. .	1.204	63.35	. .	. .	9 20	198
SCOTCH COAL, ...	. . . .	. .	. . .	. .	1.140	59.99	. .	. .	9 30	191
KARTHAUS COAL, ...	. . . .	. .	. . .	. .	1.263	66.46	. .	. .	9 20	208
RICHMOND COAL, ...	. . . .	. .	. . .	. .	1.246	65.56	. .	. .	9 20	205
STONY CREEK COAL, ...	. . . .	. .	. . .	. .	1.396	73.46	. .	. .	9 50	243
HICKORY CHARCOAL, ...	. . . .	. .	. . .	. .	.625	32.89	. .	. .	15	166
MAPLE CHARCOAL, ...	. . . .	. .	. . .	. .	.431	22.68	. .	. .	15	114
OAK CHARCOAL, ...	. . . .	. .	. . .	. .	.401	21.10	. .	. .	15	106
PINE CHARCOAL, ...	. . . .	. .	. . .	. .	.285	15	. .	. .	15	75
COAK, ...	. . . .	. .	. . .	. .	.557	29.31	. .	. .	12 50	126
COMPOSITION OF TWO PARTS LEHIGH COAL, ONE CHARCOAL, AND ONE CLAY, BY WEIGHT,	. . . .	. .	. . .	. .	. .	. .	. .	. .	13 20	

TABLE,

Exhibiting the results of experiments made to determine the comparative loss of heat sustained by using apparatus of different constructions, for the combustion of fuel.

No.	Description of Apparatus used.	Time the room was maintained at the same temperature in the combustion of equal weights of fuel compared with apparatus No. 9.	Weight of fuel required by each apparatus to maintain the room the same time and temperature compared with No. 9.
1	**CHIMNEY FIRE-PLACE**, of ordinary construction for burning Wood, ...	10	1000
2	**OPEN PARLOUR GRATE**, of ordinary construction for burning anthracite Coal, ...	18	555
3	**OPEN FRANKLIN STOVE**, with one elbow joint and 5 feet of six inch pipe placed vertically, the fire-place being closed with a fire-board, ...	37	270
4	**CAST IRON TEN PLATE STOVE**, with one elbow joint and five feet of four inch pipe placed horizontally, entering the fire-board, ...	45	222
5	**SHEET IRON CYLINDER STOVE**, the interior surface coated with clay lute, with one elbow joint and 5 feet of two inch pipe placed horizontally, entering the fire-board, ...	67	149
6	**SHEET IRON CYLINDER STOVE**, as before described, with three elbow-joints, $4\frac{1}{2}$ feet, and 9 feet of two inch pipe, the whole placed as follows: $3\frac{1}{2}$ feet horizontally, 5 feet vertically, for an ascending current, and 5 feet vertically for a descending current, entering the fire-board, . . .	78	128
7	**SHEET IRON CYLINDER STOVE**, as before described, with three elbow joints, $4\frac{1}{2}$ feet, and 9 feet of two inch pipe, placed as follows: nine inches vertically and $12\frac{3}{4}$ feet horizontally entering the fire-board, ...	82	122
8	**SHEET IRON CYLINDER STOVE**, as before described, with nine elbow joints, measuring $13\frac{1}{2}$ feet of two inch pipe, entering the fire-board, ...	95	105
9	**SHEET IRON CYLINDER STOVE**, as before described, with 42 feet of two inch pipe, as used in the course of experiments on fuel, ...	100	100

No. II.

A Grammar of the Language of the Lenni Lenape or Delaware Indians. Translated from the German Manuscript of the late Rev. David Zeisberger, for the American Philosophical Society, by Peter Stephen Duponceau.
Presented to the Society, 2d December 1816.

The Translator's Preface.

THE astonishing progress which the comparative science of languages has made within the last thirty years is not among the least important of the many wonders which the present age has produced. The first strong impulse was given towards the close of the last century by the publication of the Comparative Vocabulary*, compiled by professor Pallas, under the direction of the empress Catharine of Russia; a work indeed better conceived than executed, but which nevertheless has been and still is of great use to the learned, in the prosecution of philological studies. This work, which was left incomplete, being confined to the languages of Europe and Asia†, was followed in this country

* Linguarum totius orbis vocabularia comparativa, augustissimæ curâ collecta. Petrop. 1786—1787, 4to.

† The empress, wishing her work to be completed, committed it to M. Theodore Jankiewitsch de Miriewo, with a view, it is presumed, that he should merely add to the European and Asiatic words which Pal-

by Dr B. S. Barton's "New Views of the Origin of the Tribes and Nations of America." The object of the learned author at first was to supply the deficiency of the great philological monument which the empress Catharine had begun as far as related to the languages of America. Happy would it have been if he had not suffered his imagination to draw him away from that simple but highly useful design! But he conceived that by comparing the American with the Asiatic languages he could prove the origin of our Indians from the nations which inhabit the opposite coast of Asia; and thus he sacrificed the real advantage of science to the pursuit of a favourite theory. He has nevertheless brought together, in a comparative view, fifty-two select words in about thirty or forty of our aboriginal idioms; by which he has shewn, that he might, if he pleased, have completed professor Pallas's Vocabulary, as far as it could have been done at that period, when we had not the means that have been obtained since. His was the first attempt to collect and compare to some extent* specimens of our Indian lan-

las had given the corresponding terms in the African and American languages. But M. Jankiewitsch took upon himself to alter the whole plan of Pallas's work, and, instead of pursuing the original system, which was to give the same Russian word in the different languages in due succession, he made an alphabetical catalogue of exotic words, which he explained into Russian, and in which he mixed all nations and languages together, with a view to shew how the same sounds received different meanings in different idioms. The empress was displeased, and the edition was suppressed. A few copies, however, have gone abroad, one of which is in the library of the American Philosophical Society.

M. Jankiewitch did wrong in not following the plan of his predecessor, whose work he thus left incomplete, when its completion was the very object which was entrusted to his care. He should first have executed his task: he might afterwards have published a vocabulary on his own system, which would have been a useful counterpart to the other. Indeed these two parts seem essential to a good comparative vocabulary, precisely as in a dictionary of two languages there must be a part beginning with each and explaining the words of each into the other.

* Relandus, in the third volume of his dissertations, published vocabularies of nine American languages, extracted from different authors. They are the Brazilian, Chilese, Peruvian, Poconchi, Caribbee, Mexican, Massachusetts which he calls Virginian, Algonkin, and Huron.

guages, and as such it is useful to philologists and entitled to respect.

The next performance that appeared on a comprehensive scale on the subject of languages was the MITHRIDATES, the glory of our science. I have spoken of it at large in my Report to the Historical Committee, made in the year 1819, on the progress then made in the investigation committed to me respecting the character and grammatical forms of the languages of the American Indians*. Excellent as the Mithridates was at the time when it was published, such is the progress which the philological science has made since that period, that it would require to be almost entirely written anew. But VATER is no more, and who will venture to assume his vacant place†?

About the same time appeared at Madrid, in six octavo volumes, "A catalogue of all the known languages, classed according to the diversity of their idioms and dialects," by the Abbé Don Lorenzo Hervas‡. It had been before published in Italian at Cesena, in the Roman states, as part of a great encyclopedical performance, by the same author, entitled "An idea of the universe," in 21 volumes quarto. The five last volumes (except the 17th which treats of the arithmetic of nations) relate exclusively to languages. The 17th volume contains the catalogue above mentioned. The 18th is a treatise on the origin, formation, mechanism, and harmony of languages. The 19th is entitled "A polyglot vocabulary of more than one hundred and fifty languages." And lastly, the 21st volume is a practical essay on languages, with prolegomena, and the lord's prayer in more than three hundred languages and dialects§. It is probable that the Spanish translation, though it would seem that it only bears the title of the 17th volume in the Italian, con-

* Historical Transactions, Vol. I. p. xix.

† Professor Vater died at Halle on the 16th of March 1826.

‡ Discours sur l'Etude Philosophique des Langues, par M. de Volney, p. 31.

§ Eichhorn, Geschichte der neuen Sprachkunde, Vol. I. p. 31.

tains all the philological treatises of the author, or at least a great part of them. As, however, neither the original nor the translation have, to my knowledge, made their way into this country, I can not say any thing more upon the subject, nor can I form a judgment of the merits of the work itself: all I can say is, that it does not appear to have been written on the same plan with the Mithridates*, whose authors, however, have occasionally availed themselves of its contents, but always with due acknowledgment.

Since that period nothing has appeared, as far as I know, in Europe or elsewhere, embracing the whole science of languages; and indeed the works which I have cited cannot be said to be entitled to be so considered; for the Comparative Vocabulary is purely etymological, and the Mithridates, although it takes in a much wider scope and gives a view of the structure and grammatical forms of the different languages, is in an important point entirely deficient, being confined exclusively to oral language, while the various modes by which nations express their thoughts in writing are a no less interesting part of the philological science. I have heard of an Ethnographical Atlas by M. Balbi, which has lately appeared at Paris, containing a description of the world geographically divided by languages

* The title of this work in Italian is *Idea dell' Universo*, Cesena, 1778—1787, 21 vols. quarto.

The 17th volume is entitled *Catalogo delle lingue conosciute, e notizia delle loro affinità e diversità*, 1784. The 18th, *Origine, formazione, mecanismo, ed armonia degli idiomi*, 1785. The 19th, *Aritmetica delle nazioni e divisione del tempo fra gl'orientali*, 1786. The 20th, *Vocabulario poliglotto con prolegomeni sopra più di 150 lingue*. And the 21st, *Saggio prattico delle lingue, con prolegomeni, e una raccolta di orazioni domenicali in più de trecento lingue e dialetti*, 1787. The exotic words are all written in Roman characters.

As some of the public libraries of this country may wish to become possessed of this work or some of its parts, these titles are given in order to facilitate the means of obtaining them. I have not the Spanish title of the Madrid translation. The 1st volume was published in 1800, and the 6th and last in 1806. Volney, *Discours sur l'étude philosophique des langues*, Paris, 1821.

and dialects. The late M. Malte Brun, in a review to which he affixed his name*, spoke favourably of this performance. If well executed, it will afford considerable aid to the learned.

It is very doubtful whether philology has yet reached that degree of advancement that will allow of its various parts being methodized and reduced to a general system. There are yet, perhaps, too many unsettled opinions to be fixed, too many prejudices to be dispelled, before we can take a clear, distinct, and comprehensive view of the various modes by which mankind communicate their perceptions and ideas to each other, through the medium of the senses, and trace with a steady eye their origin and progress. New and important facts are daily exhibited to us by the unwearied labours of learned men, which overthrow long established theories and turn in a great measure the current of our ideas. By means of the light afforded in the works of Morrison, Marshman, Abel Remusat, and De Guignes, we have acquired a clear conception of the nature and character of the writing of the Chinese, about which so many fables have been disseminated by missionaries and others, who echoed the boastings of the literati of that country†. We no longer believe it to be an original written language, unconnected

* Journal des Dèbats, 1st December 1826.

† Les caractères chinois sont signes immediats des idées qu'ils expriment. On dirait que cette écriture aurait eté inventée par des muets qui ignorent l'usage des paroles. Nous pouvons comparer les caractères qui la composent avec nos chiffres numeraux, avec les signes algébriques qui expriment les rapports dans nos livres de mathématiques, &c. Que l'on presente une démonstration de géometrie exprimée en caractères algébriques aux yeux de dix mathematiciens de pays differents; ils entendront la même chose: neanmoins ces dix hommes sont supposés parler des langues differentes, et ils ne comprendront rien aux termes par lesquels ils exprimeront ces idées en parlant. C'est la même chose a la Chine; l'écriture est non seulement commune à tous les peuples de ce grand pays, qui parlent des dialectes très differents, mais encore aux japonais, aux tonquinois, et aux cochinchinois, dont les langues sont totalement distinguées du chinois.—*Réflexions sur les principes généraux de l'art d'écrire*, &c. par M. Fréret, in the Memoirs of the Academy of Inscriptions and Belles Lettres, Vol. VI. p. 609.

with and independent of speech, conveying ideas immediately to the mind, and which may be read in all the different idioms of the earth. Philology has taught us the impossibility of the existence of such a cosmopolite writing. The important discoveries of M. Champollion the younger* have also drawn aside the mystic veil which concealed the real character of the writing of the ancient Egyptians: he has shewn it beyond all controversy to be chiefly alphabetical, with some auxiliary abbreviations of the hieroglyphic kind, such as we use in our almanacs to represent the sun, the moon, and other planets, and the signs of the zodiac, and in our books of mathematics to express certain words which often recur in the science. From all these lights it seems to result, that a purely ideographical system of writing is a creature of the imagination, and cannot exist any where but for very limited purposes. The paintings of the Mexicans, as they are called, remain to be investigated, in order to fix our ideas on this interesting subject. This task ought properly to belong to the learned societies and individuals of this continent, who, it is to be hoped, will emulate those of the old world in prosecuting researches so interesting to the philological science†. In this pursuit the method which M. Champollion has followed of making the oral language subservient to the study of the written characters cannot be too strongly recommended; for it is by audible sounds that the ideas of

* Précis du système hiéroglyphique des anciens egyptiens, par M. Champollion le jeune, Paris, 1824. 1 Vol. 8vo, 410 pp. with a volume of plates.

† It is now very difficult to procure original specimens of the Mexican paintings; the government of that country having lately established a museum in their capital where all that can be collected are to be preserved, and taken measures to prevent any being exported to foreign countries. Our learned associate, Mr Poinsett, minister to that republic not only of our government but of science, gives us reason to hope that correct fac similes can be obtained, by means of which this study may be pursued to a certain extent; but certainly not with the same advantage as in the city of Mexico, where the ancient language is still in use, and where a large collection of written monuments will be at all times accessible.

mankind are embodied, and acquire an outward form to the ear and an inward form to the mind; while writing is but a secondary mode of communication, much more limited in its objects and use, and which is in necessary connection with the oral signs of ideas. It seems idle at this day to talk of a written language, entirely independent of speech, and unconnected with it. There is little reason to doubt but that such a connection will be discovered in the Mexican writing, as it has been in the Egyptian and Chinese.

Auxiliary to these vast labours, Europe has produced, since the beginning of the present century, a great number of grammars and dictionaries of languages, which till then were little known, and some of them not at all*. Several of those which had been composed by the catholic missionaries, and either never published or printed solely for the use of the missions, have been drawn forth from their recesses, and published with learned notes and additions. Among them we remark the Chinese dictionary of Father Basil de Glemona never before printed, which was published at Paris by M. de Guignes, in the year 1813, by order of the emperor Napoleon, in a large folio volume of 1114 pages, with a supplement by M. Klaproth, and the Japanese grammar of Father Rodriguez translated into French and printed at Paris by M. Landresse with valuable additions by M. Abel Remusat and a supplement by baron W. Humboldt†. The Asiatic Society of Calcutta are prosecuting their learned

* Several excellent grammars have also been published of languages already known, as the Arabic, Hebrew, &c. among which are remarked those of Gesenius, Silvestre de Sacy, and several other eminent philologists. The Arabic grammar of the latter is particularly esteemed. As an orientalist and a writer on general grammar, M. de Sacy enjoys a high and justly acquired reputation.

† Elements de la Grammaire Japonaise, par le P. Rodriguez. Traduit du Portugais sur le MS. de la Bibliothèque du Roi, et collationné avec la Grammaire publiée par le même à Nangasaki en 1604. Par M. C. Landresse. Précédé d'un explication des Syllabaires Japonais, avec deux Planches. Par M. Abel Remusat. Paris, 1825.

Supplément à la Grammaire Japonaise du P. Rodriguez, &c. Par M. le Baron G. de Humboldt. Paris, 1826.

labours, which have thrown much light on the languages of hither and farther India. A society established at Paris since 1822 emulates their exertions, and its numerous publications are highly valuable: among these we cannot help noticing the learned and interesting essay of Mess. Burnouf and Lassen, on the Pali or Bali, the sacred language of the peninsula beyond the Ganges*. The Journal Asiatique, published by that Society, of which nine volumes have already appeared, and the tenth will be completed in June next, is full of instructive matter concerning the languages of Asia. The same may be said of the Mélanges Asiatiques of M. Remusat†, and the Mémoires relatifs à l'Asie of M. Klaproth‡. The Asia Polyglotta of the latter is a work of great merit§.

There is also in London, as we are informed, an Asiatic Society lately established, but their memoirs have not yet reached us.

It is said that the sacred scriptures, or parts of them, have been translated into one hundred and fifty different languages or dialects by the exertions of the British, Russian, aud American Bible Societies. The christian missionaries of different sects and countries, and the European and American navigators and travellers, have immensely increased our stock of vocabularies and other specimens of languages hitherto unknown. Among the latter we are bound to notice lieutenant John White of the United States navy, who brought to this country, from Cochin China, a comparative vocabulary of the Chinese and Cochin Chi-

* Essai sur le Pali, ou langue sacrée de la presqu'isle au delà du Gange, avec 6 planches. Par E. Burnouf & Chr. Lassen. Paris, 1826.

† Mélanges Asiatiques, ou choix de morceaux de critique relatifs aux religions, aux sciences, &c. des nations orientales. Par M. Abel Remusat, 2 vols, 8vo. Paris, 1815.

‡ Mémoires relatifs à l'Asie, contenant des recherches historiques, geographiques, et philologiques sur les peuples de l'orient. Par M. J. Klaproth. 2 vols, 8vo. Paris, 1824—1826.

§ Asia Polyglotta von Julius Klaproth. 1 vol. quarto, with an atlas of languages, folio. Paris, 1823.

nese languages, which he has deposited in the Marine East India Company's Museum at Salem in Massachusetts, an extract from which is subjoined to the History of his Voyage to the China Sea*. It is hoped that the Boston Academy of Arts and Sciences will cause the whole to be published in their valuable Transactions. It will be interesting not only to the learned of this country, but also to those of Europe; as it not only shews the degree of affinity in the idioms of the two nations, Chinese and Cochin Chinese, but also in what manner the characters of the former are employed to represent the words of the latter, when they differ in sound or in sense: It proves to demonstration that the Chinese characters cannot be read alike in every language; not even in those which have the greatest resemblance to that of China and may be considered in a measure as Chinese dialects.

Thus learned and industrious men are collecting in all parts of the world the valuable materials out of which is to be erected the splendid edifice of *Universal Philology*. Various attempts have been made to reduce this science into a body of doctrine, but none has completely succeeded, because the facts on which it rests have not yet been sufficiently ascertained. Innumerable works have been written on the origin of language, while the greatest number of the idioms of the earth were entirely unknown. Theories have been accumulated instead of facts, every one of which had its day until superseded by some newer and more fashionable system. Now and then some gifted men pierced through the cloud of darkness by the mere force of their intuitive genius,

* History of a Voyage to the China Seas. By John White, Lieutenant in the U. S. Navy. Boston. Wells & Lilly. 1823.

This book has been since reprinted in London. But the booksellers, probably for want of Chinese characters, have left out of their edition all that relates to the Cochin Chinese language. Thus in our American edition of Barrow's Travels in China, the specimens of Tartar characters have been omitted, because the booksellers did not think it expedient to have them cast or engraved. In this manner trade prospers at the expense of science.

and their writings have not a little contributed to the advancement of knowledge. Among those we must place in the first rank the illustrious president De Brosses, whose excellent treatise on the mechanical formation of language* contains more correct reasoning than any other work on the same subject. Nor can I pass over in silence the lights that are diffused through the Elements of Ideology of our venerated associate Destutt Tracy†, so fruitful of important principles that still remain to be applied to various unsettled points of our science. But, with these helps and many others that could be mentioned, we are not yet prepared for a general elementary treatise on philology taken in its whole extent: more facts are yet to be collected, and inveterate theories submitted to the test of truth, before this great work can be undertaken with hopes of success.

Philology, in fact, in the sense in which I wish to be understood, is of immense extent. It not only embraces oral language in all its varieties, but also writing and all the signs by means of which ideas are communicated through the organs of sight. The language of signs which the deaf and dumb make use of is alone a science. But setting these aside, and confining ourselves to speech properly so called, we find in that alone a boundless field of inquiry. We are arrested in the outset by the unnumbered languages and dialects which are spread over the surface of the earth, of which a very few only can be acquired by any individual. But philology comprehends them all, it obliges us to class and compare them with each other, for which we have no other aid than the knowledge more or less perfect of a few, and a superficial view of the rest. The philologist must learn to catch the prominent traits by which the different modes of speech are distinguished,

* Traité de la formation mécanique des langues et des principes physiques de l'étymologie, 2 vols, 12mo. Paris, An IX.

† Elémens d'idéologie, par A. L. C. Destutt Tracy, Sénateur, 3 vols, 8vo. Paris, 1804—1805.

and for that must trust to the labours of others in the shape of grammars, dictionaries, vocabularies, and other works of detail. This is enough to occupy a whole life. But it is not all. The single branch of philology which relates to oral languages has its subdivisions, each of which may be considered as a separate science: There is PHONOLOGY, which teaches us to distinguish the various sounds produced by the human voice, with their tones, accents, and inflections, to analyze, class, and compare them with each other, and represent them, as much as possible, by visible signs*; ETYMOLOGY, or the knowledge of those constituent parts of language that we call *words*, by means of which we are enabled to trace the affinities of the different idioms of the earth, and the filiation of the numerous races and families of men who inhabit it; and lastly, IDEOLOGY, or the comparative study of the grammatical forms and idiomatic construction of languages, by which we are taught to analyze and distinguish the different shapes in which ideas combine themselves in order to fix perceptions in our minds, and transmit them to those of others; while we observe with wonder the effects of that tendency to order and method and that natural logic which God has implanted in the mind of every man. A considerable time must elapse before we shall have collected a sufficiency of facts to enable us to generalize to a certain extent our ideas on these various subjects, the attempting of which too soon has hitherto been the great error of philologists. It is astonishing to see what efforts have been made by men of superior as well as those of inferior talents, to discover the origin of human speech, to trace an original or primitive language in those which now exist, to invent a universal or philosophical idiom, a universal grammar, a universal alphabet, and so many other *universals*, while the *particulars* are yet to be learned.

* I have treated of this subject separately, merely in its application to the English language, in the first volume of the present series of these Transactions, p. 228. A reference to that essay will shew the immense extent of this branch of the philological science.

When we find such men as Court de Gebelin, Bishop Wilkins, Maupertuis, Rousseau, Adam Smith, and so many others, seriously employed in the pursuit of those unattainable objects, we can but lament the disposition of the human mind to transgress the bounds which Eternal Wisdom has prescribed to human knowledge and human power.

If philology had no other object than to promote and facilitate the intercourse between nations, and make men better acquainted with the globe they inhabit, it would be well worth all the trouble and labour that may be bestowed upon it. What further results it may produce, useful or interesting to mankind, it is impossible to foretel. Thus much is certain, that no science more powerfully excites that desire of knowledge which is inherent in our nature, and which, no doubt, was given to us by the Almighty for wise purposes.

Moved by these considerations, the American Philosophical Society have thought it incumbent upon them to add to the mass of facts which are accumulating on all sides, by the publication of this grammar. While the languages of Asia occupy the attention of the philologists of Europe, light is expected from this quarter to be shed on those of our own continent. This Society was the first to discover and make known to the world the remarkable character which pervades, as far as they are yet known, the aboriginal languages of America, from Greenland to Cape Horn. In the period of seven years which has elapsed since the publication of the Report presented to their Historical Committee in 1819*, all the observations which have been made on Indian languages, at that time unknown, have confirmed their theory, if theory it can be called, which is no more than the general result of a multitude of facts collected with care. This result has shewn that the astonishing variety of forms of human speech which exists in the eastern hemisphere is not to be found in

* Transactions of the Historical and Literary Committee of the American Philosophical Society, vol. 1. Philadelphia, 1819.

the western. Here we find no monosyllablic language like the Chinese*, and its cognate idioms; no analytical languages like those of the north of Europe, with their numerous expletive and auxiliary monosyllables; no such contrast is exhibited as that which is so striking to the most superficial observer, between the complication of the forms of the Basque language and the comparative simplicity of those of its neighbours the French and Spanish; but a uniform system, with such differences only as constitute varieties in natural objects, seems to pervade them all, and this *genus* of human languages has been called *polysynthetic*, from the numerous combinations of ideas which it presents in the form of words. It has also been shewn that the American languages are rich in words and regular in their forms, and that they do not yield in those respects to any other idiom. These facts have attracted the attention of the learned in Europe, as well as in this country; but they have not been able entirely to remove the prejudices that have been so long entertained against the languages of savage nations. The pride of civilization is reluctant to admit facts like these in their utmost extent, because they shew how little philosophy and science have to do with the formation of language. A vague idea still prevails that the idioms of barbarous tribes must be greatly inferior to those of civilized nations, and reasons are industriously sought for to prove that inferiority, not only in point of cultivation, which would readily be admitted, but also to shew that their organization is comparatively imperfect. Thus a learned member of the Berlin Acade-

* By a *monosyllabic* language, I do not mean one every word of which consists of a single syllable, but one of which every syllable is a complete word. The learned M. Remusat has satisfactorily proved in his *Mélanges Asiatiques*, vol. 2, p. 47, and in the third volume of the *Mines de l'Orient*, that the Chinese language is not monosyllabic in the first of these senses; but at the same time, I think it cannot be denied that it is so in the second, its polysyllabic words being formed by the junction of two or more vocables, each consisting only of one syllable, in the same manner as our compound English words *welcome*, *welfare*, &c. There may be a few exceptions; but they prove nothing against the general rule.

my of Sciences, in an ingenious and profound dissertation on the forms of languages*, while he admits that those of the American Indians are rich, methodical, and artificial in their structure, yet will not allow them to possess what he calls genuine grammatical forms (æchte formen), because, says he, their words are not inflected like those of the Greek, Latin, and Sanscrit, but are formed by a different process, which he calls *agglutination*, and on that supposition, he assigns to them an inferior rank in the scale of languages, considered in the point of view of their capacity to aid the development of ideas. That such prejudices should exist among men who have deservedly acquired an eminent reputation for science is much to be regretted; and it is particularly with a view to remove them from the minds of such men, that this grammar is published. The learned baron will, I hope, recognize in the conjugations of the Delaware verbs those inflected forms which he justly admires, and he will find that the process which he is pleased to call *agglutination*, is not the only one which our Indians employ in the combination of their ideas and the formation of their words.

But it is not in Europe alone that we find persons disposed to disparage every thing that belongs to the American Indians. The same spirit prevails, I am sorry to say in a much higher degree, among many in this country, particularly those who inhabit our frontier settlements, where causes of difference too often arise between the two races. This feeling, when once entertained, knows no bounds, and men, in other respects gifted with judgment and talents, feel its influence unperceived. I have been led into this observation by a well written and otherwise interesting article on the Indians and their languages, which appeared in the North American Review for January, 1826, the anonymous author

* Ueber das Entstehen der grammatischen Formen, und ihren Einfluss auf die Ideen Entwicklung. Von Baron Wilhelm von Humboldt. Published in the Transactions of the Berlin Academy of Sciences for the year 1822. Historical and Philological Class, p. 401.

of which labours hard to depreciate the unfortunate Indians, and make them appear the most stupid as well as the most barbarous race of men, and their languages of course as corresponding with that degraded character. It is a matter of regret that this writer should have been carried so far away by his prejudices, as to charge the venerable Heckewelder, who resided nearly forty years as a missionary among the Delaware Indians, not only with ignorance of their language, but with fabricating Delaware words, in order to suit a particular purpose*. This is carrying too far the maxim *nullius in verba*, and the reviewer who ventures so much ought first to have convinced his readers that he was himself perfectly acquainted with the Delaware language, while, on the contrary, after mentioning a few of Mr Heckewelder's substantives, the sounds of which it seems are not pleasing to his ears, he exclaims in disgust, "Pronounce these who can; we eschew the task." This strong expression of an unpleasant feeling is not natural to one who is conversant with a particular idiom: such a one, besides, must be presumed to be in some degree familiar with its sounds, and to be able, at least, to articulate them.

The reviewer that I speak of pays no greater respect to Mr Zeisberger, the author of this grammar. If he does not expressly charge him with forgery, he at least tries to make it appear that he did not know the language on which he wrote. In this grammar, in the conjugation of the causative form of the verb *wulamallsin*, to be happy, will be found the participle present *wulamalessohaluwed*, he who makes happy, which in the transitive form is changed into *wulamalessohalid*, he who makes *me* happy, and this last word, taking the vocative termination *an*, becomes *wulamalessohalian*, O thou who makest me happy! The reviewer is pleased (p. 75.) to turn this beautiful grammatical form into ridicule, and expressly denies there being such a one in the language.

* This word (*elumiangellatschik*) has been evidently formed to meet the case, and formed on erroneous principles. N. A. Review, p. 76.

Among other reasons equally unsatisfactory, he objects that the pronoun *who* or its elements are not to be found in the composition of the word; as if this pronoun could not be understood, as it is in the participial forms of all languages, when used as substantives. Thus the Latin participle *amans* may be translated he who loves. *ille qui amat*, and yet, not a trace of the pronoun *qui* is found in it. In the English language the participle present is not generally employed in a substantive sense, therefore the word *loving* can not be translated by he who loves, but the meaning of the noun substantive *lover* may be thus rendered, and the participle past *beloved* is often used in that sense, as *the beloved*, he who is beloved, the pronoun *who* being understood. But the reviewer goes farther, and pretends that there is no word in *any* Indian language answering to our pronoun *who**. Be it so; but the idea which it conveys certainly exists in the minds of the Indians, and therefore there is the greater necessity for words in which that idea may be comprehended when it cannot be separately expressed. These specimens are sufficient to give an idea of the reviewer's course of reasoning, nor do the limits of this preface allow me to pursue it farther.

It is difficult to know to what Indian language this gentleman's attention has been particularly directed. If we are to judge from his numerous specimens of Indian phrases, he should be equally familiar with the idioms of the Delawares, Chippeways, Sioux, Kickapoos, Sacs and Foxes, Potowatomies, Wyandots, and Shawanese, in all which he furnishes us with sentences, without any apparent object than to show that those languages are poor and illy constructed. Our author, Mr Zeisberger, did not pretend to so much knowledge; the Delaware and the Onondago were all he professed to know, and he proved the justice of his claim, by a dictionary of the

* On the contrary, the pronoun *who* has an equivalent in every Indian language that I know of: Delaware, *auwen* (see this grammar); Onondago, *schu, schune, schung, schunahote* (Zeisberger's Dictionary); Menomonie, *owa;* Dahcota or Sioux, *tuaa*, &c. &c.

one, and grammars of both. Mr Heckewelder pretended only to know the Delaware, and his correspondence with our Historical Committee, in the first volume of their Transactions, appears sufficient to support his pretensions. Both these gentlemen spent the greatest part of their lives among the Indians on whose languages they wrote; while the anonymous reviewer does not tell us that he ever resided with any of them. If he derived his information from Indian traders and interpreters, he is not probably aware that they are not the proper sources from which the knowledge of the grammar of those languages is to be obtained; they do not pretend to be men of science, and it is a well known fact that even Indians, who are much in the habit of conversing with white men, will adapt their forms as much as possible to the construction of our own language, expecting thereby to be better understood. It is thus that we often speak broken English, when addressing foreigners, and that nurses will lisp when speaking to children; but it is not so that Indian orators express themselves when addressing their tribes on important subjects.

I should not have taken notice of this anonymous publication, but that the high character and extensive circulation of the North American Review, in which it would seem that it was inadvertently inserted, made it incumbent upon me to say something to counteract the effect of assertions so boldly made, and therefore calculated to make an impression on those who have not leisure to investigate the subject. It is but lately that the forms of the languages of the American Indians have begun to attract attention; I am satisfied that the more they are known, the greater astonishment they will excite in unprejudiced minds. In the mean time we must expect that ancient prepossessions will have their way, and that *à priori* reasoners will not see their favourite theories disturbed without a struggle; but facts are stubborn, and their evidence must at last prevail.

The most curious thing, undoubtedly, that exists in the languages of the Indians, is the manner in which they compound their words. It was first observed by Egede in his account of Greenland, and Mr Heckewelder explains it at large in the eighteenth letter of his correspondence*. By this means, says governor Colden, speaking of the Iroquois, these nations can increase the number of their words to any extent. None of the languages of the old world that we know of appear to possess this prerogative: a multitude of ideas are combined together, by a process which may be called *agglutination*, if the term be found agreeable, but which, whatever name it may receive, is not the less a subject of real wonder to the inquiring philologist. I have not space to give here many examples of this manner which the Indians have of combining several ideas together into one locution. I must therefore refer the reader to those adduced by Egede and by Mr Heckewelder, in the above cited passage of his correspondence. I shall, however, select a word from the Delaware language, which will convey a clear idea of the mode of formation of all others of the same kind. I have chosen this word for the sake of its euphony, to which even the most delicate Italian ear will not be disposed to object. When a Delaware woman is playing with a little dog or cat, or some other young animal, she will often say to it *kuligatschis!* which I would translate into English, *give me your pretty little paw*, or *what a pretty little paw you have!* This word is compounded in the following manner:

K is the inseparable pronoun of the second person, and may be rendered by *thou* or *thy*, according to the context.

Uli (pronounced *oolee*) is part of the word *wulit*, which signifies handsome or pretty. It has also other meanings not necessary to be here specified.

Gat is part of the word *wichgat*, which signifies a leg or paw.

Schis is a diminutive termination, and conveys the idea of littleness.

* Hist. Trans. p. 405.

Thus in one word the Indian woman says to the animal, *Thy pretty little paw!* and according to the tone in which she speaks, and the gestures which she makes, either calls upon it to present its foot, or simply expresses her fondling admiration. In the same manner *Pilape*, a youth, is formed from *Pilsit*. chaste, innocent, and *Lenape*, a man*. It is difficult to find a more elegant combination of ideas in a single word of any existing idiom.

I do not know of any language out of this part of the world in which words are compounded in this manner. The process consists in putting together portions of different words, so as to awaken at the same time in the mind of the hearer the various ideas which they separately express. There are probably principles or rules pointing out the particular parts that are to be selected in order to form the compound locution. Sometimes a whole syllable, and perhaps more; sometimes a single sound, or, as we would call it, a single letter: to discover those rules would require a great proficiency in the language, and at the same time a very sound discriminating mind; qualities which are seldom found united; perhaps also the ear, an *Indian* ear, is the guide which is generally followed; but the ear has also its rules, to which the mind imperceptibly conforms: however it may be, this is an interesting fact in the natural history of human language, justly entitled to the attention of philologists.

This is not the only manner in which the American Indians combine their ideas into words. They also have many of the forms of the languages which we so much admire, the Latin, Greek, Sanscrit. Slavonic, &c. mixed with others peculiarly their own. Their conjugations are as regular as those of any language that we know; and for the proof of this I need only to refer to the numerous paradigms of Delaware verbs that are contained in this grammar, in which will be found the justly admired in-

* MS. letter of Mr Heckewelder, 22d of October 1818.

flections of the languages of ancient Europe. Although they do not appear to have the numerous tenses which the Greek boasts of, they are not, however, deficient in the expression of the relations of the present, past, and future to each other. There is no shade of idea in respect to the time, place, and manner of action which an Indian verb cannot express, and the modes of expression which they make use of for those purposes are so numerous, that if they were to be considered as parts of the conjugation of each verb, one single paradigm might fill a volume. Thus *n'mitzi* signifies I eat, in a general sense, and *n'mamitzi*. I am eating at this moment. Each of these verbs is separately conjugated in all its forms.

Indeed, the multitude of ideas which in the Indian languages are combined with the verb has justly attracted the attention of the learned in all parts of the world. It is not their transitive conjugations expressing at the same time the idea of the person acting, and that acted upon, that have excited so much astonishment. They are found also, though not with the same rich variety of forms, in the Hebrew and other oriental languages. But when two verbs with intermediate ideas are combined together into one, as in the Delaware *n'schingiwipoma*, I do not like to eat with him*, which the Abbé Molina also declares to exist in the idiom of Chili †; there is sufficient cause to wonder, particularly when we compare the complication of these languages with the simplicity of the Chinese and its kindred dialects in the ancient world. Whence can have arisen such a marked diversity in the forms of human speech?

Nor is it only with the verbs that accessary ideas are so curiously combined in the Indian languages; it is so likewise with the other parts of speech. Take the adverb for instance. The abstract idea of time is frequently annexed to it. Thus if the Delawares mean to say, If you do not return,

* Hist Trans. p. xxvi.

† *Iduancloclavin*, I do not wish to eat with him." Hist. of Chili, Append. on the Chilian Language.

they will express it by *mattatsch gluppiweque*, which may be thus construed:

Matta is the negative adverb *no; tsch* is the sign of the future, with which the adverb is inflected; *gluppiweque* is the second person of the plural number of the present tense of the subjunctive mood of the verb *gluppiechton*, To turn about or return. In this manner every idea meant to be conveyed by this sentence is clearly understood. The subjunctive mood shews the uncertainty of the action, and the sign of the future tense coupled with the adverb points to a time not yet come when it may or may not take place. The Latin phrase *nisi veneris* expresses all these meanings; but the English *If you do not come*, and the French *Si vous ne venez pas*, have by no means the same elegant precision. The idea which in Delaware and Latin the subjunctive form directly conveys is left to be gathered in the English and French from the words *if* and *si*, and there is nothing else to point out the futurity of the action. And where the two former languages express every thing with two words, each of the latter requires five, which yet represent a smaller number of ideas. To which of these grammatical forms is the epithet *barbarous* to be applied?

This very cursory view of the general structure of the Indian languages, exemplified by the Delaware, will at least convince the reader that a considerable degree of art and method has presided over their formation. Whether this astonishing fact is to be considered as a proof (as many are inclined to believe) that this continent was formerly inhabited by a civilized race of men, or whether it is not more natural to suppose that the Almighty Creator has endowed mankind with a natural logic which leads them, as it were, by instinct, to such methods in the formation of their idioms as are best calculated to facilitate their use, I shall not at present inquire; I do not, however, hesitate to say, that the bias of my mind is in favour of the latter supposition; because no language has yet been discovered, either among savage or polished nations, which was not governed by rules and principles which nature alone could dictate, and human science never could have imagined. Various attempts have been made towards the formation of a philosophical language; none of them has ever gone beyond the imitation of those which were previously known; neither Leibnitz nor Bishop Wilkins, neither Monboddo nor De Brosses, nor any of those illustrious philosophers who have written so much on the origin and formation of languages, could have discovered *à priori* the curious combinations by which the American Indians form their words; nor the manner in which they associate with the verb such an immense number of accessary ideas; we are therefore compelled, when endeavouring to account for the variety of modes in which men represent their perceptions through the organs of speech, to abandon all vain theories, and look up only to nature and nature's God.

I have been led into these preliminary observations farther than I expected; I feel that I have been insensibly drawn beyond the legitimate bounds of a preface; it is, however, necessary that I should say something of this grammar and of its author.

The Reverend David Zeisberger was a native of Moravia, where he was born in the year 1721. He was educated at Herrnhut in the principles of the religion of the United Brethren. At the age of seventeen he came to this country, and landed in Georgia, where his co-religionists had begun some settlements. Thence he came to Pennsylvania. In the year 1746, (being twenty five years of age) he was sent out as a missionary to the North American Indians, in which employment he continued, with few and short intervals, until his death, which happened in the year 1808. He died at Goshen, in the state of Ohio, at the advanced age of eighty-seven years.

Thus this venerable missionary resided upwards of sixty years among the Indians of this country, preaching the gospel to them in their native idioms. In this manner he acquired several of their languages; but was particularly skilled in the Onondago (an Iroquois dialect) and the Lenni Lenape or Delaware. On the former he wrote three grammars. two in German* and the other in English†, and a dictionary, German and Indian, consisting of seven volumes in quarto. These works, all in manuscript, are deposited in our Society's library.

Those on the Delaware, except this grammar, have been all printed. They consist of a copious spelling book in Delaware and English, of which two editions have been published‡, Sermons to Children in Delaware§, and a Collection of Hymns in the same language‖, all which appeared in his life time. After his death his translation into Delaware of Lieberkuhn's Harmony of the Four Gospels¶ was given to the public by the care and at the expense of the Female Auxiliary Missionary Society at Bethlehem, aided by private subscribers, among whom the late Honourable Elias Boudinot of New Jersey was conspicuous.

The original manuscript of this grammar the author ordered by his will to remain deposited in the library of the United Brethren at Bethlehem, where it now is. In the

* Onondagoische Grammatica. MS. 4to, pp. 176; and a shorter one also in 4to, pp. 87.

† Essay of an Onondago Grammar, or a short introduction to learning the Onondago alias Maqua tongue. MS. 4to, pp. 67.

‡ Delaware and English Spelling Book, for the use of the Missions of the United Brethren. Philadelphia, 1776 and 1806. The second edition is much improved, and contains pp. 179, 12mo.

§ Ehelittonhenk li amemensak gischitak Elleniechsink, untschi David Zeisberger. Philadelphia, 1803, pp. 115, 12mo.

‖ A Collection of Hymns for the use of the Christian Indians of the Mission of the United Brethren in America. Philadelphia, 1803, pp. 358, 12mo.

These hymns are all in the metre of German poetry, and are to be sung to German tunes. It would have required more genius than falls to the common lot of man to have discovered a rhythm suited to the character of the language, and melodies adapted to it. Such diversified talents are seldom to be looked for in those who devote their lives to the conversion of savage nations.

¶ Elekup Nihillalquonk woak Pemauchsohalquonk Jesus Christ, seki ta lauchsitup wochgidhakamike. New York, 1821, pp. 222, 12mo.

year 1816, our late lamented associate, the Reverend John Heckewelder, having been requested to aid our Historical Committee in their investigation of the forms and structure of the Indian languages, was kind enough, with the permission of his superiors, to confide to them that valuable manuscript for their temporary use. The Committee ordered it to be translated into English; and I willingly undertook the task: various circumstances have hitherto prevented its appearance. Several learned men, however, both in Europe and in this country, having repeatedly expressed their wish to see it in print, its publication could no longer be delayed.

The reader must not expect to find here a philosophical grammar, as this was not made for the use of philosophers, but of young missionaries—its object was entirely practical. The author never dreamt that the theory of the Indian languages would ever become the subject of philosophical study. He has followed the usual divisions of the parts of speech; but has not endeavoured, like the Spanish American grammarians, to force the Indian forms of language into too close an analogy with our own. To a certain degree it is necessary to explain the forms of the Indian languages by those to which we are accustomed; to do otherwise would be following the old exploded method of teaching the Latin language by means of a grammar written entirely in Latin; at the same time, the peculiar forms of the new idiom ought to be pointed out in a clear and intelligible manner, and their principles analyzed so as to lay down their rules, when differing from our own, with the greatest possible perspicuity. It were to be wished that our author had devoted a chapter to the syntax and phraseology of the language; but that, I presume, he left to be acquired by practice. Upon the whole, however, I think his grammar the best that I have seen of an American dialect. It is copious and rich in examples, and his paradigms of the conjugations of Indian verbs are sufficiently numerous to give a correct idea of the manner in which that part of speech is constructed. The personal verbs or transitions are fully and clearly explained. Indeed, it may be said that he has the merit of clearness throughout; a merit so very rare, that it deserves to be noticed. Those who before him have treated of Indian languages have either not always understood themselves, or not been very anxious to be understood by others. I do not even except the venerable Eliot, whose Grammar of the Language of the Massachusetts Indians is not free from obscurities; some of which the present one of its kindred dialect, the Delaware, will help to clear up.

The Indian words in this Grammar are to be pronounced according to the powers of the German alphabet, which Mr Zeisberger thought proper to adopt*. It has long been a desideratum in the philological science, that there should be a uniform mode of writing exotic words, in order to convey, as much as possible, the same idea of their sounds, at least to the learned, through the civilized world. But, independent of the numerous difficulties which naturally attend such a design, from the almost entire impossibility of conveying to the mind through the eye the idea of sounds which the ear never heard, an ill understood national pride makes every nation desire that their own alphabet should be chosen as the medium of communication. The least prejudiced on this subject insist at least on the Roman character being universally used. The celebrated Volney wished all the Oriental

* The translator has preserved the orthography of the original, except that he has substituted the letter *y* for the German *j*, because *y* has the same sound according to the English and German pronunciation. Also where the author has introduced the vowel *o* after *w*, in order to shew that the latter is to have the English and not the German sound, and so writes *woagan* to be pronounced *wagan*, the translator has suppressed the *o*, thinking it sufficient to give notice that *w* consonant is always to be pronounced as in English, whether it be followed by another consonant or by a vowel. In the former case a *sheva* or mute vowel is interposed between the two sounds: thus, *wdanis* (daughter) is pronounced *w'danis* and not *oo-danis*. Following the same principle, where the author writes *wiquoam* (a house) the translator writes *wikwam*, which is precisely the sound which Zeisberger meant to represent.

languages to be written in that character, and not only proposed a plan to that effect, but left a considerable legacy by his will to be employed in premiums to those who should suggest the best means of carrying it into execution. This shews how far a favourite idea may take hold of the mind of a man, however distinguished by his genius and talents.

It is not for those languages that have already an alphabet and an orthography of their own that a uniform mode of writing their words is desirable; uniformity in this respect, even among the nations that use the same characters, is absolutely unattainable. All that is desired is a common mode of communicating the sounds of unwritten languages, in order to facilitate the comparison of their words and grammatical forms with each other with the greater exactness. To this object the powers of our English alphabet are not adequate; because its vowel sounds are uncertain and a great part of them are represented by diphthongs. But most nations seem to think that their national honour is concerned in forcing their own orthography upon the learned world. Thus since the study of the Chinese language has become fashionable in Europe, the Portuguese mode of spelling Chinese words, to which all were before accustomed, has been entirely abandoned, and the English and French have each adopted the orthography of their own language; so that it is sometimes difficult to recognize the same words in the grammars and dictionaries which they have respectively published.

In this country we are free from this prejudice; therefore my learned friend Mr Pickering, with the liberality which characterizes an American man of science, has proposed a uniform mode of writing the words of our Indian languages*, which I am happy to find has been almost universally adopted by our Missionaries not only on this continent, but in the South Sea Islands. I am also informed that our go-

* An Essay on a uniform Orthography for the Indian Languages of North America. By John Pickering. Published at Boston in the Memoirs of the American Academy of Arts and Sciences, Vol. IV. p. 319.

vernment, who, it is reported and generally believed, are preparing to publish an important national work on the languages of the Indians who inhabit these United States on the model considerably improved of that of the empress Catherine, have recommended to the agents and other persons employed in collecting the materials to conform themselves as much as possible to the alphabet proposed by Mr Pickering. Thus America will have the honour of giving an example which it is to be hoped will be more generally followed.

This alphabet is entirely formed of our Roman characters. The vowel sounds are those of the German and Italian languages. The nasals are expressed by a comma or cedilla under each nasal vowel, after the Polish manner. The English *sh* is preserved, and its correlative *zh* is adopted for the sound of the French and Portuguese *j*. The compound consonant sounds are represented by their component signs, thus *ks*, *ksh*, *ts*, *tz*, &c. The Author has been careful not to introduce any new characters. Even the sound of the Greek χ and Spanish *jota* is expressed in the most usual manner by *kh*; and although there is a real difference between these two sounds, the one being *k*, and the other *g* aspirate, Mr Pickering did not think it necessary to appropriate to each a separate character, well knowing that approximation is all that can be reached, and that every attempt to distinguish nice differences of sound would eventually prove vain.

Thus, with a liberality which cannot be too much praised, Mr Pickering has selected among the various powers which the nations of Europe have given to the characters of the Roman alphabet those which best suited his purpose, without shewing favour or partiality to any country, and least to his own. His plan, moreover, is simple and easy of execution. If it is not the best that could possibly be devised, it is the one that is most likely to be certainly adopted. Brilliant theories and highly complicated schemes may dazzle for a while: but simplicity in plans presented for general practice is the mark of true genius, and must ultimately prevail.

Before I conclude this preface, I beg leave to say a few words respecting the present translation. When, eleven years ago, I undertook to make it for the Philosophical Society I had never turned my attention to the Indian languages, and I was entirely ignorant of their forms and construction. I therefore thought of nothing beyond a close and literal translation of the manuscript. I soon perceived, however, that it had been written on loose sheets, which had been bound together after the Author's death by persons not conversant with the subject. It also became clear to me that Mr Zeisberger had not given the last finishing hand to his work. He probably meant to have condensed it, and to have exhibited the various forms of the conjugations of the verbs in a lesser number of paradigms. These observations struck me as I went on with the translation which I finished as I had begun it. I left out only one chapter, in which the author explained the manner of expressing the German compound verbs into the Delaware language; as it would have required too much labour to adapt it to the English forms of speech, and would have participated in too great a degree of an original composition. I regret, however, that I did not attempt it. It is now too late, as Mr Zeisberger's manuscript has been returned to the Bethlehem library.

I had no idea at the time that this grammar would ever be published. Since the Society came to a resolution to commit it to the press, it became my duty to revise what I had done; I saw that it would require to be almost entirely recast, and above all to be considerably abridged, in order to give it that form which alone could satisfy the taste of the present age. But on this I could not venture. For more than ten years, indeed, I have applied myself to the study of the Indian languages, and have become more conversant with their structure and forms than those who have not paid a similar attention to the subject. Besides the usual helps of grammars, dictionaries, vocabularies, &c. I have had the benefit of correspondences and personal communications with Indians, missionaries, and other persons from various parts of this hemisphere, more or less skilled in those idioms. With regard to the Delaware, I have received much information from my deceased friend Mr Heckewelder, whom I always found ready to answer my queries, and solve my doubts, whenever I thought proper to communicate them to him. If he were still alive, I would not have hesitated, with his kind assistance, to have presented this grammar in a more acceptable form to the public. Without such aid I could not undertake it, being in want of that practical knowledge which can only be acquired by a long residence among the Indians.

Another reason has induced me not to make too free with this grammar, although I am satisfied that it might have been advantageously abridged. Several gentlemen, particularly of the army, who are stationed or reside in the vicinity of the Indian country, and consequently have much intercourse with the aborigines, have expressed a wish that Mr Zeisberger's Work should be given in as ample a form as possible, as it would be of great use to them in studying not only the language of the Delawares, but also those of the Chippeways, Menomonies, and other cognate idioms. Therefore it is to be considered that it is not only intended as an exhibition of the forms of the Indian dialects in a scientific point of view, but also as a guide to those who may be engaged in the study of this language. To them the multiplicity of examples which others may think unnecessary will be of great value, as there are no other written sources from which they can derive information, if we except Mr Zeisberger's Spelling Book, which has long been out of print, and his Translation of Lieberkuhn's Harmony of the Gospels, which was printed only for the use of missionaries, and is not to be purchased. Neither is the Translation of St John's Epistle by Dencke to be had in the shops. It is much to be regretted that a certain number of copies of such works are not put in the hands of booksellers for sale. They would be purchased, at least, by the public libraries of this country, and perhaps also, of Europe.

For these reasons I have ventured upon few alterations of the Manuscript now published. I have, however, sometimes varied from the Author's method, when I thought it too defective, and I have modified his explanations, so as to give them (as I thought) a greater degree of clearness and precision, and make them more easily understood. I have even occasionally, always with the same view, added some facts and illustrations which were not in the text. But this I have chiefly done in the form of notes at the bottom of the page, under my own name and responsibility. Upon the whole, I have taken no liberty with the Author's work which I was not sure he would have approved of if he had been living. As a fair copy of the original manuscript of this translation still remains in the Society's library, the alterations which I have made may be seen and judged of by all who will take the pains to compare it with the one now published.

I hope this Grammar will convince those who may still be incredulous, that I did not go too far when I asserted in my Report to the Historical Committee that the Indian languages are rich in words and grammatical forms, and that their general structure displays as much order and method as that of any of those that exist on the face of the earth. They are highly synthetical, and combine ideas together in a manner so artificial and so uniformly consistent with the rules of analogy, that it is not to be wondered at if men, reasoning *à priori*, have thought it impossible that such combinations could proceed from the minds of savages. As the fact cannot be denied, the pride of civilization has at last found out that it is very natural that it should be so; because analysis is the most difficult operation of the human mind, and barbarous nations being incapable of it, their languages must necessarily be synthetical. But Mr Adam Smith, who first broached this doctrine in a dissertation on the origin of language subjoined to his Theory of Moral Sentiments, and who has been highly applauded for this discovery, did not surely consider that before the Indians could have combined their ideas, and arranged them in regular order in the forms in which they now appear, they must first have analysed them, otherwise they could not have discovered their analogies and adhered to them so closely. But in this they did not proceed as philosophers would have done in their closets; the operations of nature are much quicker than those of science, and perhaps are not the less sure. I leave it to others to explain the details of this process; my task is to exhibit the facts, not to trace them to their origin.

I am not an enthusiastic or exclusive admirer of the Indian languages, and am far from being disposed to assert that their forms are superior to those of others. Comparisons on such subjects appear to me idle, and can lead to no useful results. Language is the instrument of thought and must always be adequate to its object. Therefore no language has yet been and probably never will be found, destitute of forms; for without them none can exist. By forms I do not mean only inflexions of words and the like; I mean every regular and methodical arrangement of the elements of speech for practical purposes. This the Chinese have as well as the Delawares, although in vulgar acceptation it is commonly said that the Chinese idiom has no forms. Like every thing else in nature, the forms of language, are various, and in that variety consists the chief beauty of the works of the Almighty Creator. A language, it is true, may be more or less adapted to certain objects. Some are more poetical than others, while there are those which are better suited to the perspicuity of logical reasoning. But it is only after they have been moulded by the hand of genius that this particular character becomes apparent. Who can say what Homer would have produced if he had had for his instrument the language of the Lenni Lenape? This, however, we may with safety assert; that he would have been able to say more in fewer words, than even in his own admirable Greek. Every mode of speech has its peculiar qualities, susceptible of being developed and improved by cultivation; but, like flowers and plants, all languages have a regular organization, and none can be called *barbarous* in the sense which presumption has affixed to that word. An unorganized language would be a chaos, unfit to be used as the medium of intercourse between men. No memory could retain a long list of arbitrary words, if order and method, founded on analogy, did not come to its aid. Grammatical forms, therefore, are as necessary to human languages as the organs of life and vegetation are to animals and plants. Neither could exist without them.

In the idiom before us we have an example of what nature can produce, unaided by the theories of science and the refinements of art. To assign to each its proper share in the composition of such noble instruments as the languages of men is not among the least important questions which philology presents to our inquiry. It deserves to be thoroughly investigated. The result, it is true, will be mortifying to our pride; but that pride, which makes us ascribe so much to our own efforts, and so little to the silent and unperceived operations of nature, is the greatest obstacle that we meet in our road to knowledge, and we cannot proceed very far in the discovery of natural causes while we remain disposed to attribute every thing to our so much boasted civilization, our limited sciences, and our mimic arts.

INTRODUCTION.

THE Delaware Indians have no *f* nor *r* in their language*. The letters must be pronounced as in German or Latin. The language has no resemblance to any of ours; it has, however, its own fixed rules, to which those must conform who will speak intelligibly. Whoever will speak Indian must learn to think in Indian.

This treatise will greatly facilitate those who wish to learn this language, if they will only impress themselves with the rules, which are neither numerous nor difficult. In proportion as the knowledge of them is acquired, a greater pleasure will be found in this study, and every day new treasures will be discovered; but above all, there must be a desire to learn, without which nothing can be effected.

* *Note by the Translator.*—The Delawares who inhabited Pennsylvania, while it was under the Swedish dominion, used the *r* instead of the *l*. They called themselves *Renni Renape*. See *Lutheri Catechismus, Oefwersat pao American-Virginiske Spraoket.* Stockholm, 1696. This race appears to be extinct.

GRAMMAR.

I SHALL treat in this essay of the different parts of speech, to wit: * Noun, Pronoun, Verb, Adverb, Preposition, Conjunction, and Interjection.

I.—Of Nouns.

Nouns are of two kinds, substantive and adjective.

Of the Noun Substantive.

The Indians have no declensions, properly so called; that is to say, the nouns are not declined by inflections, as in the Latin and Greek, except in two cases, the vocative and the local. In the others the place of these terminations is supplied by the relative position of the noun, or by grammatical forms or combinations of the verbs and other parts of speech, as will be shewn in the following examples. These grammatical forms or combinations are peculiar to the Indian languages, and I believe are not to be found in any others. They will be more fully explained under their proper heads. At present I shall only shew in what manner what are commonly called the *cases* of nouns are expressed or indicated.

Nominative.

This case (if it may be so called) has no particular form or inflection. It is simply the name of the substantive, as in English.

Lenni, the man
Ochqueu, the woman
Wikwam, the house

Sipo *or* sipu, the river
Getanittowit, God
Gischuch, the sun.

* *Note by the Translator.*—The Author does not speak of the article; yet there is one in the Delaware language, the article *mo*, which is used either in a definite or indefinite sense, as *m'hittuck*, *a* tree or *the* tree. The Minsi say *michtuk*. This article was discovered by the Translator in the Massachusetts language, and on inquiring of Mr Heckewelder, he said that the same article was also in the Delaware, but was not frequently used, because the word was sufficiently understood without it. See his letter to the Translator in the notes to Eliot's Grammar, 11th Massachusetts' Historical Collections, Second Series, p. xv.

[OF NOUNS.]

Genitive.

The genitive is expressed by placing the noun employed in that sense immediately before that which is used in the nominative. Sometimes also by prefixing to the nominative the inseparable pronoun of the third person *w*, as we say in English *John his book* for John's book.

Getannittowit quisall, God's son
Nihillalquonk wtanglowagan*, the Lord's death
Getannitowit wtahoaltowagan, God's love
Getannitowit gektemagelowagan, God's mercy
Lennowikit, the man's house
Getannitowit wtallewussowagan, God's majesty
Nihillalquonk allogewaganall, the Lord's works.

The Dative

Is expressed by inflections in the verbs and by prefixes and suffixes which will be more particularly explained.

Nemilan, I give (to) him
Milap, he gave (to) him
Ndellap, I said (to) him
Nowitschemap, I fetched (to) him
Melat hallemiwi pommauchsowoagan, eternal life
Ndatschimolschap, I related to him
Notschap, I went, came to him
Nowitschewap, I went with him.

The Accusative

Is likewise expressed by means of the verbs, as is said above.

Ndahoala, I love him
Nowaha, I know him
Npendawa, I understand him
Npenauwelema, I take care of him
Npennauwa, I look at him
Nemachelema, I honour him
Getanittowit nquitayala, I fear God. (God I fear him).

The Vocative

Is expressed in the singular by the termination *an*, and by *enk*, when coupled with the pronoun *our*.

Wo Kitanittowian†! O God!
Nihillalan! O Lord!
Nihillalian! O my Lord!
Nihillaliyenk! O our Lord!
Elangomellan! O my friend!
Wetochemellan! O my father!
Wetochemellenk! O our father!
Wetochemuxian! O father!
Pemauchsohalian! O my Saviour!
Pemauchsohaluweyan! O Saviour!
Nocha! (for Nochan), O my father! (says a child to its father)
Elenapewian! Thou Indian!
Shawanowian! Thou Shawanese!
Metapewian! O wicked man!
Welilissian! O pious man!

The Local case‡.

This as well as the preceding may be properly so called. It is formed by means of the suffixes *ink* and *unk*, and expresses *in, in the, on, out of.*

* *Note by the Translator.—Wtanglowagan.* In this word, *anglowagan* signifies death, from *angel*, to die. *W* is the inseparable pronoun *his*, and *t* is interposed for euphony's sake.

† *Note by the Translator.*—The Author frequently uses the letters *g* and *k* and *d* and *t* indiscriminately.

‡ *Note by the Translator.*—The Author calls this case the *ablative*. I have preferred the denomination *local.*

EXAMPLES.

Utenink (from Uteney, a city or town), in the town, in town
Utenink nda, I am going to town, *or* into the town
Utenink noon, I am coming from *or* out of town
Sipunk (from Sipo, river, creek, water), to *or* into the river
Mbink (from Mbi, water), in the water
Hakink (from Hacki, earth, ground), in *or* on the earth
Awossagamewunk (from Awossagame, heaven), in heaven
Wachtschunk nda (from Wachtschu, hill, mountain), I am going up the hill
Wachtschunk noom, I come from the hill
Gamunk nda *or* noom, I am going over the water *or* coming from thence
Machtschikamigunk, in the hole (meaning a hole in the ground)
Ochunk, at his father's.

OF NUMBERS.

The singular has in general no particular inflections to distinguish it from the plural, except in the third person, where it ends in *l*, but most commonly in *wall*. The plural is variously inflected. There is a singular number combined with the plural, as in *our father*, *my fathers*, and a double plural, as in *our fathers*. These are distinguished by particular inflections, the double plural, by the duplication of a syllable. Substantives are generally combined with the inseparable possessive pronoun, which in the singular is *n* for the first person, *k* for the second, and *w* or *o* for the third. The inseparable pronoun is often omitted in the plural and in the third person singular, and the sense is determined by the numeric inflection, which is at the same time pronominal.* Those inflections are *na* or *nana* in the first person, *wa* or *wawa* in the second, and *wall*, *wak* and *wawall* in the third. The duplication of a syllable, as *nana, wawa, wawawall,* indicates the double plural.

EXAMPLES.

Wetoochwink, Father.

Singular.

Nooch, my father
Kooch, thy father
Ochwall, his or her father

Singular with Plural.

Noochena, our father
Koochuwa, your father
Ochuwawall, their father.

Double Plural.

Noochenana, our fathers
Koochewawa, your fathers
Ochuwawawall, their fathers.

Gahowes, Mother.

Singular.

Ngahowes, my mother
Kahowes, thy mother
Gohessal, his or her mother.

Singular with Plural.

Gohessena, our mother
Kohessuwa, your mother
Gohessuwawall, their mother.

The double plural is formed as in the preceding example.

Sometimes the singular receives numerical inflections, and the substantive itself is somewhat modified, as we have already seen in *wetoochwink*, father, from which are formed *nooch, kooch,* &c. So in the following example :

[OF NOUNS.]

Achpoan, Bread.

Singular.	Plural.
N'dappoanum, my bread	N'dappoanummena, our bread
K'dappoanaum, thy bread	K'dappoanumowa, your bread
W'dappoanum, his bread	W'dappoanumowawall, their bread.

The following examples are sufficient to point out the general form of numerical declension :

Hakihacan, the field or plantation.

Singular.

N'dakihacan, my plantation
K'dakihacan, thy plantation
W'dakihacan, his plantation

Plural.

N'dakihacanena, our plantation
K'dakihacanena, your plantation
W'dakihacanowawall, their plantation.

Wuschkink, the eye or sight.

Singular.

Neschkink, my sight *or* eye
Keschkink, thy sight *or* eye
Wuschkink, his sight *or* eye

Plural.

Neschkinkuna, our sight *or* eye
Keschkinkuwa, your sight *or* eye
Wuschkinkuwawall, their sight *or* eye.

The singular with plural and the double plural are formed as in the former examples.

The termination *naninga* is employed in the double plural, when speaking of deceased persons.

EXAMPLES.

Nochena, our father
Nochenana, our fathers
Nochenaninga, our deceased fathers
Muchomsena, our grandfather
Muchomsenaninga, our deceased grandfathers
Kimachtenaninga, our deceased brothers
Chesmussenaninga, our deceased sisters
Gohessenaninga, our deceased mothers.

Substantives without the prefixed pronouns are generally inflected in the plural by *all* or *ak*, the former termination being applied to inanimate and the latter to animate objects. Trees and the larger plants are considered animate. There are some exceptions to this rule, as for instance *namessall*, fishes, which takes the inanimate termination ; but they are not numerous.

EXAMPLES.

Inanimate Form.

Hakihacanall, plantations
Menachgaquall, fence-rails
Siposall, rivers, creeks
Wikwahemall, houses
Uteneyall, cities, towns
Achsinall, stones
Ulakensall, dishes
Amocholall, canoes
Kitoaltewall, ships
Oyosall, pieces of meat or flesh.

Animate Form.

Lennowak, men
Ochquewak, women
Amemensak, children
Amangamequak, large fishes
Tiposak, hens, fowls
Achsinnaminschiak, sugar trees

Wschumaissak, cows, calves
Nenayungesak, horses
Hitquak *or* hitgook, trees
Tscholensak, birds
Tsquallak, frogs.

Substantives derived from active or neutral verbs take in the plural the termination *ik:*

EXAMPLES.

Wenitschanit, father *or* mother, parent, (from Wentschikin, to descend, grow out of)
Wenitschanitschik, parents
Wdallemansitschik, the owners of cattle, birds, fowls, &c.
Pemsitschik, those who are going
Peyatschik, those who are coming
Elemussitschik, those who are going away
Wikhetschik, the cultivators of the earth
Mikemossitschik, labouring people
Mannachetschik, hewers of wood
Elauwitschik, hunters.

Of the various kinds of Substantives.

The substantive combines itself in this language with almost every part of speech, but principally with the verb. We have seen those immediately derived from active or neutral verbs: we shall now proceed to others of an analogous description.

1. There are substantives derived from passive verbs: they end in *wagan* and have no plural:

EXAMPLES.

Machelemuxowagan, honour, the being honoured
Gettemegelemuxowagan, the being shewn favour, mercy, tenderness
Mamschalgussowagan, the being held in remembrance
Mamintochimgussowagan, the being esteemed
Wulakenimgussowagan, the being praised
Machelemoachgenimgussowagan, the receiving honour and praise
Amangachgenimgusswagan, the being raised or elevated by praise
Schingalgussowagan, the being taken
Mamachtschimgussowagan, the being insulted
Pilsohalgussowagan, holiness, purity

And many others of the same kind.

Note.—It might, indeed, be said that substantives in this language have a passive mood, so nearly are they allied to verbs, as will be shewn in its place.

2. There are, moreover, substantives which are akin to participles, such as,

Ahoalgussit, the beloved
Mechelemuxit, the honoured
Nilchgussit, the killed
Lekhikit, the one who is writing
Mikemossit, the one who is labouring, the labourer
Nanhillowit, the one who takes care of the dead
Schingaluesit, the enemy, the adversary.

3. There are also those which are derived from verbs but assume the character of participles, such as,

Ppmmauchsowaganit, he who is living
Ahoaltowaganit, he who is love
Wulamoewaganit, he who is the truth
Wacheyekumuit, he who is the light
Wdallemunsit, the owner of the cattle
Wewikit, the master of the house
Wenitschanit, a child's father or mother
Gettemagelowaganit, he who is mercy
Tschitanessowaganit, he who is strength.

4. There are also substantives formed of two substantives together, or a substantive with an adjective or verb :

EXAMPLES.

Yagawan, a hut
Tipas, a hen or fowl.

From which two words are formed,

Tipasigawan, the hen coop
Goschgoschigawan, the hog sty
Mosigawan, the cow stable
Pitawikham, the front roof of a house
Patamoewigawan, a house of prayer, (the Lord's house, from Patamawos, God, the Lord).

Also,

Pemauchsowaptonamik, the word of life
Wulelendamowaptonamik, the glad tiding of the gospel
Ktemakauschsowagan, a poor miserable life
Machtapan, bad, stormy weather
Matalogacan, a bad wicked servant
Pallalogasowagan, crime, evil deed
Mattalogasowagan, a wicked, sinful act
Machtatenawagan, discontent, unhappiness
Tschitanatenawagan, strength of the spirit of the inner man
Kschiechauchsowagan, a holy life and conduct.

Diminutives are formed by the suffix *tit**, as,

Amemens, amementit, a little child
Nitschan, nitschantit, my little friend (from Nitis, friend; a coaxing expression used by parents to their children)
Pilawetschitsch, pilawetit, a little boy
Ochquetit *or* quetit, a little girl
Lennotit, a little man
Wikwamtit, a little room (house)
Sipotit, a little creek or brook
Hitgutit, a little tree
Goschgotit, a pig
Tipatit, a chicken
Motit, a little calf
Achpoantit, a little loaf *or* little piece of bread
Oyotit, a little piece of meat (as is given to children)
Tscholentit, a little bird—Tscholentittak, (*Plur.*)

OF ADJECTIVES.

There are not many of these, because those words, which with us are adjectives, here are verbs, and although they are not inflected through all the persons, yet they have tenses. The adjectives proper end in *uwi* and *owi*, and are derived sometimes from substantives and sometimes from verbs.

EXAMPLES.

Hallemiwi, eternal
Genamuwi, grateful; from genam, thanks
Tgauchsuwi—good, kind; from tgauchsin, to be good *or* kind
Wulelendamuwi, merry; from wulelendam, to rejoice, to be joyful *or* merry
Wschitschanquiwi, spiritual; from wtschitschank, the spirit.

* *Note by the Translator.*—The diminutive *tit* is only used in the animate gender. In the inanimate the termination *es* is employed, as *wikwames*, a small house, *amocholes*, a small canoe. In speaking of a pretty little animal, the diminutive form is *is*, *schis*, or *tschis*, as *mamalis*, the fawn of a deer, *kuligatschis*, thy pretty little paw. (See the Preface.) There are some exceptions to this rule, as for instance, *allumes*, a little dog, in which the inanimate diminutive is employed. But these are not numerous.

Hakeyiwi, corporeal; from hakey, the body
Pommauchsuwi, living; from pommauchsin, to live
Wdehiwi, hearty, cordial; from Wdehin, the heart
Ahoaltiwi, loving; from ahoalan, to love
Wachtuchwepiwi, personal, bodily; from wachtuchwepi, the body, the flesh
Pilsuwi, piluwi, clean, chaste; from pilsin, to be clean *or* chaste
Wulatenamuwi, wulatenamowi, happy; from wulatenamen, to be happy
Wulamallessuwi, well, happy; from wulamallessin, to be in health *or* happy
Allowiwi, more, yet more
Nungiwi, trembling; from nungihillan, to tremble
Schauwewi, tired, weak; from schauchsin, to be weak
Nolemiwi, invisible, unseen
Apendawi, useful; from apendamen, to enjoy, to make use of
Mattelemuwi, contemptible; from mattelendam, to despise
Angellowi, anglowi, mortal; from angel, to die
Mboiwi, mortal; mboiwi wochganall, dead bones; from mboagan, death
Awendamowi, awendamuwi, painful; from awendam, to suffer pain
Ayandamuwi, ayandamowi, to desire, wish for
Machtamallessuwi, indisposed, sick; from machtamalsin, to be sick
Machtalenamuwi, discontented; from machtalenamen, to be dissatisfied *or* discontented
Mhukuwi, bloody; from mhuk, blood
Moschiwi, clear, luminous
Tengandasuwi, pierced through
Petapaniwi, at break of day; from petapan, the day breaks
Nipahwi, at night, by night
Wschitschanquiwi, ghostly, spiritual
Gischguniwi, in the day, by day
Sedpokuniwi, early in the morning
Wuschginquiwi, face to face; from wuschgink, face
Wewatamowi, wise, prudent; from wewoatam, to be wise
Matiauchsuwi, sinful; from mattauchsin, to sin
Mayauchsuwi, of one mind; from mayauchsin, to be of one mind
Langomuwi, friendly, peaceably disposed
Gettemagelensuwi, humble; from gettemagelensin, to be humble
Gektemagelemuwi, gettemageluwi, merciful; from gettemagelin, to be merciful
Allowelemuwi, valuable; from allowelenden, to esteem, value
Wonattamowi, weak, impotent; from wonatam, to be weak, impotent
Schahowapewi, heartless, desponding
Awullsittamuwi, obedient; from awulsittam, to be obedient
Achwandoguwi, very peaceable
Amemensuwi, childish; from amemens, child
Schacachgapewi, an honest man, (from Schacachgapewin, to be just, upright)
Nihillowewi, murderous; from nihillowen, to put to death, to murder
Machelemuwi, honourable; from machelendam, to honour
Langundowivi, peaceful, peaceable
Tachpachiwi, little, low
Tachpachelensuwi, little, low, humble
Wilawi, rich, valuable
Askiwi, raw
Tangelensuwi, tangitchewi, humble, modest
Schawelemuwi, miserable, painful, burthensome; from schawelendam, to be burthened with sorrow, labour, or trouble
Scattewi, burning
Scattewi wdehin, a burning heart.

There are also adjectives with other terminations, as

Nenapalek, unworthy, good for nothing
Segachtek, ardent
Segachtek ahoaltowan, an ardent love
Schewek, weak, tired
Wingimaktek, odoriferous, of good smell
Nundeyek, defective
Scattek, burning, ardent
Wisawek, yellow
Wapelechen, white
Asgask, green
Tekek, cold
Kschittek, warm, hot
Geschtek, ripe, cooked *or* done
Allowad, allohak, powerful, strong
Mequik, bloody
Mechek, large, great
Ktemaki, poor, miserable, infirm
Gunigischuk, daily
Esseni, stony, flinty; from achsin, a stone.

DEGREES OF COMPARISON.

The Comparative is expressed by *allowiwi*, more.

EXAMPLES.

Wulit, good
Comp. Allowiwi wulit, more good, better
Mchinqui, great
Comp. Allowiwi m'chek, greater

Wahhellemat, wide
Comp. Allowiwi wahhellemat, wider
There are some exceptions, as,
Ika, yonder. Ikalissi, further.

The Superlative is expressed by *eluwi*, most or the most.

EXAMPLES.

Eluwiwulik, the very best, the supremely good
Allowilen, eluwilek, that which is above every thing
Eluwantowit, God above all
Eluwiahoalgussit, the beloved above all things

Eluwassit, the most powerful, the most majestic
Eluwitschitanessit, the strongest of all
Eluwitschiechsit, the most holy
Eluwitakauwussit, the best, the supremely good
Eluwilissit, the most gracious one

OF GENDERS.

The genders in the Delaware are not divided as in our languages into masculine and feminine, but into *animate* and *inanimate*. To the former class belong trees and all plants of a large growth; annual plants and grasses to the latter. Adjectives of the former class generally end in *t*, those of the latter in *k*. The masculine and feminine, where it is necessary to discriminate, are expressed in various ways.

EXAMPLES.

Animate, masculine and feminine, welsit, the best
Inanimate, welhik, the best
Animate, masculine and feminine, gunaxit, great, long
Inanimate, gunaquot, great, long
Animate, geschiechsit, pure, holy
Inanimate, geschiechek, pure, holy
Animate, pilsit, pure, chaste
Inanimate, pilhik, pure, clean
Animate, allauchsit, allowat, strong, mighty
Inanimate, allohak, strong, mighty

Animate, scheuchsit, weak
Inanimate, schawek, weak
Animate, metzil, bad, wicked
Inanimate, medhik, bad, wicked
Animate, wacheyekumuit, he who is the light
Inanimate, wacheyek, the light
Animate, pommauchsowaganit, he who is the life, from pommauchsowagan, life
Animate, tenktitit, the little
Inanimate, tengettik, the little.

Speaking of quadrupeds, the masculine is generally expressed by *lennowechum*, which signifies the male of beasts, thus:

Lennowechum nenayunges, moccaneu, goschgosch, the male of the horse, dog, hog

And of fowls and birds,
Lennowehelleu, the male of fowls, birds.

The feminine of the human species is expressed as follows:

Ochqueu, a woman
Ochquewak, women
Ochquetschitsch, a girl
Ochdomus, a woman's cousin
Masc. Chans, the elder brother
Fem. Mis, the elder sister
Chesmus, the younger brother *or* sister, to which is prefixed in the masculine, lenno, man, and in the feminine, ochque; from ochqueu, woman
Masc. Muchomes, the grandfather
Fem. Ohum, the grandmother
Nohum, kohum, ohumall, my, thy, his *or* her grandmother
Masc. Noschik, my uncle
Fem. Piwitak, the aunt.

The females of fowls and birds are called *ochquehelleu*, and those of quadrupeds *ochquechum :*

Nunschetto, a doe | Nunscheach, a she bear.

OF NUMERALS.

Numerals may also be classed among adjectives, and are as follows :

Ngutti	1
Nischa	2
Nacha	3
Newo	4
Palenach	5
Guttasch	6
Nischasch	7
Chasch	8
Peschkonk	9
Tellen	10
Tellen attach* ngutti	11
Tellen attach nischa	12
Tellen attach nacha	13
Tellen attach newo	14
Tellen attach palenach	15
Tellen attach guttasch	16
Tellen attach nischasch	17
Tellen attach chasch	18
Tellen attach peschkonk	19
Nischinachke	20
Nischinachke attach ngutti	21
Nischinachke attach nischa	22
Nischinachke attach nacha	23
Nischinachke attach newo	24
Nischinachke attach palenach	25
Nischinachke attach guttasch	26
Nischinachke attach nischasch	27
Nischinachke attach chasch	28
Nischinachke attach peschkonk	29
Nachenachke	30
Nachenachke attach ngutti	31
And so forth to 39	
Newinachke	40
Palenach tchenachke	50
Guttasch tchenachke	60
Nischasch tchenachke	70
Chasch tchenachke	80
Peschkonk tchenachke	90
Nguttapachki	100
Nguttapachki attach gutti	101
Nguttapachki attach tellen	110
Nguttapachki attach tellen wak ngutti	111
Nguttapachki tellen wak nischa	112
Nguttapachki tellen wak nacha	113
Ngnttapachki tellen wak newo	114
And so forth to 119	
Nguttapachki attach nischinachke	120
Nguttapachki attach nachenachke	130
Nguttapachki attach newinachke	140
Nguttapachki attach palenach tchenachke	150
Nguttapachki attach guttasch tchenachke	160
Nguttapachki attach nischasch tchenachke	170
Nguttapachki attach chasch tchenachke	180
Nguttapachki attach peschkonk tchenachke	190
Nischapachki	200
Nachapachki	300
Newopachki	400
Palenach tchapachki	500
Guttasch tchapachki	600
Nischasch tchapachki	700
Chasch tchapachki	800
Peschkonk tchapachki	900
Tellen tchen tchapachki, *or* ngutti kittapachki	1000
Nischen kittapachki	2000
Nachen kittapachki	3000
Newon kittapachki	4000
Palenach tchen kittapachki	5000
Guttasch tchen kittapachki	6000
Nischasck tchen kittapachki	7000
Chasch tchen kittapachki	8000
Peschkonk tchen kittapachki	9000
Tellen tchen kittapachki	10,000
Nischinachk tchen kittapachki	20,000
Nachenachk tchen kittapachki	30,000
Newinachk tchen kittapachki	40,000
Palenach tchenachk tchen kittapachki	50,000
Guttasch tchenachk tchen kittapachki	60,000
Nischasch tchenachk tchen kittapachki	70,000
Chasch tchenachk tchen kittapachki	80,000
Peschkonk tchenachk tchen kittapachki	90,000
Nguttapachki tchen kittapachki	100,000
Nischapachki tchen kittapachki	200,000
Nachapachki tchen kittapachki	300,000
Palenach tchapachki tchen kittapachki	500,000
Guttasch tchapachki tchen kittapachki	600,000
Nischasch tchapachki tchen kittapachki	700,000
Chasch tchapachki tchen kittapachki	800,000
Peschonk tchapachki tchen kittapachki	900,000
We may either say	
Tellen tchapachki tchen kittapachki, ten hundred times one thousand	1,000,000
or	
Ngutti kittapachkl tchen kittapachki, one thousand times one thousand	1,000,000

* *Note by the Translator.—Attach* means beyond, above (Zeisberger's Vocab.). So that *tellen attach ngutti* means ten and one over, beyond, above, more.

[OF NOUNS.]

Note.—Kittapachki, from *kitta*, great, properly means *the great hundred.*

Kittan, a great river
Kittahican, the great ocean
Kittoaltewall, the great ships
Kittanittowit, the Great Almighty God.

And so on in many other instances.

Note.—Although few of the Indians are accustomed to calculate, so far as we have seen, and in general they do not trouble themselves much about it, because they have no use for it, yet their language has the means of doing it as well as ours. Since the Europeans have been among them, and particularly since the wars, they have got more into the use of it, the armies having afforded them more frequent opportunities. The number of times is thus expressed:

Ngutten, once
Nischen, twice
Nachen, 3 times
Newen, 4 times
Palenach tchen, 5 times
Guttasch tchen, 6 times
Nischasch tchen, 7 times
Chasch tchen, 8 times
Peschkonk tchen, 9 times
Tellen tchen, 10 times
Tellen tchen attach gutti, 11 times
Tellen tchen attach nischa, 12 times, &c.
Nichinachk tchen, 20 times
Nachenachk tchen, 30 times
Newenachk tchen, 40 times
Palenach tchenachk tchen, 50 times
Guttasch tchenachk tchen, 60 times
Nischasch tchenachk tchen, 70 times
Chasch tchenachk tchen, 90 times
Ngutta pachki tchen, 100 times, &c.

Speaking of inanimate things, as towns, rivers, houses, &c. they say:

Mawat, ngutti, one, only one

And in the Plural

Nischenol, 2
(Nischenoll uteneyall, wikwahemall, tiposall, wachtschawall, two towns, houses, rivers, mountains, &c.)
Nachenol, 3
Newenol, 4
Palanach tchennol, 5
Guttasch tchennol, 6
Nischasch tchennol, 7
Chasch tchennol, 8
Peschkonk tchennol, 9
Tellen tchennol, 10
Tellen tchennol attach gutti, 11
Tellen tchennol attach nischa, 12
Tellen tchennol attach nacha, 13
Nischinachk tchennol, 20
Nachenachk tchennol, 30
Palenachtchennachk tchennol, 50
Nguttapachki tchennol, 100

When men, animals, or other things are spoken of, which among the Indians are considered as belonging to the animated class of beings, they say:

Mauchsa, mayauchsu, one person, *or* a person, *or* living being
It is truly incorrect to say,
Ngutti lenno, a man, ngutti ochqueu, a woman.

In the Plural they say:

Nischowak lennowak, ochquewak, amemensak, wdallemansak, tipasak, &c. two men, women, children, beasts, fowls, &c. &c.
Nachoak, 3
Neyuwak, 4
Palenach tchoak, 5
Guttasch tchoak, 6
Nischasch tchoak, 7
Chasch tchoak, 8
Peschkonk tchoak, 9
Tellen tchoak, 10
Tellen tchoak attach gutti, 11
Tellen tchoak attach nischa, 12
Tellen tchoak attach nacha, 13
Nischinachk tchoak, 20
Nachenachk tchoak, 30
Ngutapachaowak, 100
Nischapachawak, 200
Palenach tchapachawak, 500
Tellen tchapachawak, 1000

ORDINAL NUMBERS.

Netami, the first, (*animate*)
Netamiechen, the first, (*inanimate*)
Tacquak, the second
Nechit, the third
Palenachtchit, the fourth
Palenachtchegit, the fifth, &c.

In the Preterite.

Mauchsop, mayauchsop, there was one
Nischopanik, there were two
Nachopanik, there were three
Newopanik, there were four
Palenach tchopanik, there were five
Tellen tchopanik, there were ten
Nischinachk tchopanik, there were twenty
Nachenachk tchopanik, there were thirty
Ngutta pachxopanik, there were a hundred
Palenach tchapachxopanik, there were five hundred
Tellen tchapachxopanik, there were a thousand of them.

OF THE COMPUTATION OF TIME.

The days among the Indians are reckoned by nights. It is, however, not improper to say:

Ngutti gischque, one day
Nischa gischquewi, two days
Nacha gischquewi, three days, &c.

But the most proper and usual mode of computing nights, is as follows:

Nguttokuni, one night
Nuktokuni, only one night
Nischogunak, two nights
Nachogunak, three nights
Newogunak, four nights
Palenach tchogunak, five nights
Guttasch tchogunak, six nights
Tellen tchogunak, ten nights
Nischinachk tchogunak, twenty nights
Newinachk tchogunak, forty nights, &c.

In the Preterite.

The preterite is always connected with the plural, as below. You cannot say in the singular *nguttokunakat*, one night ago, as you say in the plural. You must say *welaquik*, last night, *or wulaque*, yesterday.

But speaking of several nights, you say:

Nischokunakat, two nights ago
Nachokunakat, three nights ago
Newokunakat, four nights ago
Palenach tchokunakat, five nights ago
Tellen tchokunakat, ten nights ago
Mischinachk tchokunakat, twenty nights ago
Newinaschk tchokunakat, forty nights ago
Palenach tchonachk tchokunakat, fifty nights ago.

The Indians reckon their months by moons, from one new or full moon to another:

Ngutti gischuch, one month
Nischa gischuchak, two months
Nacha gischuchak, three months
Tellen tchi gischuchak, ten months.

Their reckoning of the year is from one spring, summer, autumn, or winter, to another. They have properly no beginning of the year, except that they have learned from the Europeans to distinguish New

Year's Day. They reckon commonly from one seeding time to another, from the time when the deer are red in the Spring and grey in the Autumn, when the corn is ripe or cut down and laid up in heaps, &c. and so back again. The interval between is one year:

Ngutti gachtin, one year
Nischa gachtin, two years
Nacha gachtin, three years, &c.
Nischinachk ntendchi gachtinami, I am twenty years old
Gachtinamichump (*preterite*), I was twenty years old
Newinachk tendchi gachtinamo, he is forty years old
Newinachk tendchi gachtinamiyenk, we are forty years old
Newinachk tendchi gachtinamiyek, you are forty years old
Newinachk tendchi gachtinamoak, they are forty years old.

NAMES OF THE MONTHS.

Anixi gischuch (*Squirrel month*), January
Tsqualli gischuch (*Frog month*), February
M'choamowi gischuch (*Shad month*), March
Quitauweuhewi gischuch (*Spring month*), April
Tauwinipen (*Beginning of summer*), May
Kitschinipen (*Summer*), June
Yugatamoewi gischuch, July
Sakauweuhewi gischuch (*Deer month,*) August
Kitschitachquoak (*Autumn month*), September
Pooxit (*Month of vermin*), October
Wini gischuch (*Snow month*), November
M'chakhocque (*Cold month, the month when the cold makes the trees crack*), December.

Note by the Translator.—For the above explanation of the names of the months, the Translator is partly indebted to the Author's text, and partly to some notes of the late Professor Barton, which have supplied what was wanting in the original, except the meaning of the name of the month of July, which neither has explained. Loskiel calls it the month *when the Indian corn is gathered.*

X.—Of Pronouns.

THERE is little to be said about this part of speech, of which a view has already been given under the head of nouns. Personal pronouns are either separable or inseparable, but are much more frequently used in the latter form.

The Separable Pronouns are:

Singular.	*Plural.*
Ni, I	Kiluna *or* niluna, we
Ki, thou	Kiluwa, you
Neka *or* nekama, he *or* she	Nekamawa, they.

The inseparable pronouns are in both numbers *n'* for the first person, *k'* in the second, *w'* in the third. When two pronouns are employed in verbs, the last or the pronoun governed is expressed by an inflection, as in *k'dahoalohhumo,* I love you, *k'dahoalineen,* thou lovest us, *k'dahoalawak,* thou lovest them, as will be seen more fully under the head of conjugations.

The possessive pronoun is the same as the personal, separable and inseparable, which is employed in a possessive sense. No ambiguity results from this similarity; the meaning is always understood from the context or the form or inflexion of the word with which the pronoun is combined.

The various combinations of these pronouns must be gathered from their connection with the other parts of speech, and cannot all be given under this head. Thus the personal pronoun combines itself with the conjunction *also:*

Nepe, I also	Kepewo, you also
kepe, thou also	Kepoak, they also.
Nepena *or* kepena, we also, (as the word is used in the general or particular plural)	

Note by the Translator.—The particular plural refers to a certain description of persons, as *we Delawares, we who are here together;* the other has a more general application, and shews that no discrimination is intended. In verbs, *n* prefixed (from *niluna)* indicates the particular and *k* (from *kiluna)* the general plural, in the first person. See Heckewelder's Corresp. in Histor. Trans. p. 429. The author is silent on this subject.

DEMONSTRATIVE AND RELATIVE PRONOUNS.

The modes of expressing these by various forms and combinations with other parts of speech are so numerous, that a few examples can only be given:

Auwen, who?	Nik, nikik, those
Keku, ta, koen, what?	Wemi, all
Auweni, who is he?	Wemi auween, every man
Auwenik, who are they?	Alende, some
Won, this	Alendemiyenk, some of us
Na, nanne, nall, nan, that	Alendemiyeek, some of you
Wentschim na lenno! call that man!	Alendeyuwak, some of them
Na icka ni pawit, he that stands there	Mamayauchsiyenk, each of us
Nil, nellnill, yuk, yullick, these	Mamayauchsiyeek, each of you, &c.

The remainder must be learned by practice.

III.—Of Verbs.

There is a great variety of verbs in this language. To exhibit all their compound forms would be an endless task. Every part of speech may be compounded with the verb in many ways, as will be seen in the course of this work.

The verbs *to have* and *to be* do not exist in the Delaware language, either as auxiliaries, or in the abstract substantive sense which they present to an European mind. The verb *to have* always conveys the idea of possession, and *to be* that of a particular situation of the body or mind, and they may be combined like other verbs with other accessary ideas. Thus the verb *to have* or *possess* is combined with the substantive, or the thing possessed, as follows:

N'damochol, I have a canoe
W'tamochol*, he has a canoe
Matta n'damocholiwi, I have no canoe
N'temahican, I have an axe
Nowikin, I have a house
Wiku, he has a house
Wikuwek, they have a house
N'dallemansin, I have cattle
W'dallemansu, he has cattle
N'pachksikan, I have a knife
N'peyakhikan, I have a gun.

The idea conveyed by the substantive verb *to be* is expressed by various combinations with other parts of speech, as for instance:

With the Substantive.

Ni n'damochol, it is my canoe
Ki k'damochol, it is thy canoe
Nekama w'damochol, it is his *or* her canoe
Kiluna n'damocholena, it is our canoe
Kiluwa n'damocholuwa, it is your canoe
Nekamawa w'damochowawall, it is their canoe
Ni n'dalloquepi, it is my hat
Ki k'dalloquepi, it is thy hat
Nekama w'dalloquepi, it is his *or* her hat
Ni n'dacquiwan, it is my blanket.

With the Pronoun.

Auwen, who.

Singular.	*Plural.*
Ewenikia, who I am	Ewenikiyenk, who we are
Ewenikian, who thou art	Ewenikiyek, who you are
Ewenikit, who he is	Ewenikichtit, who they are.

Allende, some.

Plural.

Alendemiyenk, some of us
Alendemiyek, some of you
Alendemowak *or* alendemichtit, some of them.

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* *Note by the Translator.*—The apostrophe between the inseparable pronoun and the noun or verb indicates a sheva or mute vowel. Eliot, in his Massachusetts Grammar, indicates it by the English short *u*: he would write, for instance, *nuttappin* for *n'dappin*. This apostrophe is sometimes omitted in the course of this grammar, but is always to be understood.

The idea of the verb *to be* is also combined with adjectives and adverbs, as will be seen under the heads of "adjective and adverbial verbs."

OF THE CONJUGATIONS.

There are eight conjugations.

The first ends in *in*, as

Achpin, to be there, in a particular place | Mikemossin, to work.

The second ends in *a*, (Infinitive in *an*,) as

N'da, I am going | Paan, to come.

The third ends in *elendam*, and indicates a disposition of the mind, as

Schiwelendam, to be sorry | Wulelendam, to be glad.

The fourth ends in *men*, as

N'gattamen, I request | N'pendamen, I hear.

The fifth ends in *an*, as

Ahoalan, to love.

The sixth ends in *e* or *we* (infinitive *en*), as

N'dellowe, I say | *Infin.* Luen, to say.

The seventh ends in *in*. It has no simple active or passive voice, and is only conjugated through the personal forms or transitions, as

Miltin, to give.

The eighth ends in *ton*—has the simple active, but not the passive form, and has the personal indicative and subjunctive transitions, as

Peton, to bring | N'peton, I bring.

The same inseparable pronouns are used with the verbs as with the substantives. The letters which indicate the pronoun, and are prefixed to the verb, are *n*, *k*, and *w* or *o*. They must be pronounced, with a short interval, when followed by a consonant.

First Conjugation.

No. I.

POSITIVE FORM.

INFINITIVE MOOD.

ACHPIN, to be there, in a particular place.

PARTICIPLE.

Singular.	*Plural.*
Epit*, he who is there, being there	Epitschik, those being there.

INDICATIVE MOOD.

Present Tense.

Singular.	*Plural.*
N'dappin, I am there (*Lat* adsum)	N'dappineen *or* n'dappihheno, we are there†
K'dappin, thou art there	K'dappihhimo, you are there
W'dappin *or* achpin, he is there	W'dappinewo, they are there.

Note.—The plural is formed by suffixes as in the substantives, and the prefixes are preserved.

Preterite.

Singular.	*Plural.*
N'dappineep *or* n'dappihump, I was there	N'dappihhenap, we were there
K'dappineep *or* k'dappihump, thou wert there	K'dappihimoap, ye were there
W'dappineep *or* achpop, he was there	Achpopannik, they were there.

* *Note by the Translator.*—*Epit* is used in the sense of the preposition *at. Philadelphia epit*, at Philadelphia, or being at Philadelphia.—Heckew. Corresp. p. 425.

† *Note by the Translator.*—This is the *particular plural* above mentioned, and is restricted to persons who are specially spoken of; when a more general idea is meant to be conveyed, another form is made use of, and the inseparable pronoun *k* is prefixed instead of the pronoun *n*. Thus *n'penameen*, we see, and *n'pendameen*, we hear, means, we who are here assembled see or hear; but if the plural is used in a general sense, it should be *k'penameen, k'pendameen.* See Heckew. Corresp. in 1 Hist. Trans. 428. The author makes no mention in this Grammar of these two plurals, which is, however, a remarkable peculiarity in the Indian languages. As has been observed in the preface, Mr Zeisberger did not write for Philologists and has left many curious facts respecting the forms of this language entirely unnoticed, and to be acquired by practice. Those who wish for more information on these interesting subjects are referred to the above cited correspondence of Mr Heckewelder, where they will find enough to satisfy their curiosity.

The reader will also observe that the author gives two different forms *n'dappineen* or *n'dappihenno*, to express the words, we are there, and he does the same in many places throughout these conjugations. This Mr Heckewelder said, was in order to shew the inflections of the Delaware verbs in the *Unami* and the *Minsi* dialects, and he promised to point out to the Translator, which belonged to the one and which to the other. But he died before he could fulfil his promise.

Future.

The future is characterized by *tsch;* it is to be observed that when the verb is preceded by an adverb, preposition, or inseparable pronoun, it is frequently added to it.

EXAMPLE.

Singular.	*Plural.*
Ikatsch n'dappin, I shall *or* will be there	Kepenatsch n'dappineen, we shall *or* will be there
Kepetsch k'dappin, thou shalt *or* wilt be there	Witschitsch k'dappihhimo, ye shall *or* will be there
Nekamatsch w'dappin, he shall *or* will be there	Nekamawaktsch w'dappinewo, they shall *or* will be there.

IMPERATIVE MOOD.

Singular.	*Plural.*
Achpil, be *or* stay thou there	Achpik, be *or* stay ye there
Achpitetsch, let him *or* he shall *or* must be *or* stay there	Achpititetsch, let them *or* they shall *or* must be *or* stay there
Achpitam, do thou let us be *or* stay there	Achpitamook, do ye let us be *or* stay there.

Note by the Translator.—There is such a compound mixture of persons and numbers in this mood, that it is impossible to designate either by marginal annotations. It is not one of the least remarkable particularities of this singular language.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Achpiya, when *or* if I am there	Achpiyenke, when *or* if we are there
Achpiyane, when *or* if thou art there	Achpiyeque, when *or* if ye are there
Achpite, when *or* if he is there	Achpichtite, when *or* if they are there.

Preterite.

Singular.	*Plural.*
Achpiyakup, as *or* when I was there	Achpiyenkup, as *or* when we were there
Achpiyanup, as *or* when thou wast there	Achpiyekup, as *or* when ye were there
Achpitup, as *or* when he was there	Achpichtitup, as or when they were there.

Pluperfect.

Singular.	*Plural.*
Achpiatpanne, if I had been there	Achpiyenkpanne, if we had been there
Achpianpanne, if thou hadst been there	Achpiyekpanne, if ye had been there
Achpitpanne, if he had been there	Achpichtitpanne, if they had been there.

Note.—The subjunctive has only a pluperfect in the active and passive voices, but not otherwise.

Future.

Singular.	*Plural.*
Achpiyaktsch, if *or* when I am *or* shall be there	Achpiyenketsch, if *or* when we are *or* shall be there
Achpiyanetsch, if *or* when thou art *or* shalt be there	Achpiyequetsch, if *or* when ye are *or* shall be there
Achpitetsch, if *or* when he is *or* shall be there	Achpichtitetsch, if *or* when they are *or* shall be there.

Another form of this verb which may be called Adverbial.

Present.

Singular.	*Plural.*
Epia, where I am	Epiyenk, where we are
Epian, where thou art	Epiyeek, where ye are
Epit, where he is	Epichtit, where they are.

Preterite.

Singular.	*Plural.*
Epiakup, where I was	Epiyenkup, where we were
Epiyannup, where thou wast	Epiyekup, where ye were
Epitup, where he was	Epichtitup, where they were.

Future.

Singular.	*Plural.*
Tatschta epia, where I shall be	Tatschta epiyenk, where we shall be
Tatschta epian, where thou shalt be	Tatschta epiyeek, where ye shall be
Tatschta epit, where he shall be	Tatschta epichtit, where they shall be.

NEGATIVE FORM.

INFINITIVE MOOD.

(*Not given.*)

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Matta n'dappiwi, I am not there	Matta n'dappiwuneen, we are not there
Matta k'dappiwi, thou art not there	Matta k'dappiwihhimo, ye are not there
Matta w'dappiwi, he is not there	Matta achpiwiwak, they are not there.

Preterite.

Singular.	*Plural.*
Matta n'dappiwip, I was not there	Matta n'dappiwunenap, we were not there
Matta k'dappiwip, thou wast not there	Matta k'dappiwihhimoap, ye were not there
Matta w'dappiwip, he was not there	Matta achpiwipannik, they were not there.

Future.

Singular.	*Plural.*
Matta n'dappiwitsch, I shall *or* will not be there	Matta n'dappiwuneentsch, we shall *or* will not be there
Matta k'dappiwitsch, thou shalt *or* wilt not be there	Matta k'dappiwihhimotsch, ye shall *or* will not be there
Matta w'dappiwitsch, he shall *or* will not be there	Matta achpiwiwaktsch, they shall *or* will not be there.

IMPERATIVE MOOD.

(*Not given.*)

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Matta achpiwake, when *or* if I am not there	Matta achpiwenke, when *or* if we are not there
Matta achpiwonne, when *or* if thou art not there	Matta achpiweque, when *or* if ye are not there
Matta achpique, when *or* if he is not there	Matta achpichtique, when *or* if they are not there.

Preterite.

Singular.	*Plural.*
Matta achpiwakup, when *or* if I was not there	Matta achpiwenkup, when *or* if we were not there
Matta achpiwonnup, when *or* if thou wast not there	Matta achpiwekup, when *or* if ye were not there
Matta achpikup, when *or* if he was not there	Matta achpichtitup, when *or* if they were not there.

Pluperfect.

Singular.	*Plural.*
Matta achpiwakpanne, if I had not been there	Matta achpiwenkpanne, if we had not been there
Matta achsiwonpanne, if thou hadst not been there	Matta achpiwekpanne, if ye had not been there
Matta achpikpanne, if he had not been there	Matta achpichtikpanne, if they had not been there.

Future.

Singular.	*Plural.*
Matta achpiwaktsch*, when *or* if I shall not be there	Mattatsch achpiwenque, when *or* if we shall not be there
Matta achpiwonnetsch, when *or* if thou shalt not be there	Mattatsch achpiweke, when *or* if ye shall not be there
Matta achpiquetsch, when *or* if he shall not be there	Mattatsch achpichtique, when *or* if they shall not be there.

* *Note by the Translator.*—It will be observed that *tsch*, the sign of the future, is here affixed in the singular to the adverb, and in the plural the verb is inflected by it. It will be found, in the preceding page, combined in both numbers with the adverb *ta*, which signifies, where. I have been informed by Mr Heckewelder, that either form may be adopted, whether in the singular or plural, and that the ear is the best guide in such cases. So the negative may be expressed by *atta* or *matta*, as the ear directs.

No. II.

LISSIN, to be *or* do so, to be so situated, disposed, *or* acting.

POSITIVE FORM.

INFINITIVE MOOD.

Present.	*Preterite.*
Lissin, to be *or* do so	Lissineep, to have been, *or* done so

Future.

Lissinitsch, to be *or* to do so at a future time.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'dellsin, I am *or* do so	N'dellsineen, we are *or* do so
K'dellsin, thou art *or* dost so	K'dellsihhimo, ye are *or* do so
W'dellsin, he is *or* does so	W'dellsinewo, they are *or* do so*.

Preterite.

Singular.	*Plural.*
N'dellsineep, I was *or* did so	N'dellsihhenap, we were *or* did so
K'dellsineep, thou wert *or* didst so	K'dellsihhimoap, ye were *or* did so
W'dellsineep, he was *or* did so	W'dellsinewoap, they were *or* did so.

Future.

Singular.	*Plural.*
Nantsch n'dellsin, I shall *or* will be *or* do so	Nantsch n'dellsineen, we shall *or* will be *or* do so
Nantsch k'dellsin, thou shalt *or* wilt be *or* do so	Nantsch k'dellsihhimo, ye shall *or* will be *or* do so
Nantsch w'dellsin, he shall *or* will be *or* do so	Nantsch w'dellsinewo, they shall *or* will be *or* do so.

Another form of the Future.

Singular.	*Plural.*
N'dellsintchi, I shall be *or* do so	N'dellsineentsch, we shall be *or* do so
K'dellsintchi, thou shalt be *or* do so	K'dellsinewotsch, ye shall be *or* do so
W'dellsintchi, he shall be *or* do so	W'dellsinewotsch, they shall be *or* do so.

* *Note by the Translator.*—The verbs ending in *si* and *in* are conjugated according to this rule, and have generally, though not always, *w* prefixed and *u* or *o* suffixed to the third person of the singular. Examples: *achpin*, to be there—*w'dappin* or *uchpo* he is there; *palsin* to be sick—*palsu*, he is sick; *mikemossin*, to work—*mikemossu*, he works, &c. &c.

IMPERATIVE MOOD.

Singular.	*Plural.*
Lissil, be *or* do thou so	Lissik, be *or* do ye so
Singular with Plural.	*Double Plural.*
Lissitam, do thou let us be *or* do so	Lissitamook, do you let us be *or* do so
Singular.	*Plural.*
Lissititsch, be *or* do he so; he shall be *or* do so	Lissichtititsch, let them be *or* do so; they shall be *or* do so.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Lissiye, if I am *or* do so	Lissiyenke, if we are *or* do so
Lissiyanne, if thou art *or* doest so	Lissiyeque, if ye are *or* do so
Lissite, if he is *or* does so	Lissichtite, if they are *or* do so.

Preterite.

Singular.	*Plural.*
Lissiyakup, if I was *or* did so	Lissiyenkup, if we were *or* did so
Lissiyannup, if thou wert *or* didst so	Lissiyekup, if ye were *or* did so
Lissitup, if he was *or* did so	Lissichtitup, if they were *or* did so.

Pluperfect.

Singular.	*Plural.*
Lissiakpanne, if I had been *or* done so	Lissiyenkpanne, if we had been *or* done so
Lissiyanpanne, if thou hadst been *or* done so	Lissiyekpanne, if ye had been *or* done so
Lissitpanne, if he had been *or* done so	Lissichtitpanne, if they had been *or* done so.

Future.

Singular.	*Plural.*
Lissiyaktsch, I shall be *or* do so	Lissiyenketsch, if we shall be *or* do so
Lissiyantsch, if thou shalt be *or* do so	Lissiyeketsch, if ye shall be *or* do so
Lissitsch, if he shall be *or* do so	Lissichtitetsch, if they shall be *or* do so.

Another form of the same verb.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Elsiya, as I am *or* do	Elsiyenk, as we are *or* do
Elsiyan, as thou art *or* dost	Elsiyek, as ye are *or* do
Elsit, as he is *or* does	Elsichtit, as they are *or* do.

Preterite.

Singular.	*Plural.*
Elsiyakup, as I was *or* did	Elsiyenkup, as we were *or* did
Elsiyanup, as thou wert *or* didst	Elsiyekup, as ye were *or* did
Elsitup, as he was *or* did	Elsichtitup, as they were *or* did.

Future.

Singular.	*Plural.*
Tatsch* elsiya, as I shall *or* will be *or* do	Tatsch elsiyenk, as we shall *or* will be *or* do
Tatsch elsiyan, as thou shalt *or* wilt be *or* do	Tatsch elsiyeek, as ye shall *or* will be *or* do
Tatsch elsit, as he shall *or* will be *or* do	Tatsch elsichtit, as they shall *or* will be *or* do.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Elsiyake, if I am *or* do so	Elsiyenke, if we are *or* do so
Elsiyanne, if thou art *or* dost so	Elsiyeque, if ye are *or* do so
Elsite, if he is *or* does so	Elsichtite, if they are *or* do so.

Preterite.

Singular.	*Plural.*
Elsiyakup, if I was *or* did so	Elsiyenkup, if we were *or* did so
Elsiyannup, if thou wert or didst so	Elsiyeekup, if ye were *or* did so
Elsitup, if he was *or* did so	Elsichtitup, if they were *or* did so.

Pluperfect.

Singular.	*Plural.*
Elsiyakpanne, if I had been *or* done so	Elsiyenkpanne, if we had been *or* done so
Elsiyanpanne, if thou hadst been *or* done so	Elsiyekpanne, if ye had been *or* done so
Elsitpanne, if he had been *or* done so	Elsichtitpanne, if they had been *or* done so.

Future.

Singular.	*Plural.*
Elsiyatsch, if I shall be *or* do so	Elsiyenketsch, if we shall be *or* do so
Elsiyannetsch, if thou shalt be *or* do so	Elsiyequetsch, if ye shall *or* will do so
Elsitetsch, if he shall be *or* do so	Elsichtitetsch, if they shall *or* will do so.

Impersonal Forms.

Elek, as it is	Leep, it was so
Elekup, as it was	Atta ne lewi, it is not so
Tatsch elek, as it will be	Atta ne lewip, it was not so.
Leu, it is so; it is true	

NEGATIVE FORM.

INFINITIVE MOOD.

Lissiwi, not to be *or* do so.

* *Note by the Translator.*—This word *tatsch* is compounded of *ta*, which here is an adverb of similitude, and of *tsch*, the usual indication of the future, which is sometimes affixed to the adverb and sometimes to the verb, as has before been observed.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Matta n'dellsiwi, I am not *or* do not so	Matta n'dellsiwuneen, we are not *or* do not so
Matta k'dellsiwi, thou art not *or* dost not so	Matta k'dellsiwunewo, ye are not *or* do not so
Matta w'dellsiwi, he is not *or* does not so	Matta w'dellsiwiwak, they are not *or* do not so.

Preterite.

Singular.	*Plural.*
Matta n'dellsiwip, I was not *or* did not so	Matta n'dellsiwuneenakup, we were not *or* did not so
Matta k'dellsiwip, thou wert not *or* didst not so	Matta k'dellsiwunewakup, ye were not *or* did not so
Matta w'dellsiwip, he was not *or* did not so	Matta w'dellsiwipannik, they were not *or* did not so.

Future.

Singular.	*Plural.*
Mattatsch n'dellsiwi, I shall *or* will not be *or* do so	As in the Present tense, with *mattatsch* prefixed.
Mattatsch k'dellsiwi, thou shalt *or* wilt not be *or* do so	
Mattatsch w'dellsiwi, he shall *or* will not be *or* do so	

IMPERATIVE MOOD.

Singular.	*Plural.*
Katschi lissiham, do not thou do so	Katschi lissihek, do not ye do so.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Matta n'lissiwake, if *or* when I am *or* do not so	Matta lissiwenke, if *or* when we are *or* do not so
Matta lissiwonne, if *or* when thou art *or* dost not so	Matta lissiweque, if *or* when ye are *or* do not so
Matta lissique, if *or* when he is *or* does not so	Matta lissichtique, if *or* when they are *or* do not so.

Preterite.

Singular.	*Plural.*
Matta n'lissiwakup, if *or* when I was *or* did not so	Matta lissiwenkup, if *or* when we were *or* did not so
Matta lissiwonnup, if *or* when thou wert *or* didst not so	Matta lissiwekup, if *or* when ye were *or* did not so
Matta lissitup, if *or* when he was *or* did not so	Matta lissichtitup, if *or* when they were *or* did not so.

The future is formed from the present tense, by affixing *tsch* to the adverb *matta*, as *mattatsch n'lissiwake*, &c.

[FIRST CONJUGATION.]

No. III.

MIKEMOSSIN, to work.

POSITIVE FORM.

INFINITIVE MOOD.

Present.	*Preterite.*
Mikemossin, to work	Mikemossinep, to have worked.

PARTICIPLES.

Present.	*Past.*
Mikemossit, working	Mikemossitschik, having worked

Future.

Mikemossintsch, being to work, having work to do.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'mikemossi, I work	Mikemossihhena*, we work
K'mikemossi, thou workest	K'mikemossihhimo, ye work
Mikemossu, he works	Mikemossuwak, they work.

Preterite.

Singular.	*Plural.*
N'mikemossihump, I worked	Mikemossihhenap, we worked
K'mikemossihump, thou workedst	K'mikemossihhimoap, ye worked
Mikemossop, he worked	Mikemossopannik, they worked.

Future.

Singular.	*Plural.*
N'mikemossitsch, I shall *or* will work	Mikemossihhenatsch, we shall *or* will work
K'mikemossitsch, thou shalt *or* wilt work	K'mikemossihhimotsch, ye shall *or* will work
Mikemossutsch, he shall *or* will work	Mikemossuwatsch, they shall *or* will work.

* *Note by the Translator.*—This is a contraction of *mikemossihhummena*, and is often used for the sake of euphony. The double *h* has not a guttural sound; it merely shews that the preceding vowel is short.

IMPERATIVE MOOD.

Singular.	*Plural.*
Mikemossil, work thou	Mikemossik, work ye
Mikemossitetsch, let him work, he shall work	Mikemossichtitetsch, let them work, they shall work
Singular with Plural.	*Double Plural.*
Mikemossitam, do thou let us work	Mikemossitamoak, do ye let us work.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Mikemossiya, when *or* if I work	Mikemossiyenk, when *or* if we work
K'mikemossiyan *or* yanne, when *or* if thou workest	Mikemossiyek, when *or* if ye work
Mikemossit, when *or* if he works	Mikemossichtit, when *or* if they work.

Preterite.

Singular.	*Plural.*
Mikemossiyakup, when *or* if I worked	Mikemossiyenkup, when *or* if we worked
Mikemossiyannup, when *or* if thou workedst	Mikemossiyekup, when *or* if ye worked
Mikemossitup, when *or* if he worked	Mikemossichtitup, when *or* if they worked.

Pluperfect.

Singular.	*Plural.*
Mikemossiyakpanne, when *or* if I had worked	Mikemossiyenkpanne, when *or* if we had worked
Mikemossiyanpanne, when *or* if thou hadst worked	Mikemossiyekpanne, when *or* if ye had worked
Mikemossitpanne, when *or* if he had worked	Mikemossichtitpanne, when *or* if they had worked.

Future.

Singular.	*Plural.*
Mikemossiyatsch, when *or* if I shall work	Mikemossiyenketsch, when *or* if we shall work
Mikemossiyanetsch, when *or* if thou shalt work	Mikemossiyequetsch, when *or* if ye shall work
Mikemossitetsch, when *or* if he shall work	Mikemossichtitsch, when *or* if they shall work.

NEGATIVE FORM.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Atta n'mikemossiwi, I do not work	Atta n'mikemossuwune *or* mikemossuwuneen, we have not worked
Atta k'mikemossiwi, thou dost not work	Atta k'mikemossihhimowi, ye have not worked
Attta mikemossuwi, he does not work	Atta mikemossiwiwak, they have not worked.

[FIRST CONJUGATION.]

Preterite.

Singular.	*Plural.*
Atta n'mikimossiwip, I did not work *or* have not worked	Atta n'mikemossiwunap, we did not work *or* have not worked
Atta k'mikemossiwi, thou didst not work *or* hast not worked	Atta k'mikemossiwihhimoap, ye did not work *or* have not worked
Atta mikemossuwik, he did not work *or* has not worked	Atta mikemossiwipannik, they did work *or* have not worked.

Future.

Singular.	*Plural.*
Atta n'mikemossiwitsch, I shall not work	Atta mikemossiwunatsch, we shall not work
Atta k'mikemossiwitsch, thou shalt not work	Atta k'mikemossiwihhimatsch, ye shall not work
Atta mikemossuwitsch, he shall not work	Atta mikemossuwiwaktsch, they shall not work.

IMPERATIVE MOOD.

Singular.	*Plural.*
Katschi mikemossihon, work not thou	Katschi mikemossihek, work ye not.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Matta mikemossiwa, when *or* if I do not work	Matta mikemossiwenk, when *or* if we do not work
Matta mikemossiwonne, when *or* if thou dost not work	Matta mikemossiwek, when *or* if ye do not work
Matta mikemossique, when *or* if he does not work	Matta mikemossichtik, when *or* if they do not work.

Preterite.

Singular.	*Plural.*
Matta mikemossiwakup, when *or* if I did not work	Matta mikemossiwenkup, when *or* if we did not work
Matta mikemossiwonnup, when *or* if thou didst not work	Matta mikemossiwekup, when *or* if ye did not work
Matta mikemossikup, when *or* if he did not work	Matta mikemossichtitup, when *or* if they did not work.

Future.

Singular.	*Plural.*
Atta mikemossiwatsch, when *or* if I shall not work	Atta mikemossiwenketsch, when *or* if we shall not work
Atta mikemossiwonnetsch, when *or* if thou shalt not work	Atta mikemossiweketsch, when *or* if ye shall not work
Atta mikemossiketsch, when *or* if he shall not work	Atta mikemossichtiktsch, when *or* if they shall not work.

No. IV.

MITZIN, to eat.

POSITIVE FORM.

INFINITIVE MOOD.

Present.	*Preterite.*
Mitzin, to eat	Mitzineep *or* mitzihump, to have eaten.

PARTICIPLES.

Singular.	*Plural.*
Mitzit, he who is eating there	Mitzichtit, they who are eating there.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'mitzi, I eat	N'mitzineen *or* mitzihhenna, we eat
K'mitzi, thou eatest	K'mitzihhimo, ye eat
Mitzu, he eats	Mitzowak, they eat.

Preterite.

Singular.	*Plural.*
N'mitzineep *or* n'mitzihump, I have eaten	N'mitzihhenakup, we have eaten
K'mitzineep *or* k'mitzihump, thou hast eaten	K'mitzihhimoakup, ye have eaten
Mitzoop, he has eaten	Mitzopannik, they have eaten.

Future.

(Not given.)

IMPERATIVE MOOD.

Singular.	*Plural.*
Mitzil, eat thou	Mitzik, eat ye
Mitzitetsch, let him eat	Mitzichtitetsch, let them eat
Singular with Plural.	*Double Plural.*
Mitzitam, do thou let us eat	Mitzitamoak, do you let us eat.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
N'mitzianne, when *or* if I eat	Mitziyenke, when *or* if we eat
K'mitzianne, when *or* if thou eatest	Mitziyeque, when *or* if ye eat
Mitzite, when *or* if he eats	Mitzichtite, when *or* if they eat.

Preterite.

Singular.	*Plural.*
N'mitziyannup, when *or* if I did eat *or* have eaten	N'mitziyenkup, when *or* if we did eat *or* have eaten
K'mitziyannup, when *or* if thou didst eat *or* hast eaten	Mitziyekup, when *or* if ye did eat *or* have eaten
Mitzite, when *or* if he did eat *or* has eaten	Mitzichtitup, when *or* if they did eat *or* have eaten.

The Future

Is conjugated like the present tense, *n'mitziyanetsch*, when *or* if I shall have eaten, &c.

The preterite is often joined to or preceded by the adverb *metschi* (already), as for instance, *metschi mitziyanne*, when *or* if I shall have eaten, *metschi mitzite*, when *or* if he shall have eaten.

No. V.

POMMISSIN, to go, to walk.

POSITIVE FORM.

INFINITIVE MOOD.

Present.	*Preterite.*
Pommissin, to go	Pommissineep, to have gone.

PARTICIPLES.

Singular.	*Plural.*
Pemsit, one who is going	Pemsitschik, those who are going, (euntes, ambulantes)

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'pomsi, I go	N'pommissineen, we go
K'pomsi, thou goest	Pomsihhimo, ye go
Pomsu, he goes	Pommissowak, they go.

Preterite.

Singular.	*Plural.*
N'pomsineep, I went	Pommissihhenakup, we went
K'pomsineep, thou didst go	Pommissihhimoakup, ye went
Pommissop, he went	Pommissopannik, they went.

The Future

Is conjugated like the present, with *tsch* suffixed:

EXAMPLE.

Singular.	*Plural.*
N'pomsitsch	N'pommissineentsch
K'pomsitch	Pommissihhimotsch *or* pomsihhimotsch
Pommissutsch *or* pomsutch	Pommissowaktsch.

IMPERATIVE MOOD.

Singular.	*Plural.*
Pommissil, go thou	Pommissik, go ye.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Pommissiyane, when *or* if I go	Pommissiyenke, when *or* if we go
K'pommissiyane, when *or* if thou goest	Pommissiyeque, when *or* if ye go
Pommissite, when *or* if he goes	Pommissichtite, when *or* if they go.

Preterite.

Singular.	*Plural.*
Pommissiyannup, when *or* if I went	Pommissiyenkup, when *or* if we went
K'pommissiyannup, when *or* if thou didst go	Pommissiyekup, when *or* if ye went
Pommissitup, when *or* if he went	Pommissichtitup, when *or* if they went.

Future.

Singular.	*Plural.*
Pommissiyanetsch, when *or* if I shall go	Pommissiyenketsch, when *or* if we shall go
K'pommissiyanetsch, when *or* if thou shalt go	Pommissiyequetsch, when *or* if ye shall go
Pommissitetsch, when *or* if he shall go	Pommissichtitetsch, when *or* if they shall go.

Note.—This verb is not used in the sense of "going to or away from a particular place." In this case *aan*, to go, and *allumsin*, to go away, are used.

No. VI.

GAUWIN, to sleep.

POSITIVE FORM.

INFINITIVE MOOD.

Present.	*Preterite.*
Gauwin, to sleep	Gauwineep, to have slept

Future.

Gauwintschi, to be about to sleep (dormiturus esse).

PARTICIPLES.

Present.

Singular.	*Plural.*
Gewi, he who sleeps, (dormiens)	Gewitschik, they who sleep, (dormientes)

Preterite.

Singular.	*Plural.*
Gewitup, he *or* one who has slept	Gewitpannik, they who have slept.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'gauwi, I sleep	Gauwineen, we sleep
K'gauwi, thou sleepest	Gauwihhimo, ye sleep
Gauwiu, he sleeps	Gauwiwak, they sleep.

Preterite.

Singular.	*Plural.*
N'gauwineep, I slept	Gauwihhenakup, we slept
K'gauwineep, thou didst sleep	Gauwihhimoakup, ye slept
Gauwip, he slept	Gauwipannik, they slept.

Future.

Singular.	*Plural.*
N'gauwintschi, I shall *or* will sleep	Gauwihhenatsch, we shall *or* will sleep
K'gauwintschi, thou shalt *or* wilt sleep	Gauwihhimotsch, ye shall *or* will sleep
Gauwiuchtsch, he shall *or* will sleep	Gauwiwaktsch, they shall *or* will sleep.

IMPERATIVE MOOD.

Singular.	*Plural.*
Gauwil, sleep thou	Gauwik, sleep ye
Gauwiwetsch, let him *or* he shall sleep	Gauwichtitetsch, they shall sleep
Singular with Plural.	*Double Plural.*
Gauwitam, do thou let us sleep	Gauwitamook, do ye let us sleep.

SUBJUNCTIVE MOOD.

(*Not given.*)

Note.—Gauwoheen, to lie down to sleep.

No. VII.

POMMAUCHSIN, to live.

POSITIVE FORM.

INFINITIVE MOOD.

Pommauchsin, to live
Pommauchsineep, to have lived

Pommauchsintsch, *victurus esse*. The idea cannot be expressed in English.

PARTICIPLES.

Present.

Pemauchsit, living

Perfect.

Pemauchsitpannik, he who lived

Future.

Pemauchsitschick, he who shall live.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'pommauchsi, I live	N'pommauchsihummena, we live
K'pommauchsi, thou livest	K'pommauchsihhimo, ye live
Pommauchsu, he liveth	Pommauchsowak, they live.

Preterite.

Singular.	*Plural.*
N'pommauchsineep, I lived	N'pommauchsihummenakup, we lived
K'pommauchsineep, thou livedst	K'pommauchsik, ye lived
Pommauchsop, he lived	Pommauchsopannik, they lived.

Future.

Singular.	*Plural.*
N'pommauchsitsch, I shall live	N'pommauchsihummenatsch, we shall live
K'pommauchsitsch, thou shalt live	K'pommauchsihhimotsch, ye shall live
Pommauchsutsch, he shall live	Pommauchsowaktsch, they shall live

IMPERATIVE MOOD.

Singular.	*Plural.*
Pommauchsil, live thou	Pommauchsik, live ye
Future Singular.	*Future Plural.*
Pommauchsitetsch, he shall live	Pommauchsichtitetsch, they shall live.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
N'pommauchsiyanne, if *or* when I live	Pommauchsiyenke, if *or* when we live
K'pommauchsiyanne, if *or* when thou livest	Pommauchsiyeque, if *or* when ye live
Pommauchsite, if *or* when he lives	Pommauchsichtite, if *or* when they live.

Preterite.

Singular.	*Plural.*
N'pommauchsiyannup, if *or* when I have lived	Pommauchsiyenkup, if *or* when we have lived
K'pommauchsiyannup, if *or* when thou hast lived	Pommauchsiyekup, if *or* when ye have lived
Pommauchsitup, if *or* when he has lived	Pommauchsichtitup, if *or* when they have lived

Pluperfect.

Singular.	*Plural.*
N'pommauchsiyanpanne, if *or* when I had lived	Pommauchsiyenkpanne, if *or* when we had lived
K'pommauchsiyanpanne, if *or* when thou hadst lived	Pommauchsiyekpanne, if *or* when ye had lived
Pommauchsitpanne, if *or* when he had lived	Pommauchsichtitpanne, if *or* when they had lived.

The Future

Is like the present with only *tsch* suffixed: thus *n'pommauchsiyannetsch, k'pommauchsiyannetsch,* &c.

NEGATIVE FORM.

INFINITIVE MOOD.

(*Not given.*)

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Matta n'pommauchsiwi, I do not live	Matta n'pommauchsiwuneen *or* n'pommauchsiwenk, we do not live
Matta k'pommauchsiwi, thou dost not live	Matta k'pommauchsiwunevo *or* k'pommauchsiweek, ye do not live
Matta pommauchsiwi, he does not live	Matta pommauchsiwiwak, they do not live.

Preterite.

Singular.	*Plural.*
Matta n'pommauchsiwip, I have not lived	Matta n'pommauchsiwenkup, we have not lived
Matta k'pommauchsiwip, thou hast not lived	Matta k'pommauchsiwekup, ye have not lived
Matta pommauchsiwip, he has not lived	Matta pommauchsiwipannik, they have not lived.

The Future

Is like the present with *tsch* suffixed.

IMPERATIVE MOOD.

(*Not given.*)

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Matta n'pommauchsiwonne, if I do not live	Matta pommauchsiwenke, if we do not live
Matta k'pommauchsiwonne, if thou dost not live	Matta pommauchsiweque, if ye do not live
Matta pommauchsique, if he does not live	Matta pommauchsichtique, if they do not live

Preterite.

Singular.	*Plural.*
Matta n'pommauchsiwonnup, if *or* when I did not live	Matta pommauchsiwenkup, if *or* when we did not live
Matta k'pommauchsiwonnup, if *or* when thou didst not live	Matta pommauchsiwekup, if *or* when ye did not live
Matta pommauchsitup, if *or* when he did not live	Matta pommauchsichtitup, if *or* when they did not live.

Pluperfect.

Singular.	*Plural.*
Matta n'pommauchsiwipanne, if *or* when I had not lived	Matta pommauchsiwenkpanne, if *or* when we had not lived
Matta k'pommauchsiwonpanne, if *or* when thou hadst not lived	Matta pommauchsiwekpanne, if *or* when ye had not lived
Matta pommauchsiwipanne, if *or* when he had not lived	Matta pommauchsuwiwakpanne, if *or* when they had not lived.

The Future

Is formed from the present, as is said above, by adding *tsch.*

CAUSATIVE FORM.

INFINITIVE MOOD

Pommauchsoheen, to make to live.

PARTICIPLES.

Present.

Singular.	*Plural.*
Pemauchsohaluwed, he who makes to live	
Pemauchsohalid, he who makes me live	Pemauchsohalquenk, he who makes us live
Pemauchsohalquon, he who makes thee live	Pemauchsohalqueek, he who makes you live
Pemauchsohalat, he who makes him live	Pemauchsohalquichtit, he who makes them live

Preterite.

Pemauchsohalitup, he who made me live.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'pommauchsohalgun *or* n'pommauchsohaluk, he makes me live	Pommauchsohalguna *or* pommauchsohalquenk, he makes us live
K'pommauchsohalgun, he makes thee live	K'pommauchsohalguwa, he makes you live
Pommauchsohalal *or* pommauchsohalgol, he makes him live	Pommauchsohalawak, he makes them live.

Preterite.

Singular.	*Plural.*
N'pommauchsohalguneep, he made me live	Pommauchsohalquenkup, he made us live
K'pommauchsohalguneep, he made thee live	Pommauchsohalquekup, he made you live
Pommauchsohalap, he made him live	Pommauchsohalapannit, he made them live.

Future.

Singular.	*Plural.*
N'pommauchsohalaktsch, he shall *or* will make me live	N'pommauchsohalgunatsch, he shall *or* will make us live
K'pommauchsohalaktsch, he shall *or* will make thee live	K'pommauchsohalguwaktsch, he shall *or* will make you live
Pommauchsohaluchtsch, he shall *or* will make him live	Pommauchsohalawaktsch, he shall *or* will make them live.

IMPERATIVE MOOD.

Singular.	*Plural.*
Pommauchsohalil, make me live	Pommauchsohalineen, make us live.

NEGATIVE FORM.

Present.

Singular.	*Plural.*
Matta n'pommauchsohalgowi, he does not make me live	Matta pommauchsohalguwuneen, he does not make us live
Matta k'pommauchsohalgowi, he does not make thee live	Matta k'pommauchsohalguweek, he does not make you live
Matta pommauchsohalawi, he does not make him live	Matta pommauchsohalawiwak, he does not make them live.

Preterite.

Singular.	*Plural.*
Matta pommauchsohalgowip, he did not make me live	Matta pommauchsohalguwenkup, he did not make us live
Matta k'pommauchsohalgowip, he did not make thee live	Matta pommauchsohalgawekup, he did not make you live
Matta pommauchsohalawip, he did not make him live	Matta pommauchsohalawipannit, he did not make them live.

The Future.

May be formed from the present tense, as has been already shewn.

Note.—From the verb *pommauchsin* is also formed *petauchsin,* to live so long, till now, to this time, and is conjugated through all the moods and tenses of the radical verb. When we say *petauchsohalgun,* it is as much as to say "he" (the Saviour) "has preserved our lives *or* kept (keeps) us living until this time." In this sense, it can only be said of the Deity and of no one else. It is, as one might say, a *religious* verb.

No. IX.

Lauchsin, to live, to walk.

This verb is derived from *pommauchsin* above conjugated*.

INFINITIVE MOOD.

Lauchsin, to live, walk.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'dellauchsin, I live *or* walk	N'dellauchsineen *or* n'dellauchsihummena, we live *or* walk
K'dellauchsin, thou livest *or* walkest	K'dellauchsihhimo, ye live *or* walk
W'dellauchsin *or* lauchsu, he lives *or* walks	W'dellauchsinewo *or* lauchsowak, they live *or* walk.

Preterite.

Singular.	*Plural.*
N'dellauchsineep *or* n'dellauchsihump, I lived *or* walked	N'dellauchsihummenakup, we lived *or* walked
K'dellauchsineep *or* k'dellauchsihump, thou livedst *or* walkedst	K'dellauchsihimoakup, ye lived *or* walked
W'dellauchsineep *or* lauchsop, he lived *or* walked	W'dellauchsinewo *or* lauchsopannik, they lived *or* walked.

* *Note by the Translator.*—The author does not explain himself further, but I have been informed by Mr Heckewelder that the Delawares have various verbs in which they combine the idea of life with actions of living men. Thus a person who has been sick, being asked how he is, will answer, I live, I walk, I am on my feet, I am lively, able to walk about. In other circumstances, the answer to such a question will be given by a different verb. The author, in his copious Delaware Vocabulary, in the form of a spelling book, has neither *lauchsin* nor *pommauchsin,* he has *pommissin,* to walk, *pommixin,* to creep. These shades of language can only be acquired by practice.

[FIRST CONJUGATION.]

Future.

Singular.	*Plural.*
N'dellauchsintsch, I shall live *or* walk	N'dellauchsihummenatsch, we shall live *or* walk
K'dellauchsintsch, thou shalt live *or* walk	K'dellauchsihimmotsch, you shall live *or* walk
Lauchsutsch, he shall live *or* walk	W'dellauchsowaktsch, they shall live *or* walk.

IMPERATIVE MOOD.

Singular.	*Plural.*
Lauchsil, live thou *or* walk	Lauchsik, live ye
	Lauchsitam, let us live.

More of this mood is not given.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Lauchsiya, if I live *or* walk	Lauchsiyenke, if we live *or* walk
Lauchsiyanne, if thou livest *or* walkest	Lauchsiyeque, if ye live *or* walk
Lauchsite, if he lives *or* walks	Lauchsichtite, if they live *or* walk.

Preterite.

Singular.	*Plural.*
Lauchsiyakup, if I lived	Lauchsiyenkup, if we lived
K'dellauchsiyannup, if thou livedst	Lauchsiyekup, if ye lived
Lauchsitup, if he lived	Lauchsichtitup, if they lived.

Pluperfect.

Singular.	*Plural.*
Lauchsiyanpanne, if I had lived	Lauchsiyenkpanne, if we had lived
K'dellauchsiyanpanne, if thou hadst lived	Lauchsiyekpanne, if ye had lived
Lauchsitpanne, if he had lived	Lauchsichtitpanne, if they had lived.

Future.

Singular.	*Plural.*
Lauchsiyannetsch, if I shall live	Lauchsiyenketsch, if we shall live
K'dellauchsiyannetsch, if thou shalt live	Lauchsiyequetsch, if ye shall live
Lauchsitetsch, if he shall live	Lauchsichtitetsch, if they shall live.

CAUSATIVE FORM.

Lauchsoheen, to cause *or* make one to live, walk, be lively, happy.

INFINITIVE MOOD.

Lauchsoheen, to make one live (in the sense above mentioned).

PARTICIPLES.

Singular.	*Plural.*
Lauchsohalid, he who makes me live	Lauchsohalquenk, he who makes us live.
Lauchsohalitup, he who made me live	

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'dellauchsohalgun, he who makes me live	N'dellunchsohalguneen, he who makes us live
Lauchsohalquon, he who makes thee live	K'dellauchsohalguwa, he who makes you live
Lauchsohalgol, he who makes him live	Lauchsohalawak, he who makes them live.

Preterite.

Singular.	*Plural.*
N'dellauchsohalguneep, he made me live	Lauchsohalquenkup, he made us live
K'dellauchsohalguneep, he made thee live	Lauchsohalquekup, he made you live
Lauchsohalgop, he made him live	Lauchsohalapannit, he made them live.

Future.

Singular.	*Plural.*
Nekamatsch n'dellauchsohalgun, he will make me live	N'dellauchsohalgunatsch, he will make us live
Nekamatsch k'dellauchsohalgun, he will make thee live	K'dellauchsohalguwatsch, he will make you live
Nekamatsch lauchsohalgol, he will make him live	Lauchsohalawatsch, he will make them live.

IMPERATIVE MOOD.

Singular.	*Plural.*
Lauchsohalil, make me live	Lauchsohalineen, make us live.

No more of this verb is given.

No. X.

WULAMALLSIN, to be well, happy.

POSITIVE FORM.

INFINITIVE MOOD.

Wulamallsin, to be well, happy.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Nulamallsi, I am well	Nulamallsihhummena, *or shorter*, nulamallsihhena, we are well
Kulamallsi, thou art well	Kulamallsihhimo, ye are well
Wulamallsi, he is well	Wulamallsowak, they are well.

Preterite.

Singular.	*Plural.*
Nulamallsihump, I was well	Nulamallsihhummenakup, we were well
Kulamallsihump, thou wast well	Kulamallsihhimoakup, ye were well
Wulamalessop, he was well	Wulamallsopannik, they were well.

Future.

Singular.	*Plural.*
Nulalmalsitsch, I shall *or* will be well	Nulamallsihhenatsch, we shall *or* will be well
Kulamallsitsch, thou shalt *or* wilt be well	Kulamallsihhimotsch, ye shall *or* will be well
Wulamallessutsch, he shall *or* will be well	Wulamallsowaktsch, they shall *or* will be well.

IMPERATIVE MOOD.

(*Not given.*)

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Nulamallsiyanne, if *or* when I am well	Wulamallsiyenke, if *or* when we are well
Kulamallsiyanne, if *or* when thou art well	Wulamallsiyeque, if *or* when ye are well
Wulamallsite, if *or* when he is well	Wulamallsichtite, if *or* when they are well.

Preterite.

Singular.	*Plural.*
Nulamallsiyannup, if *or* when I was well	Nulamallsyenkup, if *or* when we were well
Kulamallsiannup, if *or* when thou wert well	Kulamallsiyekup, if *or* when ye were well
Wulamallsitup, if *or* when he was well	Wulamallsichtitup, if *or* when they were well.

Pluperfect.

Singular.	*Plural.*
Nulamallsiyanpanne, if *or* when I had been well	Wulamallsiyenkpanne, if *or* when we had been well
Kulamallsiyanpanne, if *or* when thou hadst been well	Wulamallsiyekpanne, if *or* when ye had been well
Wulamallessitpanne, if *or* when he had been well	Wulamallsichtitpanne, if *or* when they had been well.

Future.

Singular.	*Plural.*
Nulamallsiyannetsch, if *or* when I shall *or* will be well	Wulamallsiyenketsch, when *or* if we shall *or* will be well
Kulamallsiyannetsch, if *or* when thou shalt *or* wilt be well	Wulamallsiyequetsch, when *or* if ye shall *or* will be well
Wulamallsitetsch, if *or* when he shall *or* will be well	Wulamallsichtitetsch, when *or* if they shall *or* will be well.

NEGATIVE FORM.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Matta nulamallsiwi, I am not well	Matta nulamallsiwuneen, we are not well
Matta kulamallsiwi, thou art not well	Matta kulamalliwihhimo, ye are not well
Matta wulamallsiwi, he is not well	Matta wulamallsiwiwak, they are not well.

Preterite.

Singular.	*Plural.*
Matta nulamallsiwip, I have not been well	Matta nulamallsiwenkup, we have not been well
Matta kulamallsiwip, thou hast not been well	Matta kulamallsiwekup, ye have not been well
Matta wulamallsiwi, he has not been well	Matta wulamallsiwipannik, they have not been well.

The remainder may be easily conjugated by following the negative form of *pommauchsin*, to live, above given.

CONTINUOUS FORM.

To be conjugated as the preceding with *wa* prefixed.

EXAMPLE.

Wawulamallsin, to be always well *or* happy.

Singular.	*Plural.*
N'wawulamallsi, I am always well	Wawulamallsihhummena, we are always well
K'wawulamallsi, thou art always well	K'wawulamallsihhimo, ye are always well
Wawulamallsu, he is always well	Wawulamallsowak, they are always well, &c.

CAUSATIVE FORM.

Wulamallesscheen, to make *or* cause a person to be well *or* happy.

INFINITIVE MOOD.

Wulamallesscheen, to make one happy.

[FIRST CONJUGATION.]

PARTICIPLES.

Wulamallessohaluwed, he who makes one happy
Wulamallessohalid, he who makes me happy
Wulamallessohalian (*vocative*), O thou who makest me happy!
Wulamallessohalquon, he who makes thee happy
Wulamallessohalat, he who makes him happy
Wulamallessohalquenk, he who makes us happy
Wulamallessohalqueek, he who makes you happy
Wulamallessohalquichtit, he who makes them happy.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Nulamallsohalgun, he makes me happy	Wulamallsohalguna, he makes us happy
Kulamallsohalgun, he makes thee happy	Wulamallsohalguwa, he makes you happy
Wulamallsohalgol, he makes him happy	Wulamallsohalawak, he makes them happy.

Preterite.

Singular.	*Plural.*
Nulamallsohalguneep, he made me happy	Wulamallsohalgunap, he made us happy
Kulamallsohalguneep, he made thee happy	Wulamallsohalguwoap, he made you happy
Wulamallsohalap, he made him happy	Wulamallsohalapannik, he made them happy.

Future.

Singular.	*Plural.*
Nulamallsohaluktsch, he shall make me happy	Wulamallsohalgunatsch, he shall make us happy
Kulamallsohaluktsch, he shall make thee happy	Wulamallsohalguwatsch, he shall make you happy
Wulamallsohalauchtsch, he shall make him happy	Wulamallsohalawaktsch, he shall make them happy.

IMPERATIVE MOOD.

Singular.	*Plural.*
Wulamallsohalil, make me happy	Wulamallsohalineen, make us happy.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Wulamallsohalite, if *or* when he makes me happy	Wulamallsohalquenke, if *or* when he makes us happy
Wulamallsohalquonne, if *or* when he makes thee happy	Wulamallessohalqueque, if *or* when he makes you happy
Wulamallsohalate, if *or* when he makes him happy	Wulamallsohalquichtite, if *or* when he makes them happy.

Preterite.

Singular.	*Plural.*
Wulamallsohalitup, if *or* when he made me happy	Wulamallsohalquenkup, if *or* when he made us happy
Wulamallsohalquonnup, if *or* when he made thee happy	Wulamallsohalquekup, if *or* when he made you happy
Wulamallsohalatup, if *or* when he made him happy	Wulamallsohalquichtup, if *or* when he made them happy.

Future.

(Not given.)

Note.—The proper orthography of this verb is *wulamallessin, wulamallesscheen, wulamallessi*, &c.; but the *e* is frequently left out for brevity's sake, both in speaking and writing, therefore in this conjugation the two modes of spelling are indifferently used.

No. XI.

NIHILLAPEWIN, to be one's own master, to be free.

INFINITIVE MOOD.

Nihillapewin, to be free.

PARTICIPLES.

Present.

Singular.	*Plural.*
Nihillapewid, he who is free	Nihillapewitschik, they who are free.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Nihillapewi, I am free	Nihillapewineen, nihillapewiyenk, nihillapewihummena, we are free
K'nihillapewi, thou art free	Nihillapewihhimo, nihillapewiyek, ye are free
Nihillapeu, he is free	Nihillapewak, they are free.

Preterite.

Singular.	*Plural.*
Nihillapewihump, I was free	Nihillapewihummenakup, we were free
K'nihillapewihump, thou wast free	K'nihillapewihummoakup, ye were free
Nihillapewip, he was free	Nihillapewapannik, they were free.

The Future

Is as usual formed from the present by means of the suffix *tsch*.

IMPERATIVE MOOD.

(*Not given.*)

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Nihillapewiyake, when *or* if I am free	Nihillapewiyenke, when *or* if we are free
K'nihillapewiyane, when *or* if thou art free	Nihillapewiyeque, when *or* if ye are free
Nihillapewite, when *or* if he is free	Nihillapewichtite, when *or* if they are free.

[FIRST CONJUGATION.]

Preterite.

Singular.	*Plural.*
Nihillapewiyannup, when *or* if I was free	Nihillapewiyenkup, when *or* if we were free
K'nihillapewiyannup, when *or* if thou wert free	Nihillapewiyekup, when *or* if ye were free
Nihillapewitup, when *or* if he was free	Nihillapewichtitup, when *or* if they were free.

Pluperfect.

Singular.	*Plural.*
Nihillapewiyanpanne, when *or* if I had been free	Nihillapewiyenkpanne, when *or* we had been free
K'nihillapewiyanpanne, when *or* if thou hadst been free	Nihillapewiyekpanne, when *or* if ye had been free
Nihillapewipanne, when *or* if he had been free	Nihillapewichtitpanne, when *or* if they had been free.

Future.

(Not given.)

Note.—As this verb has the syllable *wi*, which in general indicates a negative form, its negative has *wiwi*.

CAUSATIVE FORM.

INFINITIVE MOOD.

Nihillapucheen, to liberate *or* make free.

PARTICIPLES.

Present.

Singular.	*Plural.*
Nihillapeuhoalid, he who makes me free, my deliverer	Nihillapeuhoalquenk, he who makes us free, our deliverer
Nihillapeuhalquon, he who makes thee free, thy deliverer	Nihillapeuhoalqueek, he who makes you free, your deliverer
Nihillapeuhoalat, he who makes him free, his deliverer	Nihillapeuhoalquichtit, he who makes them free, their deliverer.

Preterite.

Nihillapeuhoalitup, he who made me free, &c.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Nihillapeuhalgun, he *or* one* makes me free	Nihillapeuhoalguna *or* nihillapeuhalquenk, he *or* one makes us free
K'nihillapeuhoalgun, he *or* one makes thee free	Nihillapeuhoalguwa *or* nihillapeuhoalqueek, he *or* one makes you free
Nihillapeuhoalgol, he *or* one makes him free	Nihillapeuhoalgook *or* nihillapeuhoalawak, he *or* one makes them free.

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* *Note by the Translator.*—*One* answers here to the French particle *on: on me délivre.*

Preterite.

Singular.	*Plural.*
Nihillapeuhoalgoap, he made me free	Nihillapeuhoalgunakup, he made us free
K'nihillapeuhoalgop, he made thee free	Nihillapeuhoalguwoakup, he made you free
W'nihillapeuhoalap, he made him free	W'nipihillapeuhoalapannik, he made them free.

The Future.

Is formed from the present, by means of the suffix *tsch*.

IMPERATIVE MOOD.

Singular.	*Plural.*
Nihillapeuhoalil, make me free	Nihillapeuhoalineen, make us free.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Nihillapeuhoalite, if *or* when he makes me free	Nihillapeuhoalquenke, if *or* when he makes us free
Nihillapeuhoalquonne, if *or* when he makes thee free	Nihillapeuhoalqueque, if *or* when he makes you free
W'nihillapeuhoalate, if *or* when he makes him free	Nihillapeuhoalquichtite, if *or* when he makes them free.

Preterite.

Singular.	*Plural.*
Nihillapeuhoalitup, if *or* when he made me free	Nihillapeuhoalquenkup, if *or* when he made us free
Nihillapeuhoalquonnup, if *or* when he made thee free	Nihillapeuhoalquekup, if *or* when he made you free
Nihillapeuhoalatup, if *or* when he made him free	Nihillapeuhoalquichtitup, if *or* when he made them free.

Pluperfect.

Singular.	*Plural.*
Nihillapeuhoalitpanne, if *or* when he had made me free	Nihillapeuhoalquenkpanne, if *or* when he had made us free
Nihillapeuhoalatquonpanne, if *or* when he had made thee free	Nihillapeuhoalqueekpanne, if *or* when he had made you free
Nihillapeuhoalatpanne, if *or* when he had made him free	Nihillapeuhoalquichtitpanne, if *or* when he had made them free.

Future.

(Not given.)

[FIRST CONJUGATION.]

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Nihillapeuhoalgussia, if *or* when I am made free	Nihillapeuhoalgussiyenque, if *or* when we are made free
K'nihillapeuhoalgussiyane, if *or* when thou art made free	Nihillapeuhoalgussiyeque, if *or* when ye are made free
Nihillapeuhoalgussite, if *or* when he is made free	Nihillapeuhoalgussichtite, if *or* when they are made free.

Preterite.

Singular.	*Plural.*
Nihillapeuhoalgussiyakup, if *or* when I was made free	Nihillapeuhoalgussiyenkup, if *or* when we were made free
K'nihillapeuhoalgussiyanup, if *or* when thou wert made free	K'nihillapeuhoalgussiyekup, if *or* when ye were made free
Nihillapeuhoalgussitup, if *or* when he was made free	Nihillapeuhoalgussichtitup, if *or* when they were made free.

Pluperfect.

Singular.	*Plural.*
Nihillapeuhoalgussiyakpanne, if *or* when I had been made free	Nihillapeuhoalgussiyenkpanne, if *or* when we had been made free
K'nihillapeuhoalgussiyanpanne, if *or* when thou hadst been made free	K'nihillapeuhoalgussiyekpanne, if *or* when ye had been made free
Nihillapeuhoalgussitpanne, if *or* when he had been made free	Nihillapenhoalgussichtitpanne, if *or* when they had been made free.

Future.

Singular.	*Plural.*
Nihillapeuhoalgussitsch, if *or* when I shall be made free	Nihillapeuhoalgussihummenatsch, if *or* when we shall be made free
K'nihillapeuhoalgussitsch, if *or* when thou shalt be made free	K'nihillapeuhoalgussihimatsch, if *or* when ye shall be made free
Nihillapeuahoalgussutsch, if *or* when he shall be made free	Nihillapeuhoalgussowaktsch*, if *or* when they shall be made free.

* *Note by the Translator.*—This verb in its various forms is derived from, or at least connected with *nihillatamen*, I own, I am master of, and to that class belong words which may be used as substantives, signifying lord or master, or as participles, in their personal forms, as he who owns me, thee, him, &c. See the 4th conjugation, No. III. to which that verb belongs.

With this family of verbs and substantives is connected the verb, *nihilla*, I kill, or strike dead, and its forms, *knihillall*, I kill thee, strike thee dead; and *nilchgussiani*, (used only in the subjunctive mood) if or when I am killed or struck dead. It is very curious to observe the chains of ideas which different nations pursue in the formation of their languages. Here we find right, power, and force confounded together, as if there was no difference between them—I am owner, master, lord; I strike, kill, destroy; all—words derived from the same root produced under different forms, and this will, no doubt, be ascribed to the *barbarity* of American Indians. But may not similar connections and derivations be found in the languages of civilized nations? For instance the Italian *cattivo*, wicked, from *captivus*, a prisoner, whence the English word *caitiff* is derived; the French *gueux*, a scoundrel, which signifies also a *beggar;* thus stigmatizing misfortune with the imputation of baseness and crime; and in almost all European languages, the words *wretch*, *malheureux*, *miserable*, &c. used to express the highest degree of defamation and contempt. "Take physic, pomp!"—Let us learn first to know ourselves, before we pass too severe a judgment on other nations.

Second Conjugation.

No. I.

AAN, to go (thither, to a place.)

POSITIVE FORM.

INFINITIVE MOOD.

Aan, to go.

PARTICIPLES.

Singular.	*Plural.*
Eyat, going	Eyatschik
Ahek, gone	Ahektschik.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'da, I go	N'daneen *or* n'dahhena, we go
K'da, thou goest	K'dahhimo, ye go
Eu *or* waeu, he goes	Ewak, waewak, *or* w'danewo, they go.

Preterite.

Singular.	*Plural.*
N'dahump, n'danep, I went	N'dahhenap *or* n'dahhenakup, we went
K'dahump, k'danep, thou didst go	K'dahhimoakup, ye went
Eep, w'danep, he went	Epannik, they went.

Future.

Singular.	*Plural.*
N'dantsch, I shall *or* will go	N'dahhenatsch, we shall *or* will go
K'dantsch, thou shalt *or* wilt go	K'dahhimotsch, ye shall *or* will go
Euchtsch, he shall *or* will go	Ewaktsch, they shall *or* will go.

IMPERATIVE MOOD.

Present.

Singular.	*Plural.*
Aal, go thou	Atam let us go
	Aak, go ye.

Future.

Singular.	*Plural.*
Atetsch, he shall go	Achtitetsch, they shall go.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Aane, when *or* if I go	Ayenke, when *or* if we go
Ayane, when *or* if thou goest	Ayeque, when *or* if ye go
Ate, when *or* if he goes	Aachtite, when *or* if they go.

Preterite.

Singular.	*Plural.*
Aanup, when *or* if I went	Ayenkup, when *or* if we went
Ayanup, when *or* if thou didst go	Ayekup, when *or* if ye went
Atup, when *or* if he went	Aachtitup, when *or* if they went.

Pluperfect.

Singular.	*Plural.*
Aanpanne, when *or* if I had gone	Ayenkpanne, when *or* if we had gone
Ayanpanne, when *or* if thou hadst gone	Ayekpanne, when *or* if ye had gone
Atpanne, when *or* if he had gone	Achtitpanne, when *or* if they had gone.

Future.

Singular.	*Plural.*
Aanetsch, when *or* if I shall go	Ayenketsch, when *or* if we shall go
Ayanetsch, when *or* if thou shalt go	Ayequetsch, when *or* if ye shall go
Aktsch, when *or* if he shall go	Aachtitetsch, when *or* if they shall go.

LOCAL RELATIVE MOOD.

Present.

Singular.	*Plural.*
Eyaya, where *or* whither I go	Eyayenk, where *or* whither we go
Eyayan, where *or* whither thou goest	Eyayek, where *or* whither ye go
Eyat, where *or* whither he goes	Eyachtit, where *or* whither they go.

Preterite.

Singular.	*Plural.*
Eyayakup, where *or* whither I went	Eyayenkup, where *or* whither we went
Eyayanup, where *or* whither thou didst go	Eyayekup, where *or* whither ye went
Eyatup, where *or* whither he went	Eyachtitup, where *or* whither they went.

Future.

Singular.	*Plural.*
Eyayatsch, where *or* whither I shall *or* will go	Eyayenktsch, where *or* whither we shall *or* will go
Eyayannetsch, where *or* whither thou shalt *or* wilt go	Eyayektsch, where *or* whither ye shall *or* will go
Eyatsch, where *or* whither he shall *or* will go	Eyaktitsch, where *or* whither they shall *or* will go.

NEGATIVE FORM.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Matta n'dawi, I do not go	Matta n'dawuneen, we do not go
Matta k'dawi, thou dost not go	Matta k'dawunewo, ye do not go
Matta ewi, he does not go	Matta ewiwak, they do not go.

Preterite.

Singular.	*Plural.*
Matta n'dawip, I did not go	Matta n'dawunenap, we did not go
Matta k'dawip, thou didst not go	Matta k'dawihhimoap *or* k'dawunewoap, ye did not go
Matta ewip, he did not go	Matta w'dawunewoap *or* ewipannik, they did not go.

Future.

Singular.	*Plural.*
Mattatsch n'dawi, I shall not go	Mattatsch n'dawuneen, we shall not go
Mattatsch k'dawi, thou shalt not go	Mattatsch k'dawunewo, ye shall not go
Mattatsch w'dawi *or* ewi, he shall not go	Mattatsch ewiwak, they shall not go.

IMPERATIVE MOOD.

Singular.	*Plural.*
Katschi ta ahan, do not go	Katschi ta ahek, go ye not.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Matta n'dawonne, when *or* if I do not go	Matta awenke, when *or* if we do not go
Matta awonne, when *or* if thou dost not go	Matta aweque, when *or* if ye do not go
Matta aque, when *or* if he does not go	Matta achtite, when *or* if they do not go.

The other tenses of this verb in the subjunctive mood are not given.

SOCIAL FORM.

To go with some body.

INFINITIVE MOOD.

Witeen*, to go with	Witeneep, to have gone with.

* *Note by the Translator.*—The derivation of this word *witeen* from *n'da*, I go, does not immediately appear. In the first place it must be observed, that the author frequently con-

[SECOND CONJUGATION.]

PARTICIPLE.

Witetschik, he who goes with his companion.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'wite, I go with	N'witeneen, we go with
K'wite, thou goest with	K'witenewo, ye go with
Witeu, he goes with	Witewak, they go with.

Preterite.

Singular.	*Plural.*
N'witeneep, I went with	N'witenenakup, we went with
K'witeneep, thou didst go with	K'witenewoakup, ye went with
Witeep, he went with	Witepannik, they went with.

Future.

Singular.	*Plural.*
N'witetsch, I shall go with	N'witeneentsch, we shall go with
K'witetsch, thou shalt go with	K'witenewotsch, ye shall go with
Witeuchtsch, he shall go with	Witewaktsch, they shall go with.

IMPERATIVE MOOD.

Singular.	*Plural.*
Witel, go thou with	Witek, go ye with
Witscheewil, go thou with me	Witscheewik, go ye with me.

TRANSITIONS.—FIRST TRANSITION.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
K'witschewulanne *or* k'witschewulen, I go with thee	K'witschewullohhumo, I go with you
N'witschewan, I go with him	N'witschewawak, I go with them.

Preterite.

Singular.	*Plural.*
K'witschewulleneep, I went with thee	K'witschewullohhumoap *or* k'witschewullenne-woap, I went with you
N'witschewoap, I went with him	N'witschewoapannik, I went with them.

founds the sounds *d* and *t*, which to a German untutored ear appear to be the same; therefore if we write *wideen*, the etymology becomes at once apparent. *W* is the inseparable pronoun of the third person he or she, him or her; *i* is interposed for euphony's sake, and *deen* or *teen* is a form of the verb *aan*, to go, as *n'da* or *n'ta* is another. We should be very careful how we ascribe a want of analogy to Indian derivations; although it may not be always observable at first sight, it will be discovered by those who investigate the subject with the necessary attention.

[SECOND CONJUGATION.]

SUBJUNCTIVE MOOD.

Present.

Witschewane, when I go with him

No more of this tense is given, nor of the subjunctive mood throughout these transitions, except two persons in the second, and two in the third.

SECOND TRANSITION.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
K'witschewi, thou goest with me	K'witschewineen *or* k'witschewihhena, thou goest with us
K'witschewan, thou goest with him	K'witschewawak, thou goest with them.

Preterite.

Singular.	*Plural.*
K'witschewip, thou didst go with me	K'witschewihummeneep, (*or abridged*, k'witschewimeneep,) thou didst go with us
K'witschewoap, thou didst go with him	K'witschewoapannik, thou didst go with them.

SUBJUNCTIVE MOOD.

Present.

K'witschewianne, when thou goest with me | K'witschewanne, when thou goest with him.

THIRD TRANSITION.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'witscheyuk, he goes with me	Witscheuchguna, he goes with us
K'witscheyuk, he goes with thee	Witscheuchguwa, he goes with you
Witschewawall, he goes with him	Witschewawak, he goes with them.

Preterite.

Singular.	*Plural.*
N'witscheuchkup, he went with me	Witscheuchgunap, he went with us
K'witscheuchkup, he went with thee	Witscheuchguwoap, he went with you
Witschewoap, he went with him	Witschewoapannik, he went with them.

[SECOND CONJUGATION.]

SUBJUNCTIVE MOOD.

Present.

N'witschewite, when *or* if he goes with me	K'witsche, when *or* if he goes with thee

FOURTH TRANSITION.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
K'witschewuleneen, we go with thee	K'witschewullohhena, we go with you
N'witschewaneen, we go with him	N'witschewawuna, we go with them.

Preterite.

Singular.	*Plural.*
K'witschewullohhenap, we went with thee	N'witschewullohhenakup, we went with you
N'witschewawunap *or* n'witschewaneenakup, we went with him	N'witschewawunap, we went with them.

FIFTH TRANSITION.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
K'witschewihhimo, you go with me	K'witschewineen *or* k'witschewihhummena, you go with us
K'witschewanewo, you go with him	K'witschewawawall, you go with them.

Preterite.

Singular.	*Plural.*
K'witschewihhimoakup, you went with me	K'witschewihummenakup, you went with us
K'witschewanewoakup, you went with him	K'witschewawapannik, you went with them.

SIXTH TRANSITION.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'witscheuchgook, they go with me	Witscheuchgunanak, they go with us
K'witscheuchgook, they go with thee	Witscheuchguwawak, they go with you
Witscheuchgol, they go with him	Witscheuchgook, they go with them.

Preterite.

Singular.	*Plural.*
N'witscheuchgokpannik, they went with me	Witscheuchgunapannik, they went with us
K'witscheuchgopannik, they went with thee	Witscheuchguwapannik, they went with you
Witscheuchgopannik, they went with him	Witscheuchgokpannik, they went with them.

No. II.

PAAN, to come.

POSITIVE FORM.

INFINITIVE MOOD.

Paan, to come.

PARTICIPLES.

Singular.	*Plural.*
Payat, he who comes *or* is coming	Payatchik, they who come *or* are coming.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'pa, I come	N'paneen *or* n'pahhena, we come
K'pa, thou comest	K'pahhimo *or* k'panewo, ye come
Peu *or* peyeya, he comes	Pewak, penewo, they come.

Preterite.

Singular.	*Plural.*
N'pahump *or* n'paneep, I came	N'pahhenap *or* n'pakup, we came
K'pahump *or* k'paneep, thou camest	K'pahhimoap *or* k'pahhimoakup, ye came
Peep, panep, *or* peuchsa, he came	Pepannik *or* pannewoakup, they came.

Future.

Singular.	*Plural.*
N'patsch, I shall *or* will come	N'pahhenatsch, we shall *or* will come
K'patsch, thou shalt *or* wilt come	K'pahhenatsch, ye shall *or* will come
Peuchtsch, he shall *or* will come	Pewaktsch, they shall *or* will come.

IMPERATIVE MOOD.

Present.

Singular.	*Plural.*
Pal, come thou	Paak, come ye.

[SECOND CONJUGATION.]

Future.

Singular.	*Plural.*
Patetsch, he shall come	Pachtitetsch, they shall come.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Paane, paya, if *or* when I come	Payenk, payenke, if *or* when we come
Payane, if *or* when thou comest	Payeque, if *or* when ye come
Pate, if *or* when he comes	Pachtit, pachtite, if *or* when they come.

Preterite.

Singular.	*Plural.*
Payakup, if *or* when I came	Payenkup, if *or* when we came
Payanup, if *or* when thou camest	Payekup, if *or* when ye came
Patup, peyatup, if *or* when he came	Pachtitup, if *or* when they came.

Pluperfect.

Singular.	*Plural.*
Payakpanne, if *or* when I had come	Payenkpanne, if *or* when we had come
Payanpanne, if *or* when thou hadst come	Payekpanne, if *or* when ye had come
Patpanne, if *or* when he had come	Pachtitpanne, if *or* when they had come.

The Future

Is formed from the present as above mentioned.

NEGATIVE FORM.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Matta n'pawi, I do not come	N'pawuneen, we do not come
Matta k'pawi, thou dost not come	K'pawunewo, ye do not come
Matta pewi, he does not come	Pewiwak, pewichtik, *or* pachtique, they do not come.

Preterite.

Singular.	*Plural.*
Matta n'pawip, I did not come	Matta n'pawihhenap, we did not come
Matta k'pawip, thou didst not come	Matta k'pawihhimoap, ye did not come
Matta pewip, he did not come	Matta pewipanik, they did not come.

Future.

Mattatsch n'pawi, &c. Like the present tense.

IMPERATIVE MOOD.

Present.

Singular.	*Plural.*
Katschi pahan, come thou not	Katschi pahik, come ye not.

Future.

Singular.	*Plural.*
Katschi pahitsch, he shall *or* must not come	Katschi pachtitetsch, they shall *or* must not come.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Matta pawiyak, if *or* when I do not come	Matta pawenke, if *or* when we do not come
Matta k'pawonne, if *or* when thou dost not come	Matta paweque, if *or* when ye do not come
Matta paque *or* pewite, if *or* when he does not come	Matta pachtite, if *or* when they do not come.

Preterite.

Singular.	*Plural.*
Matta pawiyakup, if *or* when I did not come	Matta pawenkup, if *or* when we did not come
Matta k'pawonnup, if *or* when thou didst not come	Matta pawekup, if *or* when ye did not come
Matta pakup *or* pewitup, if *or* when he did not come	Matta pachtitup, if *or* when they did not come.

Pluperfect.

Singular.	*Plural.*
Matta payakpanne, if *or* when I had not come	Matta pawenkpanne, if *or* when we had not come
Matta pawonpanne, if *or* when thou hadst not come	Matta pawekpanne, if *or* when ye had not come
Matta pakpanne, if *or* when he had not come	Matta pachtitpanne, if *or* when they had not come.

Future.

The future is like the present. *Mattatsch pawiyak, k'pawonne, paque, &c.*

Another form of the Future.

Singular.	*Plural.*
Atta n'pawiyatsch, if *or* when I shall not come	Atta pawenketsch, if *or* when we shall not come
Atta k'pawonnetsch, if *or* when thou shalt not come	Atta pawequetsch, if *or* when ye shall not come
Atta pewitetsch, if *or* when he shall not come	Atta pewichtitetsch *or* pauchtitetsch, if *or* when they shall not come.

Third Conjugation.

The third conjugation ends in *elendam*, and all the verbs with this termination express a disposition, situation, or operation of the mind.

No. I.

SCHIWELENDAM, to be melancholy *or* sad.

POSITIVE FORM.

INFINITIVE MOOD.

Present.

Schiwelendam, to be sad.

Preterite.

Schiwelendamenep, to have been sad.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'schiwelendam, I am sad	Schiwelendameneen, we are sad
K'schiwelendam, thou art sad	Schiwelendamohhumo, ye are sad
Schiwelendam, he is sad	Schiwelendamoak, they are sad.

Preterite.

Singular.	*Plural.*
N'schiwelendamenep, I was sad	Schiwelendamenenap, we were sad
K'schiwelendamenep, thou wast sad	Schiwelendamohhumoap, ye were sad
Schiwelendamenep, he was sad	Schiwelendamopannik, they were sad.

The Future

Is conjugated like the present, with *tsch* suffixed.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Schiwelendama, if *or* when I am sad	Schiwelendamenke, if *or* when we are sad
K'schiwelendamane, if *or* when thou art sad	Schiwelendameque, if *or* when ye are sad
Schiwelendanke, if *or* when he is sad	Schiwelendamichtite, if *or* when they are sad.

Preterite.

Singular.	*Plural.*
Schiwelendamakup, if *or* when I was sad	Shiwelendamenkup, if *or* when we were sad
Schiwelendankup, if *or* when thou wert sad	Shiwelendamekup, if *or* when ye were sad
Schiwelendankup, if *or* when he was sad	Shiwelendamichtitup, if or when they were sad.

Pluperfect.

Singular.	*Plural.*
Schiwelendamakpanne, if *or* when I had been sad	Schiwelendamenkpanne, if *or* when we had been sad
Schiwelendamanpanne, if *or* when thou hadst been sad	Schiwelendamekpanne, if *or* when ye had been sad
Schiwelendankpanne, if or when he had been sad	Schiwelendamichtitpanne, if *or* when they had been sad.

Future.

Singular.	*Plural.*
Schiwelendamaktsch, if *or* when I shall *or* will be sad	Schiwelendamenketsch, if *or* when we shall *or* will be sad
Schiwelendamantsch, if *or* when thou shalt *or* wilt be sad	Schiwelendamequetsch, if *or* when ye shall *or* will be sad
Schiwelendanktsch, if *or* when he shall *or* will be sad	Schiwelendamichtitetsch, if *or* when they shall *or* will be sad.

NEGATIVE FORM.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Atta n'schiwelendamowi, I am not sad	Atta schiwelendamowuneen, we are not sad
Atta k'schiwelendamowi, thou art not sad	Atta k'schiwelendamohhumo, ye are not sad
Atta schiwelendamowi, he is not sad	Atta schiwelendamowunewo, they are not sad.

Preterite.

Singular.	*Plural.*
Atta n'schiwelendamowip, I was not sad	Atta schiwelendamowuneen, we were not sad
Atta k'schiwelendamowip, thou wast not sad	Atta schiwelendamowihhimoap, ye were not sad
Atta schiwelendamowip, he was not sad	Atta schiwelendamowipannik, they were not sad.

Future.

Singular.	*Plural.*
Mattatsch n'schiwelendamowi, I shall *or* will not be sad, &c.	Mattatsch schiwelendamowuneen, we shall *or* will not be sad, &c.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Matta schiwelendamowak, if *or* when I am not sad	Atta schiwelendamowenk, if *or* when we are not sad
Matta k'schiwelendamowanne, if *or* when thou art not sad	Atta schiwelendamowek, if *or* when ye are not sad
Matta schiwelendamoque, if *or* when he is not sad	Atta schiwelendamichtik, if *or* when they are not sad.

Preterite.

Singular.	*Plural.*
Atta schiwelendamowakup, if *or* when I was not sad	Atta schiwelendamowenkup, if *or* when we were not sad
Atta schiwelendamowanup, if *or* when thou wert not sad	Atta schiweledamowekup, if *or* when ye were not sad
Atta schiwelendamokup, if *or* when he was not sad	Atta schiwelendamichtitup, if *or* when they were not sad.

No. II.

WULELENDAM, to rejoice.

POSITIVE FORM.

INFINITIVE MOOD.

Present.

Wulelendam, to rejoice.

Preterite.

Wulelendamenep, to have rejoiced.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Nolelendam *or* nulelendam, I rejoice	Nolendamen, we rejoice
Kulelendam *or* kulelendamen, thou rejoicest	Kulelendamohhumo, ye rejoice
Wulelendam *or* wulelendamohummena, he rejoices	Wulelendamoak *or* wulelendamenewo, they rejoice.

Preterite.

Singular.	*Plural.*
Nolelendameneep, I rejoiced	Nolelendamenenap *or* nolelendamennakup, we rejoiced
Kulelendameneep, thou rejoiced	Nolelendamohhenap *or* nolelendahummoakup, ye rejoiced
Wulelendamenep *or* wulelendamoap, he rejoiced	Wulelendamopannik, they rejoiced.

The Future

Is formed like the present, with *tsch* suffixed.

IMPERATIVE MOOD.

Singular.	*Plural.*
Wulelenda, rejoice thou	Wulelendamook, do ye rejoice
	Wulelendamotam, let us rejoice.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Nulelendama, if *or* when I rejoice	Wulelendamenke, if *or* when we rejoice
Kulelendamane, if *or* when thou rejoicest	Kulelendameque, if *or* when ye rejoice
Wulelendanke, if *or* when he rejoices	Wulelendamichtite, if *or* when they rejoice.

Preterite.

Singular.	*Plural.*
Wulelendamakup, if *or* when I rejoiced	Nolelendamenkup, if *or* when we rejoiced
Kulelendamanup, if *or* when thou rejoicedst	Wulelendamekup, if *or* when ye rejoiced
Wulelendankup, if *or* when he rejoiced	Wulelendamichtitup, if *or* when they rejoiced.

Pluperfect.

Singular.	*Plural.*
Nolelendamakpanne, if *or* when I had rejoiced	Wulelendamenkpanne, if *or* when we had rejoiced
Kulelendamanpanne, if *or* when thou hadst rejoiced	Kulelendamekpanne, if *or* when ye had rejoiced
Wulelendankpanne, if *or* when he had rejoiced	Wulelendamichtitpanne, if *or* when they had rejoiced.

Future.

Singular.	*Plural.*
Nolelendamaktsch, if *or* when I shall rejoice	Wulelendamenketsch, if *or* when we shall rejoice
Kulelendamaktsch, if *or* when thou shalt rejoice	Kulelendamequetsch, if *or* when ye shall rejoice
Wulelendamaktsch, if *or* when he shall rejoice	Wulelendamichtitetsch, if *or* when they shall rejoice.

NEGATIVE FORM.

INFINITIVE MOOD.

Atta wulelendamowi, not to rejoice.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Atta nulelendamowi, I do not rejoice	Atta wulelendamowuneen, we do not rejoice
Atta kulelendamowi, thou dost not rejoice	Atta kulelendamohhumo, ye do not rejoice
Atta wulelendamowi, he does not rejoice	Atta wulelendamowunewo, they do not rejoice.

[THIRD CONJUGATION.]

Preterite.

Singular.	*Plural.*
Atta nulelendamowip, I did not rejoice	Atta wulelendamowunenap, we did not rejoice
Atta kulelendamowip, thou didst not rejoice	Atta kulelendamohhumoap, ye did not rejoice
Atta wulelendamowip, he did not rejoice	Atta wulelendamowunewoap, they did not rejoice.

Future.

Singular.	*Plural.*
Atta nulelendamowitsch, I shall *or* will not rejoice	Atta wulelendamowuneentsch, we shall *or* will not rejoice
Atta kulelendamowitsch, thou shalt *or* wilt not rejoice	Atta kulelendamohhumotsch, ye shall *or* will not rejoice
Atta wulelendamowitsch, he shall *or* will not rejoice	Atta wulelendamowunewotsch, they shall *or* will not rejoice.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Atta nulelendamowak, if *or* when I do not rejoice	Atta wulelendamowenke, if *or* when we do not rejoice
Atta wulelendamowane, if *or* when thou dost not rejoice	Atta wulelendamoweque, if *or* when ye do not rejoice
Atta wulelendamoque, if *or* when he does not rejoice	Atta wulelendamichtite, if *or* when they do not rejoice.

Preterite.

Singular.	*Plural.*
Atta nulelendamowakup, if *or* when I did not rejoice	Atta wulelendamowenkup, if *or* when we did not rejoice
Atta kulelendamowannup, if *or* when thou didst not rejoice	Atta wulelendamowekup, if *or* when ye did not rejoice
Atta wulelendamokup, if *or* when he did not rejoice	Atta wulelendawichtikup, if *or* when they did not rejoice.

Pluperfect.

Singular.	*Plural.*
Atta nulelendamowakpanne, if *or* when I had not rejoiced	Atta wulelendamowenkpanne, if *or* when we had not rejoiced
Atta kulelendamowanpanne, if *or* when thou hadst not rejoiced	Atta wulelendamowekpanne, if *or* when ye had not rejoiced
Atta wulelendamowakpanne, if *or* when he had not rejoiced	Atta wulelendamichtitpanne, if *or* when they had not rejoiced.

The Future

Is formed like the present, with *sch* suffixed.

The following verbs may easily be conjugated according to the foregoing rule :

Tipelendam, to have enough, to be satiated	Schingelendam, to be tired of, to dislike, something
Tschanelendam, to be considering, to be in doubt	

Schachachgelendam, to have one's mind made up, to be determined
Wingelendam, to be pleased with something
Aptelendam, to grieve to death
Gischelendam, to hatch or meditate something good or bad, to lie
Klakelendam (jocularly) to be rakish, extravagant, dissolute, a good for nothing fellow
Lachauwelendam, to be troubled in mind
Machelendam, to honour a person
Mattelendam, to despise
Miechanelendam, to be ashamed
Miwelendam, to forgive
Wahhellemelendam, to think one's self far off
Gunelendam, to think it a long time
Pechuwelendam, to think one's self near
Sacquelendam, to be melancholy, sad
Apuelendam, to think something or labour easy
Achowelendam, to think something difficult
Kitelendam, to be in earnest
Komelendam, to be free from trouble *or* care
Tschipelendam, to think a person disagreeable
Ayanhelendam, to be indifferent
Niskelendam, to loathe something
Kschiechelendam, kschiechelensin, to think one's self free from sin *or* stain, to think one's self holy, pious, clean
Uschuwelendam, to be overwhelmed with care or trouble
Allacquelendam, to be repentant even to despair
Quesquelendam, to be out of humour
Yechauwelendam, to love better, to prefer
Allowelendam, to prize something above all other things
Ksinelendam, to be easy, without care.

Fourth Conjugation.

No. I.

GATTAMEN, to desire, long for.

POSITIVE FORM.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'gattamen, I desire	Gattatameneen *or* n'gattatamohhena, we desire
Gattatamen, thou desirest	Gattatamohhumo, ye desire
Gottatamen, he desires	Gattatamenewo, they desire.

Preterite.

Singular.	*Plural.*
N'gattatamenep, I desired	Gattatamenap *or* gattamohhenap, we desired
Gattatamenep, thou desiredst	Gattatamohhumoap, ye desired
Gottatameneep, he desired	Gattatamenowoap, they desired.

Future.

Singular.	*Plural.*
N'gattatamtsch, I shall *or* will desire	N'gattatamohhenatsch, we shall *or* will desire
Gattatamtsch, thou shalt *or* wilt desire	Gattatamohhumotsch, ye shall *or* will desire
Gottatamtsch, he shall *or* will desire	Gattatamenewotsch, they shall *or* will desire.

IMPERATIVE MOOD.

Singular.	*Plural.*
Gattati,	Gattatook *or* gattatamook.

The Imperative Mood is used in these verbs by way of exhortation, as come now, be diligent, industrious, &c.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
N'gattatama, if *or* when I desire	Gattatamenk *or* gattatamenke, if *or* when we desire
Gattatamane, if *or* when thou desirest	Gattatameque, if *or* when ye desire
Getatanke, if *or* when he desires	Gattatamichtite, if *or* when they desire.

Preterite.

Singular.	*Plural.*
Gattatamakup, if *or* when I desired	Gattatamenkup, if *or* when we desired
Gattatamanup, if *or* when thou desiredst	Gattatamekup, if *or* when ye desired
Getatankup, if *or* when he desired	Gattatamichtitup, if *or* when they desired.

Pluperfect.

Singular.	*Plural.*
Gattatamakpanne, if *or* when I had desired	Gattatamenkpanne, if *or* when we had desired
Gattatamanpanne, if *or* when thou hadst desired	Gattatamekpanne, if *or* when ye had desired
Getatankpanne, if *or* when he had desired	Gattatamichtitpanne, if *or* when they had desired.

Future.

Singular.	*Plural.*
Gattatamaktsch, if *or* when I shall desire	Gattatamenketsch, if *or* when we shall desire
Gattatamantsch, if *or* when thou shalt desire	Gattatamequetsch, if *or* when ye shall desire
Gattatanktsch, if *or* when he shall desire	Gattatamichtitetsch, if *or* when they shall desire.

NEGATIVE FORM.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Atta n'gattatamowi, I do not desire	Atta gattatamowuneen, we do not desire
Atta gattatamowi, thou dost not desire	Atta gattatamohhumowi, ye do not desire
Atta gottatamowi, he does not desire	Atta gattatamowunewo, they do not desire.

Preterite.

Singular.	*Plural.*
Atta n'gattatamowip, I did not desire	Atta gattatamowunenap, we did not desire
Atta gattatamowip, thou didst not desire	Atta gattatamohhumoap, ye did not desire
Atta gottatamowip, he did not desire	Atta gattatamowunewoap *or* gattatamowipannik, they did not desire.

Future.

Singular.	*Plural.*
Atta n'gattatamowitsch, I shall not desire	Atta gattatamowuneentsch, we shall not desire
Atta gattatamowitsch, thou shalt not desire	Atta gattatamohhumotsch, ye shall not desire
Atta gottatamowitsch, he shall not desire	Atta gattatamowunewotsch, they shall not desire.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Atta gattatamowak, if *or* when I do not desire	Atta gattatamowenke, if *or* when we do not desire
Atta gattatamowane, if *or* when thou dost not desire	Atta gattatamoweque, if *or* when ye do not desire
Atta gattatamoque, if *or* when he does not desire	Atta gattatamichtite, if *or* when they do not desire.

Preterite.

Singular.	*Plural.*
Atta gattatamowakup, if *or* when I did not desire	Atta gattatamowenkup, if *or* when we did not desire
Atta gattatamowannup, if *or* when thou didst not desire	Atta gattatamowekup, if *or* when ye did not desire
Atta gattatamokup, if *or* when he did not desire	Atta gattatamichtitup, if *or* when they did not desire.

Pluperfect.

Singular.	*Plural.*
Atta gattatamowakpanne, if *or* when I had not desired	Atta gattatamowenkpanne, if *or* when we had not desired
Atta gattatamowanpanne, if *or* when thou hadst not desired	Atta gattatamowekpanne, if *or* when ye had not desired
Atta gattatamowakpanne, if *or* when he had not desired	Atta gattatamichtitpanne, if *or* when ye had not desired.

Future.

Singular.	*Plural.*
Atta gattatamowaktsch, if *or* when I shall not desire	Atta gattatamowenketsch, if *or* when we shall not desire
Atta gattatamowannetsch, if *or* when thou shalt not desire	Atta gattatamowequetsch, if *or* when ye shall not desire
Atta gattatamoquetsch, if *or* when he shall not desire	Atta gattatamichtitetsch, if *or* when they shall not desire.

No. II.

PENDAMEN, to hear.

Note by the Translator.—This verb is given here in a variety of forms, active, passive, reciprocal, transitive, reflected, and adverbial; all, except the two last, in the positive and the negative. It will be easily perceived that if all the verbs were presented in the different forms of which they are capable, with all their moods, tenses, and other combinations, a grammar of this language might be swelled to an enormous size, to avoid which the Author, as may be observed, has frequently abridged his paradigms, and it must not be supposed that it always follows, because a particular form of a verb is not given in its conjugation, that it is not susceptible of it.

POSITIVE FORM.

INFINITIVE MOOD.

Pendamen, to hear*.

PARTICIPLES.

(Not given.)

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'pendamen *or* n'pendam, I hear†	N'pendameneen, we hear
K'pendamen, thou hearest	K'pendamohhumo, ye hear
Pendamen, he hears	Pendamenewo, they hear.

Preterite.

Singular.	*Plural.*
N'pendamenep, I did hear	N'pendamohhenap, we did hear
K'pendamenep, thou didst hear	K'pendamohhumoap, ye did hear
Pendamenep, he did hear	Pendamenewoap, they did hear.

* *Note by the Translator.*—The late Professor Vater, to whom I communicated a manuscript of Mr Zeisberger, containing the conjugation of this verb and a few others, inserted them in his *Analekten der Sprachenkunde*, 2d half of the 2d part; but ascribed them by mistake to the *Chippeway* language, when, in fact, they belong to the Delaware.

† *Note by the Translator.*—From this verb and *wulit*, good, well, is formed *nulipendam*, I hear *or* understand well. A part of the word *wulit* is interposed between the pronoun and the verb.

Future.

Singular.	*Plural.*
N'pendamentsch, I shall hear	N'pendameneentsch, we shall hear
K'pendamentsch, thou shalt hear	K'pendamohumotsch, ye shall hear
Pendamentsch, he shall hear	Pendamenewotsch, they shall hear.

IMPERATIVE MOOD.

Singular.	*Plural.*
Penda, hear thou	Pendamook, hear ye.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Pendama *or* pendamaya, if *or* when I hear	Pendamenk *or* pendamenke, if *or* when we hear
Pendamane, if *or* when thou hearest	Pendamenque, if *or* when ye hear
Pendanke, if *or* when he hears	Pendamichtite, if *or* when they hear.

Preterite.

Singular.	*Plural.*
Pendamakup, if *or* when I did hear	Pendamenkup, if *or* when we did hear
K'pendamanup, if *or* when thou didst hear	Pendamekup, if *or* when ye did hear
Pendankup, if *or* when he did hear	Pendamichtitup, if *or* when they did hear.

Pluperfect.

Singular.	*Plural.*
Pendamakpanne, if *or* when I had heard	Pendamenkpanne, if *or* when we had heard
Pendamanpanne, if *or* when thou hadst heard	Pendamekpanne, if *or* when ye had heard
Pendankpanne, if *or* when he had heard	Pendamichtitpanne, if *or* when they had heard.

Future.

Singular.	*Plural.*
Pendamaktsch, if *or* when I shall hear	Pendamenketsch, if *or* when we shall hear
K'pendamantsch, if *or* when thou shalt hear	Pendamequetsch, if *or* when ye shall hear
Pendanktsch, if *or* when he shall hear	Pendamichtitetsch, if *or* when they shall hear.

NEGATIVE FORM.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Atta n'pendamowi, I do not hear	Atta n'pendamowuneen, we do not hear
Atta k'pendamowi, thou dost not hear	Atta k'pendamohumowi, ye do not hear
Atta pendamowi, he does not hear	Atta pendamowunewo, they do not hear.

Preterite.

Singular.	*Plural.*
Atta n'pendamowip, I did not hear	Atta n'pendamenenap, we did not hear
Atta k'pendamowip, thou didst not hear	Atta k'pendamowunewoap, ye did not hear
Atta pendamowip, he did not hear	Atta pendamowunewoap, they did not hear.

Future.

Singular.	*Plural.*
Mattatsch n'pendamowi, I shall *or* will not hear	Mattatsch pendamowuneen, we shall *or* will not hear
Mattatsch k'pendamowi, thou shalt *or* wilt not hear	Mattatsch k'pendamohumowi, ye shall *or* will not hear
Mattatsch pendamowi, he shall *or* will not hear	Mattatsch pendamowunewo, they shall *or* will not hear.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Atta n'pendamowak, if *or* when I do not hear	Atta pendamowenke, if *or* when we do not hear
Atta pendamowane, if *or* when thou dost not hear	Atta pendamoweque, if *or* when ye do not hear
Atta pendamoque, if *or* when he does not hear	Atta pendamichtite, if *or* when they do not hear.

Preterite.

Singular.	*Plural.*
Atta pendamowakup, if *or* when I have not heard	Atta pendamowenkup, if *or* when we have not heard
Atta pendamowannup, if *or* when thou hast not heard	Atta k'pendamowekup, if *or* when ye have not heard
Atta pendamokup, if *or* when he has not heard	Atta pendamichtitup, if *or* when they have not heard.

Pluperfect.

Singular.	*Plural.*
Atta pendamowakpanne, if *or* when I had not heard	Atta pendamowenkpanne, if *or* when we had not heard
Atta k'pendamowanpanne, if *or* when thou hadst not heard	Atta k'pendamowekpanne, if *or* when ye had not heard
Atta pendamowakpanne, if *or* when he had not heard	Atta pendamichtitpanne, if *or* when they had not heard.

Future.

Singular.	*Plural.*
Atta n'pendamowaktsch, if *or* when I shall *or* will not hear	Atta pendamowenketsch, if *or* when we shall *or* will not hear
Atta k'pendamowantsch, if *or* when thou shalt *or* wilt not hear	Atta pendamowequetsch, if *or* when ye shall *or* will not hear
Atta pendamoquetsch, if *or* when he shall *or* will not hear	Atta pendamichtitetsch, if *or* when they shall *or* will not hear.

PASSIVE FORM.—POSITIVE.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'pendaxi, I am heard	N'pendaxihhena, we are heard
K'pendaxi, thou art heard	K'pendaxihhimo, ye are heard
Pendaxu *or* pendaquol, he is heard	Pendaxowak, they are heard.

Preterite.

Singular.	*Plural.*
N'pendaxihump, I was heard	N'pendaxihhenakup, we were heard
K'pendaxihump, thou wast heard	K'pendaxihhimoakup, ye were heard
Pendaxop *or* pendaquachtop, he was heard	Pendaxopannik, they were heard.

Future.

Singular.	*Plural.*
N'pendaxitsch, I shall *or* will be heard	N'pendaxihhenatsch, we shall *or* will be heard
K'pendaxitsch, thou shalt *or* wilt be heard	K'pendaxihhimotsch, ye shall *or* will be heard
Pendaxutsch *or* pendaquotsch, he shall *or* will be heard	Pendaxiwiwaktsch, they shall *or* will be heard

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Pendaxia, if *or* when I am heard	Pendaxiyenke, if *or* when we are heard
Pendaxiane, if *or* when thou art heard	Pendaxiyeque, if *or* when ye are heard
Pendaxite, if *or* when he is heard	Pendaxichtite, if *or* when they are heard.

Preterite.

Singular.	*Plural.*
Pendaxiakup, if *or* when I was heard	Pendaxiyenkup, if *or* when we were heard
Pendaxiannup, if *or* when thou wert heard	Pendaxiyekup, if *or* when ye were heard
Pendaxitup, if *or* when he was heard	Pendaxichtitup, if *or* when they were heard.

Pluperfect.

Singular.	*Plural.*
Pendaxiakpanne, if *or* when I had been heard	Pendaxiyenkpanne, if *or* when we had been heard
Pendaxianpanne, if *or* when thou hadst been heard	Pendaxiyekpanne, if *or* when ye had been heard
Pendaxitpanne, if *or* when he had been heard	Pendaxichtitpanne, if *or* when they had been heard.

Future.

Singular.	*Plural.*
N'pendaxiatsch, if *or* when I shall be heard	Pendaxiyenketsch, if or when we shall be heard
K'pendaxianetsch, if *or* when thou shalt be heard	Pendaxiyequetsch, if or when ye shall be heard
Pendaxitetsch, if *or* when he shall be heard	Pendaxichtitetsch, if *or* when they shall be heard.

[FOURTH CONJUGATION.]

NEGATIVE.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Matta n'pendaxiwi, I am not heard	Matta pendaxiwuneen, we are not heard
Matta k'pendaxiwi, thou art not heard	Matta k'pendaxihhumo, ye are not heard
Matta pendaxuwi, he is not heard	Matta pendaxiwiwak, they are not heard.

Preterite.

Singular.	*Plural.*
Matta n'pendaxiwip, I was not heard	Matta n'pendaxiwiwunap, we were not heard
Matta k'pendaxiwip, thou wast not heard	Matta k'pendaxiwunewo, ye were not heard
Matta pendaxuwip *or* pendaquachtowip, he was not heard	Matta pendaxiwipannik, they were not heard.

Future.

Singular.	*Plural.*
Mattatsch n'pendaxiwi, I shall *or* will not be heard	Mattatsch n'pendaxiwuneen, we shall *or* will not be heard
Mattatsch k'pendaxiwi, thou shalt *or* wilt not be heard	Mattatsch k'pendaxihhumo, ye shall *or* will not be heard
Mattatsch pendaxuwi, he shall *or* will not be heard	Mattatsch pendaxiwiwak, they shall *or* will not be heard.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Atta n'pendaxiwa, if *or* when I am not heard	Atta pendaxiwenke, if *or* when we are not heard
Atta pendaxiwanne, if *or* when thou art not heard	Atta pendaxiweque, if *or* when ye are not heard
Atta pendaxite, if *or* when he is not heard	Atta pendaxichtite, if *or* when they are not heard.

Preterite.

Singular.	*Plural.*
Atta n'pendaxiwakup, if *or* when I was not heard	Atta pendaxiwenkup, if *or* when we were not heard
Atta k'pendaxiwannup, if *or* when thou wert not heard	Atta pendaxiwekup, if *or* when ye were not heard
Atta pendaxitup, if *or* when he was not heard	Atta pendaxichtitup, if *or* when they were not heard.

Pluperfect.

Singular.	*Plural.*
Atta pendaxiwakpanne, if *or* when I had not been heard	Atta pendaxiwenkpanne, if *or* when we had not been heard
Atta pendaxiwanpanne, if *or* when thou hadst not been heard	Atta pendaxiwekpanne, if *or* when ye had not been heard
Atta pendaxuwipanne, if *or* when he had not been heard	Atta pendaxichtitpanne, if *or* when they had not been heard.

Future.

Singular.	*Plural.*
Atta pendaxiwaktsch, if *or* when I shall not be heard	Atta pendaxiwenketsch, if *or* when we shall not be heard
Atta pendaxiwannetsch, if *or* when thou shalt not be heard	Atta pendaxiwenquetsch, if *or* when ye shall not be heard
Atta pendaxiquetsch, if *or* when he shall not be heard	Atta pendaxichtitetsch, if *or* when they shall not be heard.

RECIPROCAL FORM.—POSITIVE.

INFINITIVE MOOD.

Present.

Pendawachtin, to hear each other

Preterite.

Pendawachtinep, to have heard each other.

Future.

Pendawaktitsch, to be to hear each other.

INDICATIVE MOOD.

Present.

Pendawachtineen *or* pendawachtihhena, we hear each other
Pendawachtihhimo, ye hear each other
Pendawachtowak, they hear each other.

Preterite.

Pendawachtihhenakup *or* pendawachtihhummenakup, we heard each other
Pendawachtohhimoakup, ye heard each other
Pendawachtopannik, they heard each other.

Future.

Pendawachtihhenatsch, we shall *or* will hear each other
Pendawachtihhimotsch, ye shall *or* will hear each other
Pendawachtowaktsch, they shall *or* will hear each other.

IMPERATIVE MOOD.

Present.

Pendawachtik, hear ye there (what the other is saying)
Pendawachtitam, let us hear each other.

Future.

Pendawachtichtitetsch, they shall *or* must *or* let them hear each other.

SUBJUNCTIVE MOOD.

Present.

Pendawachtiyenk *or* pendawachtiyenque, if *or* when we hear each other
Pendawachtiyek *or* pendawachtiyeque, if *or* when ye hear each other
Pendawachtichtit, if *or* when they hear each other.

Preterite.

Pendawachtiyenkup, if *or* when we heard each other
Pendawachtiyekup, if *or* when ye heard each other
Pendawachtichtitup, if *or* when they heard each other.

[FOURTH CONJUGATION.]

Pluperfect.

Pendawachtiyenkpanne, if *or* when we had heard each other
Pendawachtiyekpanne, if *or* when ye had heard each other
Pendawachtichtitpanne, if *or* when they had heard each other.

Future.

Pendawachtiyenketsch, if *or* when we shall *or* will hear each other
Pendawachtiyequetsch, if *or* when ye shall *or* will hear each other
Pendawaktichtitetsch, if *or* when they shall *or* will hear each other.

NEGATIVE.

INDICATIVE MOOD.

Present.

Atta pendawachtiwuneen, we do not hear each other
Atta pendawachtiwek, ye do not hear each other
Atta pendawachtiwiwak, they do not hear each other.

Preterite.

Atta pendawachtiwunenap, we did not hear each other
Atta pendawachtiwihhimoap, ye did not hear each other
Atta pendawachtiwipannik, they did not hear each other.

Future.

Atta pendawachtiwuneentsch, we shall *or* will not hear each other
Atta pendawachtiwihhimotsch, ye shall *or* will not hear each other
Atta pendawachtiwiwaktsch, they shall *or* will not hear each other.

IMPERATIVE MOOD.

Katschi* pendawachtihek, do not hear each other.

SUBJUNCTIVE MOOD.

Present.

Atta pendawachtiwenke, if *or* when we do not hear each other
Atta pendawachtiweque, if *or* when ye do not hear each other
Atta pendawachtichtite, if *or* when they do not hear each other.

Preterite.

Atta pendawachtiwenkup, if *or* when we did not hear each other
Atta pendawachtiwekup, if *or* when ye did not hear each other
Atta pendawachtichtitup, if *or* when they did not hear each other.

Pluperfect.

Atta pendawachtiwenkpanne, if *or* when we had not heard each other
Atta pendawachtiwekpanne, if *or* when ye had not heard each other
Atta pendawachtichtitpanne, if *or* when they had not heard each other.

Future.

Atta pendawachtiwenketsch, if *or* when we shall *or* will not hear each other
Atta pendawachtiwequetsch, if *or* when ye shall *or* will not hear each other
Atta pendawachtichtitetsch, if *or* when they shall *or* will not hear each other.

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* *Note by the Translator.—Katschi* is a word of prohibition, as in English *don't*, and appears to be compounded from *atta.* The Author classes it with adverbs. See below, *adverbs of negation, prohibition.*

REFLECTED FORM.

There is also a reflected form of the verb :

As

N'penda n'hakey*, I hear myself
K'pendawa hakey, thou hearest thyself
Pendawawall hokeyall, he hears himself.

Likewise

N'dahowala n'hakey, I love myself
K'dahowala hakey, thou lovest thyself
W'dahoalawall *or* w'dahowalawall hokeyall, he loves himself.

PERSONAL FORMS OR TRANSITIONS.

In order to enable the reader to compare these forms in the positive and negative voices, they are placed here in opposition to each other.

FIRST TRANSITION.

First Person Singular, I.

INDICATIVE MOOD.

Present.

POSITIVE.	*NEGATIVE.*
K'pendolen, I hear thee	Atta k'pendolowi, I hear not thee
N'pendawa, I hear him	Atta n'pendawawi, I hear not him
K'pendolohhumo, I hear you	Atta k'pendolhummowi, I hear not you
N'pendawawak, I hear them.	Atta n'pendawawiwak, I hear not them.

Preterite.

K'pendolenep, I did hear thee	Atta k'pendolowip, I heard not thee
N'pendawap, I did hear him	Atta n'pendawawip, I heard not him
K'pendolohhumoap, I did hear you	Atta k'pendolohummowip, I heard not you.
N'pendawoapannik, I did hear them.	Atta n'pendawawipannik, I heard not them.

Future.

K'pendolentsch, I shall *or* will hear thee	Atta k'pendolowitsch, I shall *or* will not hear thee
N'pendawatsch, I shall *or* will hear him	Atta n'pendawawitsch, I shall *or* will not hear him
K'pendolohhumotsch, I shall *or* will hear you	Atta k'pendolhummowitsch, I shall *or* will not hear you
N'pendawawaktsch, I shall *or* will hear them.	Atta n'pendawawiwaktsch, I shall *or* will not hear them.

* *Note by the Translator.—N'hakey* signifies literally "my body," which is synonymous to "my person," or "myself" In English we say "somebody, nobody," for *aliquis, nemo.* There is nothing *barbarous* in those words.

[FOURTH CONJUGATION.]

SUBJUNCTIVE MOOD.

Present.

POSITIVE.	*NEGATIVE.*
K'pendolane, if *or* when I hear thee	Atta pendolowonne, if *or* when I do not hear thee
Pendawake, if *or* when I hear him	Atta n'pendamawonne, if *or* when I do not hear him
Pendoleque, if *or* when I hear you	Atta n'pendoleque, if *or* when I do not hear you
Pendawawake, if *or* when I hear them.	Atta n'pendawawiwonne, if *or* when I do not hear them.

Preterite.

K'pendolannup, if *or* when I did hear thee	Atta pendolowonnup, if *or* when I did not hear thee
N'pendawakup, if *or* when I did hear him	Atta n'pendamawonnup, if *or* when I did not hear him
N'pendolekup, if *or* when I did hear you	Atta n'pendolekup, if *or* when I did not hear you
K'pendawawakup, if *or* when I did hear them.	Atta n'pendawawiwonnup, if *or* when I did not hear them.

Pluperfect.

K'pendolanpanne, if *or* when I had heard thee	Atta pendolowonpanne, if *or* when I had not heard thee
N'pendawakpanne, if *or* when I had heard him	Atta n'pendamawonpanne, if *or* when I had not heard him
Pendolekpanne, if *or* when I had heard you	Atta pendolowekpanne, if *or* when I had not heard you
N'pendawawakpanne, if *or* when I had heard them.	Atta pendawawipanne, if *or* when I had not heard them.

Future.

K'pendolanetsch, if *or* when I shall *or* will hear thee	Atta n'pendolowonnetsch, if *or* when I shall *or* will not hear thee
N'pendawanetsch, if *or* when I shall *or* will hear him	Atta n'pendamawonnetsch, if *or* when I shall *or* will not hear him
N'pendolequetsch, if *or* when I shall *or* will hear you	Atta n'pendolowequetsch, if *or* when I shall *or* will not hear you
N'pendawawaketsch, if *or* when I shall *or* will hear them.	Atta n'pendawawiwonnetsch, if *or* when I shall *or* will not hear them.

SECOND TRANSITION.

Second Person Singular, THOU.

INDICATIVE MOOD.

Present.

K'pendawi, thou hearest me	Atta k'pendawiwi, thou hearest not me
K'pendawa, thou hearest him	Atta k'pendawawi, thou hearest not him
K'pendawihhena, thou hearest us	Atta k'pendawiwuneen, thou hearest not us
K'pendawawak, thou hearest them.	Atta k'pendawawiwak, thou hearest not them.

Preterite.

POSITIVE.	*NEGATIVE.*
K'pendawinep, thou didst hear me	Atta k'pendawiwip, thou didst not hear me
K'pendawap, thou didst hear him	Atta k'pendawawip, thou didst not hear him
K'pendawihhenap, thou didst hear us	Atta k'pendawiwunap, thou didst not hear us
K'pendawoapannik, thou didst hear them.	Atta k'pendawawapannik, thou didst not hear them.

Future.

K'pendawitsch, thou shalt *or* wilt hear me	Atta k'pendawiwitsch, thou shalt *or* wilt not hear me
K'pendawatsch, thou shalt *or* wilt hear him	Atta k'pendawawitsch, thou shalt *or* wilt not hear him
K'pendawihhenatsch, thou shalt *or* wilt hear us	Atta k'pendawiwuneentsch, thou shalt *or* wilt not hear us
K'pendawawaktsch, thou shalt *or* wilt hear them.	Atta k'pendawawiwaktsch, thou shalt *or* wilt not hear them.

SUBJUNCTIVE MOOD.

Present.

K'pendawiyane, if *or* when thou hearest me	Atta k'pendawiwonne, if *or* when thou dost not hear me
K'pendawane, if *or* when thou hearest him	Atta k'pendawawonne, if *or* when thou dost not hear him
K'pendawiyenk, if *or* when thou hearest us	Atta k'pendakuwenque, if *or* when thou dost not hear us
K'pendawawonne, if *or* when thou hearest them.	Atta k'pendawawiwonne, if *or* when thou dost not hear them.

Preterite.

K'pendawiyanup, if *or* when thou didst hear me	Atta k'pendawiwonnup, if *or* when thou didst not hear me
K'pendawanup, if *or* when thou didst hear him	Atta k'pendawawonnup, if *or* when thou didst not hear him
K'pendawiyenkup, if *or* when thou didst hear us	Atta k'pendawenkup, if *or* when thou didst not hear us
K'pendawawawonnup, if *or* when thou didst hear them.	Atta k'pendawawiwonnup, if *or* when thou didst not hear them.

Pluperfect.

K'pendawiyanpanne, if *or* when thou hadst heard me	Atta k'pendawiwonpanne, if *or* when thou hadst not heard me
K'pendawanpanne, if *or* when thou hadst heard him	Atta k'pendawonpanne, if *or* when thou hadst not heard him
K'pendawiyenkpanne, if *or* when thou hadst heard us	Atta k'pendawenkpanne, if *or* when thou hadst not heard us
K'pendawawawonpanne, if *or* when thou hadst heard them.	Atta k'pendawawiwonpanne, if *or* when thou hadst not heard them.

Future.

POSITIVE.	*NEGATIVE.*
K'pendawiyanetsch, if *or* when thou shalt *or* wilt hear me	Atta k'pendawiwonnetsch, if *or* when thou shalt *or* wilt not hear me
K'pendawanetsch, if *or* when thou shalt *or* wilt hear him	Atta k'pendawawonnetsch, if *or* when thou shalt *or* wilt not hear him
K'pendawiyenquetsch, if *or* when thou shalt *or* wilt hear us	Atta k'pendawenquetsch, if *or* when thou shalt *or* wilt not hear us
K'pendawawawonnetsch, if *or* when thou shalt *or* wilt hear them.	Atta k'pendawawiwonnetsch, if *or* when thou shalt *or* wilt not hear them.

THIRD TRANSITION.

Third Person Singular, HE.

INDICATIVE MOOD.

Present.

N'pendagun, he hears me	Atta n'pendagowi, he does not hear me
K'pendagun, he hears thee	Atta k'pendagowi, he does not hear thee
Pendagol, he hears him	Atta pendamawi, he does not hear him
Pendaguna, he hears us	Atta pendaguwuneen, he does not hear us
K'pendaguwa, he hears you	Atta k'pendaguwawi, he does not hear you
Pendawawak, he hears them.	Atta pendawawiwak, he does not hear them.

Preterite.

N'pendagop, he heard *or* did hear me	Atta n'pendagowip, he did not hear me
K'pendagop, he heard *or* did hear thee	Atta pendagowip, he did not hear thee
Pendagop *or* pendap, he heard *or* did hear him	Atta pendawawip, he did not hear him
N'pendagunap, he heard *or* did hear us	Atta n'pendaguwuneenap, he did not hear us
Pendaguwap, he heard *or* did hear you	Atta pendaguwawip, he did not hear you
Pendawapannik, he heard *or* did hear them.	Atta n'pendawawipannik, he did not hear them.

Future.

N'pendaguktsch, he shall *or* will hear me	Atta n'pendagowitsch, he shall *or* will not hear me
K'pendaguktsch, he shall *or* will hear thee	Atta k'pendagowitsch, he shall *or* will not hear thee
Pendagoltsch, he shall *or* will hear him	Atta pendawawitsch, he shall *or* will not hear him
N'pendagunatsch, he shall *or* will hear us	Atta pendaguwuneentsch, he shall *or* will not hear us
K'pendaguwatsch, he shall *or* will hear you	Atta k'pendaguwawitsch, he shall *or* will not hear you
Pendawawaktsch, he shall *or* will hear them.	Atta pendawawiwaktsch, he shall *or* will not hear them.

[FOURTH CONJUGATION.]

SUBJUNCTIVE MOOD.

Present.

POSITIVE.	*NEGATIVE.*
Pendawite, if *or* when he heareth me	Atta pendawique, if *or* when he does not hear me
Pendagake, if *or* when he heareth thee	Atta pendaquonne, if *or* when he does not hear thee
Pendawate, if *or* when he heareth him	Atta pendawaque, if *or* when he does not hear him
Pendaquenke, if *or* when he heareth us	Atta pendaguwonque, if *or* when he does not hear us
Pendaqueque, if *or* when he heareth you	Atta pendaguweque, if *or* when he does not hear you
Pendawachtite, if *or* when he heareth them.	Atta pendawachtique, if *or* when he does not hear them.

Preterite.

Pendawitup, if *or* when he did hear me	Atta pendawikup, if *or* when he did not hear me
Pendagukup, if *or* when he did hear thee	Atta pendaquonnup, if *or* when he did not hear thee
Pendawatup, if *or* when he did hear him	Atta pendawakup, if *or* when he did not hear him
Pendaquenkup, if *or* when he did hear us	Atta pendawenkup, if *or* when he did not hear us
Pendaquekup, if *or* when he did hear you	Atta pendawekup, if *or* when he did not hear you
Pendawachtitup, if *or* when he did hear them.	Atta pendawachtitup, if *or* when he did not hear them.

Pluperfect.

Pendawitpanne if *or* when he had heard me	Atta pendawikpanne, if *or* when he had not heard me
Pendagukpanne, if *or* when he had heard thee	Atta pendaquonpanne, if *or* when he had not heard thee
Pendawatpanne, if *or* when he had heard him	Atta pendawatpanne, if *or* when he had not heard him
Pendayquenkpanne, if *or* when he had heard us	Atta pendaquenkpanne, if *or* when he had not heard us
Pendaquekpanne, if *or* when he had heard you	Atta pendaquekpanne, if *or* when he had not heard you
Pendawachtitpanne, if *or* when he had heard them.	Atta pendawachtitpanne, if *or* when he had not heard them.

Future.

Pendawitetsch, if *or* when he shall *or* will hear me	Attatsch* pendawite, if *or* when he shall *or* will not hear me
Pendaguketsch, if *or* when he shall *or* will hear thee	Attatsch pendaquonne, if *or* when he shall *or* will not hear thee
Pendawatetsch *or* pendagoltsch, if *or* when he shall *or* will hear him	Attatsch pendawaque, if *or* when he shall *or* will not hear him
Pendaquenquetsch, if *or* when he shall *or* will hear us	Attatsch pendaquenque, if *or* when he shall *or* will not hear us
Pendaqueketsch, if *or* when he shall *or* will hear you	Attatsch pendaqueque, if *or* when he shall *or* will not hear you
Pendawachtitsch, if *or* when he shall *or* will hear them.	Attatsch pendawachtite, if *or* when he shall *or* will not hear them.

* *Note by the Translator.*—Here the sign of the future tense, *tsch*, is suffixed to the adverb *not*, and not to the verb.

FOURTH TRANSITION.

First Person Plural, WE.

INDICATIVE MOOD.

Present.

POSITIVE.	*NEGATIVE.*
K'pendoloneen, we hear thee	Atta k'pendolowuneen, we do not hear thee
N'pendawaneen, we hear him	Atta n'pendawawuneen, we do not hear him
K'pendolohhena, we hear you	Atta k'pendolhummowuneen, we do not hear you
N'pendawawunanak, we hear them.	Atta n'pendawawunanak, we do not hear them.

Preterite.

K'pendolonenap *or* k'pendolohhenap, we did hear thee	Atta k'pendolowuneenap, we did not hear thee
N'pendawawunap, we did hear him	Atta n'pendamawunap, we did not hear him
K'pendolohhenap, we did hear you	Atta k'pendolhummowuneenap, we did not hear you
N'pendamawunapannik, we did hear them.	Atta n'pendawawuneenak, we did not hear them.

Future.

K'pendoloneentsch *or* k'pendolohhenatsch, we shall *or* will hear thee	Atta k'pendolowuneentsch, we shall *or* will not hear thee
N'pendawaneentsch, we shall *or* will hear him	Atta n'pendawawuneentsch, we shall *or* will not hear him
K'pendolohhumenatsch, we shall *or* will hear you	Atta k'pendolhumowuneentsch, we shall *or* will not hear you
N'pendawawunanaktsch, we shall *or* will hear them.	Atta n'pendawawunaktsch, we shall or will not hear them.

SUBJUNCTIVE MOOD.

Present.

Pendolenque, if *or* when we hear thee	Atta pendolowonque, if *or* when we do not hear thee
Pendamanque, if *or* when we hear him	Atta pendawanque, if *or* when we do not hear him
Pendolohhumanque, if *or* when we hear you	Atta k'pendamolanque, if *or* when we do not hear you
Pendawamanque, if *or* when we hear them.	Atta pendawawonque, *or* if when we do not hear them.

Preterite.

Pendolenkup, if *or* when we did hear thee	Atta pendolowonkup, if *or* when we did not hear thee
Pendamankup, if *or* when we did hear him	Atta pendawankup, if *or* when we did not hear him
Pendolhumankup, if *or* when we did hear you	Atta k'pendamolekup, if *or* when we did not hear you
Pendawawankup, if *or* when we did hear them.	Atta pendawawankup, if *or* when we did not hear them.

Pluperfect.

POSITIVE.

Pendolenkpanne, if *or* when we had heard thee
Pendamenkpanne, if *or* when we had heard him
Pendolhumopanne, if *or* when we had heard you
Pendamawawonkpanne, if *or* when we had heard them.

NEGATIVE.

Atta pendolowankpanne, if *or* when we had not heard thee
Atta pendawankpanne, if *or* when we had not heard him
Atta pendamowekpanne, if *or* when we had not heard you
Atta pendawawonkpanne, if *or* when we had not heard them.

Future.

Pendolenquetsch, if *or* when we shall *or* will hear thee
Pendamanquetsch, if *or* when we shall *or* will hear him
Pendolohummanquetsch, if *or* when we shall *or* will hear you
Pendawawanquetsch, if *or* when we shall *or* will hear them.

Atta pendolowunatsch, if *or* when we shall *or* will not hear thee
Atta pendawanquetsch, if *or* when we shall *or* will not hear him
Atta pendamolhummotsch, if *or* when we shall *or* will not hear you
Atta pendawawonquetsch, if *or* when we shall *or* will not hear them.

FIFTH TRANSITION.

Second Person Plural, YE.

INDICATIVE MOOD.

Present.

K'pendawihhimo, ye hear me
K'pendawawa, ye hear him
K'pendawihhenook, ye hear us
K'pendawawak, ye hear them.

Atta k'pendawihhimo, ye do not hear me
Atta k'pendawawunewo, ye do not hear him
Atta k'pendawiwuna, ye do not hear us
Atta k'pendawawunewo, ye do not hear them.

Preterite.

K'pendawihhimoakup, ye heard *or* did hear me
K'pendawawap, ye heard *or* did hear him
K'pendawihummenakup, ye heard *or* did hear us
K'pendawawapannik, ye heard *or* did hear them.

Atta k'pendawihhimoap, ye heard not *or* did not hear me
Atta k'pendawawihhimoap, ye heard not *or* did not hear him
Atta k'pendawiwunap, ye heard not *or* did not hear us
Atta k'pendawawunewo, ye heard not *or* did not hear them.

Future.

K'pendawihhimotsch, ye shall *or* will hear me
K'pendawawatsch, ye shall *or* will hear him
K'pendawihummenatsch, ye shall *or* will hear us
K'pendawanewotsch, ye shall *or* will hear them.

Atta k'pendawihhimotsch, ye shall *or* will not hear me
Atta k'pendawawunewotsch, ye shall *or* will not hear him
Atta k'pendawihummenatsch, ye shall *or* will not hear us
Atta k'pendawawunewotsch, ye shall *or* will not hear them.

SUBJUNCTIVE MOOD.

Present.

POSITIVE.	*NEGATIVE.*
K'pendolane, if *or* when ye hear me	Atta pendawiweke, if *or* when ye do not hear me
Pendawake, if *or* when ye hear him	Atta pendamaweque, if *or* when ye do not hear him
Pendoleque, if *or* when ye hear us	Atta pendawonquek, if *or* when ye do not hear us
Pendawawake, if *or* when ye hear them.	Atta pendawiweque, if *or* when ye do not hear them.

Preterite.

K'pendolannup, if *or* when ye did hear me	Atta pendawiwekup, if *or* when ye did not hear me
N'pendawakup, if *or* when ye did hear him	Atta pendamawekup, if *or* when ye did not hear him
N'pendolekup, if *or* when ye did hear us	Atta pendawonquekup, if *or* when ye did not hear us
N'pendawawakup, if *or* when ye did hear them.	Atta pendawawiwekup, if *or* when ye did not hear them.

Pluperfect.

K'pendolanpanne, if *or* when ye had heard me	Atta pendawiwekpanne, if *or* when ye had not heard me
N'pendawakpanne, if *or* when ye had heard him	Atta pendamawekpanne, if *or* when ye had not heard him
Pendolekpanne, if *or* when ye had heard us	Atta pendawonquekpanne, if *or* when he had not heard us
N'pendawawakpanne, if *or* when ye had heard them.	Atta pendawawiwekpanne, if *or* when ye had not heard them.

Future.

K'pendolanetsch, if *or* when ye shall *or* will hear me	Atta pendawiwektsch, if *or* when ye shall *or* will not hear me
N'pendawanetsch, if *or* when ye shall *or* will hear him	Atta pendamawequetsch, if *or* when ye shall *or* will not hear him
N'pendolequetsch, if *or* when ye shall *or* will hear us	Atta pendawonquektsch, if *or* when ye shall *or* will not hear us
N'pendawawaketsch, if *or* when ye shall *or* will hear them.	Atta pendawawiwektsch, if *or* when ye shall *or* will not hear them.

SIXTH TRANSITION.

Third Person Plural, THEY.

INDICATIVE MOOD.

Present.

POSITIVE.	*NEGATIVE.*
N'pendagenewo, they hear me	Atta n'pendaguwiwak, they do not hear me
K'pendaguwak, they hear thee	Atta k'pendaguwiwak, they do not hear thee
Pendawawall, they heard him	Atta pendawawiwak, they do not hear him
Pendageneen, they heard us	Atta pendaguwuneen, they do not hear us
Pendaguwawak, they heard you	Atta pendaguwawiwak, they do not hear you
Pendawawawall, they heard them.	Atta pendawawiwak, they do not hear them.

Preterite.

N'pendagopannik, they heard me	Atta n'pendagewip, they did not hear me
K'pendagopannik, they heard thee	Atta k'pendagewip, they did not hear thee
Pendawawoapannik, they heard him	Atta pendawawip, they did not hear him
Pendagunapannik, they heard us	Atta pendaguwunenap, they did not hear us
Pendaguwapannik, they heard you	Atta pendaguwawip, they did not hear you
Pendawawapannik, they heard them.	Atta pendawawipannik, they did not hear them.

Future.

N'pendagunewotsch, they shall *or* will hear me	Atta n'pendaguwiwaktsch, they shall *or* will not hear me
Pendagooktsch, they shall *or* will hear thee	Atta k'pendaguwiwaktsch, they shall *or* will not hear thee
Pendawawaktsch, they shall *or* will hear him	Atta pendawawiwaktsch, they shall *or* will not hear him
Pendaguneentsch, they shall *or* will hear us	Atta pendaguwuneentsch, they shall *or* will not hear us
Pendaguhhimotsch, they shall *or* will hear you	Atta pendaguwawitsch, they shall *or* will not hear you
Pendawawaktsch, they shall *or* will hear them.	Atta pendawawiwaktsch, they shall *or* will not hear them.

IMPERATIVE MOOD.

Sing. Pendawil, do thou hear me	*(Not given.)*
Sing. with Plur. Pendawik, do ye hear me	
Plur. Pendawineen, hear us.	

[FOURTH CONJUGATION.]

SUBJUNCTIVE MOOD.

Present.

POSITIVE.	*NEGATIVE.*
Pendamichtite, if *or* when they hear me	Atta pendamichtike, if *or* when they do not hear me
Pendageyane, if *or* when they hear thee	Atta pendagewichtike, if *or* when they do not hear thee
Pendawachtit, if *or* when they hear him	Atta pendawachtike, if *or* when they do not hear him
Pendageyenke, if *or* when they hear us	Atta pendagewenke, if *or* when they do not hear us
Pendageyeque, if *or* when they hear you	Atta pendageweque, if *or* when they do not hear you
Pendawawachtite, if *or* when they hear them.	Atta pendawawachtite, if *or* when they do not hear them.

Preterite.

Pendamichtitup, if *or* when they heard me	Atta pendagewichtikup, if *or* when they do not hear me
Pendageyannup, if *or* when they heard thee	Atta k'pendagewichtikup, if *or* when they do not hear thee
Pendawachtitup, if *or* when they heard him	Atta pendawachtikup, if *or* when they do not hear him
Pendageyenkup, if *or* when they heard us	Atta pendakewenkup, if *or* when they do not hear us
Pendageyekup, if *or* when they heard you	Atta pendagewekup, if *or* when they do not hear you
Pendawawachtitup, if *or* when they heard them.	Atta pendawawichtitup, if *or* when they do not hear them.

Pluperfect.

Pendamichtitpanne, if *or* when they had heard me	Atta pendamichtikpanne, if *or* when they had not heard me
Pendakhittitpanne, if *or* when they had heard thee	Atta pendagewichtikpanne, if *or* when they had not heard thee
Pendawachtitpanne, if *or* when they had heard him	Atta pendawachtikpanne, if *or* when they had not heard him
Pendageyenkpanne, if *or* when they had heard us	Atta pendagewenkpanne, if *or* when they had not heard us
Pendageyekpanne, if *or* when they had heard you	Atta k'pendagewekpanne, if *or* when they had not heard you
Pendawawachtitpanne, if *or* when they had heard them.	Atta pendawawichtikpanne, if *or* when they had not heard them.

Future.

Pendamichtitsch, if *or* when they shall *or* will hear me	Atta pendamichtiketsch, if *or* when they shall *or* will not hear me
Pendakhittitsch, if *or* when they shall *or* will hear thee	Atta pendagewichtiktsch, if *or* when they shall *or* will not hear thee
Pendawachtitsch, if *or* when they shall *or* will hear him	Atta pendawawichtiktsch, if *or* when they shall *or* will not hear him
Pendageyenktsch, if *or* when they shall *or* will hear us	Atta pendagewenktsch, if *or* when they shall *or* will hear us
Pendageyektsch, if *or* when they shall *or* will hear you	Atta pendagewektsch, if *or* when they shall *or* will hear you
Pendawawachtitsch, if *or* when they shall *or* will hear them.	Atta pendawawichtiketsch, if *or* when they shall *or* will hear them.

No. III.

NIHILLATAMEN, I own *or* am master of.

ACTIVE FORM.

INFINITIVE MOOD.

(*Not given.*)

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Nihillatamen, I own	Nihillatameneen, we own
K'nihillatamen, thou ownest	K'nihillatohhimo, ye own
W'nihillatamen, he owns	Nihillatamenewo, they own.

Preterite.

Singular.	*Plural.*
Nihillatameneep, I did own	Nihillatamohhummoakup, we did own
K'nihillatameneep, thou didst own	K'nihillatamohhummoakup, ye did own
W'nihillatameneep, he did own	Nihillatamenewoakup, they did own.

Future.

Singular.	*Plural.*
Nihillatamentsch, I shall *or* will own	Nihillatameneentsch, we shall *or* will own
K'nihillatamentsch, thou shalt *or* wilt own	K'nihillatamohhumotsch, ye shall *or* will own
Wunihillatamentsch, he shall *or* will own	Nihillatamenewotsch, they shall *or* will own.

IMPERATIVE MOOD.

Singular.	*Plural.*
Nihillalil, own me, let me belong to thee	Nihillalineen, own us.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Nihillatamane, if *or* when it belongs to me	Nihillatamenke, if *or* when it belongs to us
K'nihillatamane, if *or* when it belongs to thee	Nihillatameque, if *or* when it belongs to you
Nihillatanke, if *or* when it belongs to him	Nihillatamichtite, if *or* when it belongs to them.

Preterite.

Singular.	*Plural.*
Nihillatamanup, if *or* when it belonged to me	Nihillatamenkup, if *or* when it belonged to us
K'nihillatamanup, if *or* when it belonged to thee	Nihillatamekup, if *or* when it belonged to you
Nihillatankup, if *or* when it belonged to him	Nihillatamichtitup, if *or* when it belonged to them.

Pluperfect.

Singular.	*Plural.*
Nihillatamanpanne, if *or* when it had belonged to me	Nihillatamenkpanne, if *or* when it had belonged to us
K'nihillatamanpanne, if *or* when it had belonged to thee	Nihillatamekpanne, if *or* when it had belonged to you
Nihillatankpanne, if *or* when it had belonged to him	Nihillatamichtitpanne, if *or* when it had belonged to them.

The Future

Is like the present, with the addition of *tsch*.

Imperativo Caret.

PASSIVE FORM.

INFINITIVE MOOD.

(The proper Infinitive Form is not given.)

PARTICIPLES.

Singular.	*Plural.*
Nihillalgussid, he who is owned *or* under power	Nihillalgussitschik, they who are owned *or* under power.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Nihillalgussi, I am owned	Nihillalgussihummena, we are owned
K'nihillalgussi, thou art owned	K'nihillalgussihhimo, ye are owned
Nihillalgussu, he is owned	Nihillalgussowak, they are owned.

Preterite.

Singular.	*Plural.*
Nihillalgussihump, I was owned	Nihillalgussihhummenakup, we were owned
K'nihillalgussihump, thou wast owned	K'nihillalgussihhimmoakup, ye were owned
Nihillalgussop, he was owned	Nihillalgussopannik, they were owned.

Future.

Singular.	*Plural.*
Nihillalgussitsch, I shall *or* will be owned	Nihillalgussihummenotsch, we shall *or* will be owned
K'nihillalgussitsch, thou shalt *or* wilt be owned	K'nihillalgussihhimotsch, ye shall *or* wilt be owned
Nihillalgussutsch, he shall *or* will be owned	Nihillalgussowaktsch, they shall *or* will be owned.

Imperativo Caret.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Nihillalgussiane, if *or* when I am owned	Nihillalgussiyenke, if *or* when we are owned
K'nihillalgussiane, if *or* when thou art owned	Nihillalgussiyeque, if *or* when ye are owned
Nihillalgussite, if *or* when he is owned	Nihillalgussichtite, if *or* when they are owned.

Preterite.

Singular.	*Plural.*
Nihillalgussiyannup, if *or* when I was owned	Nihillalgussiyenkup, if *or* when we were owned
K'nihillalgussiyannup, if *or* when thou wert owned	Nihillalgussiyekup, if *or* when ye were owned
Nihillalgussitup, if *or* when he was owned	Nihillalgussichtitup, if *or* when they were owned.

Pluperfect.

Singular.	*Plural.*
Nihillalgussianpanne, if or when I had been owned	Nihillalgussiyenkpanne, if *or* when we had been owned
K'nihillalgussianpanne, if *or* when thou hadst been owned	Nihillalgussiyekpanne, if *or* when ye had been owned
Nihillalgussitpanne, if *or* when he had been owned	Nihillalgussichtitpanne, if *or* when they had been owned.

The Future

Is like the present, adding *tsch.*

Imperativo Caret.

PERSONAL FORMS.

INFINITIVE MOOD.

(Not given.)

PARTICIPLES*.

Singular.	*Plural.*
Nihillalid, he who owns me, my Lord, my master	Nihillalquenk, he who owns us, our Lord
Nihillalquonk, he who owns thee, thy Lord	Nihillalqueek, he who owns you, your Lord
Nihillalat, he who owns him, his Lord	Nihillalquichtit, he who owns them, their Lord.

Substantively in the Vocative case.

Singular.	*Plural.*
Nihillalian, O thou my Lord!	Nihillaliyenk, O thou our Lord!

Hence the following verbal form:

Nihillalek, I am your Lord.

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* See above, p. 141 in note.

TRANSITIONS.—FIRST TRANSITION.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
K'nihillalel, I own, am the master of thee	Nihillalek *or* k'nihillalellhummo, I own you
Nihillala, I own him	Nihillalawak, I own them.

SECOND TRANSITION.

Singular.	*Plural.*
K'nihillali, thou ownest me	K'nihillalineen, thou ownest us
K'nihillal, thou ownest him	K'nihillalawak, thou ownest them.

THIRD TRANSITION.

Singular.	*Plural.*
Nihillaluk, he owns me	W'nihillalguneen *or* w'nihillalquenk, he owns us
K'nihillaluk, he owns thee	W'nihillalqueek he owns you
W'nihillalawall, he owns him	W'nihillalawak, he owns them.

FOURTH TRANSITION.

Singular.	*Plural.*
K'nihillalellohhena, we own thee	K'nihillalhummo, we own you
Nihillalaneen, we own him	Nihillalawuna, we own them.

FIFTH TRANSITION.

Singular.	*Plural.*
K'nihillalihhimo, ye own me	K'nihillalineen *or* k'nihillalihhena, ye own us
K'nihillalanewo, ye own him	K'nihillalawak, ye own them.

SIXTH TRANSITION.

Singular.	*Plural.*
Nekamawa nihillalukgunewo or nihillalgunewa, they own me	Nekamawa nihillalguna, they own us
Nekamawa k'nihillalukgunewo *or* k'nihillalgunewo, they own thee	Nekamawa k'nihillalguwa, they own you
Nekamawa w'nihillalawak, they own him	Nekamawa nihillalawak, they own them.

IMPERATIVE MOOD.

Singular.	*Plural.*
Nihillalil, own me, be thou my Lord	Nihillalineen, own us, be thou our Lord.

Fifth Conjugation.

Note by the Translator.—Of this conjugation, one verb alone is given: *Ahoalan*, to love. It is conjugated through the Active, Passive, Personal, and Reciprocal forms, positive and negative. The negative transitions, however, have been omitted in the Subjunctive mood. They are left blank in the original, and were probably meant to have been filled up by the Author. They therefore do not appear in this grammar.

AHOALAN, to love.

ACTIVE FORM.—POSITIVE.

INFINITIVE MOOD.

Ahoalan, to love.

PARTICIPLES.

(*Not given.*)

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'dahoala, I love	N'dahoalaneen, we love
K'dahoala, thou lovest	K'dahoalohhumo, ye love
Ahoaleu *or* w'dahoala, he loves	Ahoalewak, they love.

Preterite.

Singular.	*Plural.*
N'dahoalep, I loved	N'dahoalennenap, we loved
K'dahoalep, thou lovedst	K'dahoalohhummoap, ye loved
Ahoalep, he loved	Ahoalepannik, they loved.

Future.

Singular.	*Plural.*
N'dahoalatsch, I shall *or* will love	N'dahoaleneentsch, we shall *or* will love
K'dahoalatsch, thou shalt *or* wilt love	K'dahoalohhummotsch, ye shall *or* will love
Ahoaleuchtsch, he shall *or* will love	Ahoalewaktsch, they shall *or* will love.

IMPERATIVE MOOD.

Singular.	*Plural.*
Ahoal, love thou	Ahoalek, love ye.

[FIFTH CONJUGATION.]

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Ahoalak, if *or* when I love	Ahoalenke, if *or* when we love
Ahoalanne, if *or* when thou lovest	Ahoaleque, if *or* when ye love
Ehoalat, if *or* when he loves	Ahoalachtite, if *or* when they love.

Preterite.

Singular.	*Plural.*
Ahoalachkup, if *or* when I loved	Ahoalenkup, if *or* when we loved
Ahoalannup, if *or* when thou lovedst	Ahoalekup, if *or* when ye loved
Ehoalachtup, if *or* when he loved	Ahoalachtitup, if *or* when they loved.

Pluperfect.

Singular.	*Plural.*
Ahoalakpanne, if *or* when I had loved	Ahoalenkpanne, if *or* when we had loved
Ahoalanpanne, if *or* when thou hadst loved	Ahoalekpanne, if *or* when ye had loved
Ehoalatpanne, if *or* when he had loved	Ahoalachtitpanne, if *or* when they had loved.

Future.

Singular.	*Plural.*
Ahoalaktsch, if *or* when I shall *or* will love	Ahoalenketsch, if *or* when we shall *or* will love
Ahoalantsch, if *or* when thou shalt *or* wilt love	Ahoalequetsch, if *or* when ye shall *or* will love
Ehoalatsch, if *or* when he shall *or* will love	Ahoalichtitetsch, if *or* when they shall *or* will love.

NEGATIVE.

INFINITIVE MOOD.

Atta ahoalan, not to love.

PARTICIPLES.

(Not given.)

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Atta n'dahoalawi, I do not love	Atta n'dahoalawuneen, we do not love
Atta k'dahoalawi, thou dost not love	Atta k'dahoalawunewo, ye do not love
Atta ahoalewi, he does not love	Atta ahoalewiwak, they do not love.

Preterite.

Singular.	*Plural.*
Atta n'dahoalawip, I did not love	Atta n'dahoalowunenap, we did not love
Atta k'dahoalawip, thou didst not love	Atta k'dahoalowunewo, ye did not love
Atta ahoalewip, he did not love	Atta ahoalewipannik, they did not love.

Future.

Singular.	*Plural.*
Atta n'dahoalawitsch, I shall *or* will not love	Atta n'dahoalawuneentsch, we shall *or* will not love
Atta k'dahoalawitsch, thou shalt *or* wilt not love	Atta k'dahoalawunewotsch, ye shall *or* will not love
Atta ahoalewitsch, he shall *or* will not love	Atta ahoalawiwaktsch, they shall or will not love.

IMPERATIVE MOOD.

(*Not given.*)

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Atta n'dahoalawanne, if *or* when I do not love	Atta ahoalawonk, if *or* when we do not love
Atta k'dahoalawonne, if *or* when thou dost not love	Atta ahoalawek, if *or* when ye do not love
Atta ehoalaque, if *or* when he does not love	Atta ahoalachtik, if *or* when they do not love.

Preterite.

Singular.	*Plural.*
Atta ahoalawonnup, if *or* when I did not love	Atta ahoalawonkup, if *or* when we did not love
Atta ahoalawonnup, if *or* when thou didst not love	Atta ahoalawekup, if *or* when ye did not love
Atta ehoalakup, if *or* when he did not love	Atta ahoalachtikup, if *or* when they did not love.

Pluperfect.

Singular.	*Plural.*
Atta ahoalawakpanne, if *or* when I had not loved	Atta ahoalawonkpanne, if *or* when we had not loved
Atta ahoalawonpanne, if *or* when thou hadst not loved	Atta ahoalawekpanne, if *or* when ye had not loved
Atta ahoalakpanne, if *or* when he had not loved	Atta ahoalachtikpanne, if *or* when they had not loved.

Future.

Singular.	*Plural.*
Atta n'dahoalawiwonne, if *or* when I shall *or* will not love	Atta ahoalawonktsch, if *or* when we shall *or* will not love
Atta k'dahoalawonnetsch, if *or* when thou shalt *or* wilt not love	Atta ahoalawektsch, if *or* when ye shall *or* will not love
Atta ehowalequetsch, if *or* when he shall *or* will not love	Atta ahoalachtiktsch, if *or* when they shall *or* will not love.

[FIFTH CONJUGATION.]

PASSIVE FORM.—POSITIVE.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'dahoalgussi, I am loved	N'dahoalgussihhena, we are loved
K'dahoalgussi, thou art loved	K'dahoalgussihhimo, ye are loved
Ahoalgussi, he is not loved	Ahoalgussowak, they are loved.

Preterite.

Singular.	*Plural.*
N'dahoalgussihump, I was loved	N'dahoalgussihhenap, we were not loved
K'dahoalgussinep, thou wast loved	K'dahoalgussihhimoakup, ye were not loved
W'dahoulgussop, he was loved	W'dahoalgussopannik, they were not loved.

Future.

Singular.	*Plural.*
N'dahoalgussitsch, I shall *or* will be loved	N'dahoalgussihhenatsch, we shall *or* will be loved
K'dahoalgussitsch, thou shalt *or* wilt be loved	K'dahoalgussihhimotsch, ye shall *or* will be loved
Ahoalgussutsch, he shall *or* will be loved	Ahoalgussiwiwaktsch, they shall *or* will be loved.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Ahoalgussiya, if *or* when I am loved	Ahoalgussiyenk, if *or* when we are loved
Ahoalgussiyen, if *or* when thou art loved	Ahoalgussiyek, if *or* when ye are loved
Ahoalgussite, if *or* when he is loved	Ahoalgussichtit, if *or* when they are loved.

Preterite.

Singular.	*Plural.*
Ahoalgussiyakup, if *or* when I was loved	Ahoalgussiyenkup, if *or* when we were loved
Ahoalgussiyannup, if *or* when thou wast loved	Ahoalgussiyekup, if *or* when ye were loved
Ahoalgussitup, if *or* when he was loved	Ahoalgussichtitup, if *or* when they were loved.

Pluperfect.

Singular.	*Plural.*
Ahoalgussiyakpanne, if *or* when I had been loved	Ahoalgussiyenkpanne, if *or* when we had been loved
Ahoalgussiyanpanne, if *or* when thou hadst been loved	Ahoalgussiyekpanne, if *or* when ye had been loved
Ahoalgussitpanne, if *or* when he had been loved	Ahoalgussichtitpanne, if *or* when they had been loved.

Future.

Singular.	*Plural.*
Ahoalgussiyaktsch, if *or* when I shall *or* will be loved	Ahoalgussiyenktsch, if *or* when we shall *or* will be loved
Ahoalgussiyantsch, if *or* when thou shalt *or* wilt be loved	Ahoalgussiyektsch, if *or* when ye shall *or* will be loved
Ahoalgitsch, if *or* when he shall *or* will be loved	Ahoalgussichtitsch, if *or* when they shall *or* will be loved.

NEGATIVE.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Atta n'dahoalgussiwi, I am not loved	Atta n'dahoalgussiwuneen, we are not loved
Atta k'dahoalgussiwi, thou art not loved	Atta k'dahoalgussiwihhimo, ye are not loved
Atta w'dahoalgussuwi, he is not loved	Atta ahoalgussiwiwak, they are not loved.

Preterite.

Singular.	*Plural.*
Atta n'dahoalgussiwip, I was not loved	Atta n'dahoalgussiwunenap, we were not loved
Atta k'dahoalgussiwip, thou wast not loved	Atta k'dahoalgussihhimoap, ye were not loved
Atta w'dahoalgussiwip, he was not loved	Atta w'dahoalgussiwipannik, they were not loved.

Future.

Singular.	*Plural.*
Atta n'dahoalgussiwitsch, I shall *or* will not be loved	Atta n'dahoalgussiwuneentsch, we shall *or* will not be loved
Atta k'dahoalgussiwitsch, thou shalt *or* wilt not be loved	Atta k'dahoalgussiwunewotsch, ye shall *or* will not be loved
Atta ahoalgussuwitsch, he shall *or* will not be loved	Atta ahoalgussiwiwaktsch, they shall *or* will not be loved.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Atta ahoalgussiwak, if *or* when I am not loved	Atta ahoalgussiwenk, if *or* when we are not loved
Atta ahoalgussiwonne, if *or* when thou art not loved	Atta ahoalgussiwek, if *or* when ye are not loved
Atta ahoalgussique, if *or* when he is not loved	Atta ahoalgussichtik, if *or* when they are not loved.

Preterite.

Singular.	*Plural.*
Atta ahoalgussiwakup, if *or* when I was not loved	Atta ahoalgussiwenkup, if *or* when we were not loved
Atta ahoalgussiwonnup, if *or* when thou wast not loved	Atta ahoalgussiwekup, if *or* when ye were not loved
Atta ahoalgussikup, if *or* when he was not loved	Atta ahoalgussichtikup, if *or* when they were not loved.

Pluperfect.

Singular.	*Plural.*
Atta ahoalgussiwakpanne, if *or* when I had not been loved	Atta ahoalgussiwenkpanne, if *or* when we had not been loved
Atta ahoalgussiwonpanne, if *or* when thou hadst not been loved	Atta ahoalgussiwekpanne, if *or* when ye had not been loved
Atta ahoalgussikpanne, if *or* when he had not been loved	Atta ahoalgussichtitpanne, if *or* when they had not been loved.

Future.

Singular.	*Plural.*
Atta ahoalgussiwaktsch, if *or* when I shall *or* will not be loved	Atta ahoalgussiwenktsch, if *or* when we shall *or* will not be loved
Atta ahoalgussiwonktsch, if *or* when thou shalt *or* wilt not be loved	Atta ahoalgussiwektsch, if *or* when ye shall *or* will not be loved
Atta ahoalgussiktsch, if *or* when he shall *or* will not be loved	Atta ahoalgussichtitsch, if *or* when they shall *or* will not be loved.

PERSONAL FORMS.—POSITIVE.

FIRST TRANSITION.

INDICATIVE MOOD.

Present.

K'dahoatell, I love thee	K'dahoalohhummo, I love you
N'dahoala, I love him	N'dahoalawak, I love them.

Preterite.

K'dahoalennep, I loved thee	K'dahoalohhummoap, I loved you
N'dahoalap, I loved him	N'dahoalapannik, I loved them.

Future.

K'dahoalelltsch, I shall *or* will love thee	K'dahoalohhummotsch, I shall *or* will love you
N'dahoalauchtsch, I shall *or* will love him	N'dahoalawaktsch, I shall *or* will love them.

SUBJUNCTIVE MOOD.

Present.

Ahoalanne, if *or* when I love thee	Ahoaleque, if *or* when I love you
Ahoalachte, if *or* when I love him	Ahoalachtite, if *or* when I love them.

Preterite.

Ahoalannup, if *or* when I loved thee	Ahoalekup, if *or* when I loved you
Ahoalachtup, if *or* when I loved him	Ahoalachtup, if *or* when I loved them.

Pluperfect.

Ahoalanpanne, if *or* when I had loved thee	Ahoalekpanne, if *or* when I had loved you
Ahoalachtuppanne, if *or* when I had loved him	Ahoalatpanne, if *or* when I had loved them.

Future.

Ahoalanhetsch, if *or* when I shall or will love thee	Ahoalequetsch, if *or* when I shall *or* will love you
Ahoalachtetsch, if *or* when I shall *or* will love him	Ahoalachtitetsch, if *or* when I shall *or* will love them.

SECOND TRANSITION.

INDICATIVE MOOD.

Present.

K'dahoali, thou lovest me	K'dahoalineen, thou lovest us
K'dahoala, thou lovest him	K'dahoalawak, thou lovest them.

Preterite.

K'dahoalinep, thou didst love me	K'dahoalihhenap, thou didst love us
K'dahoalap, thou didst love him	K'dahoalapannik, thou didst love them.

Future.

K'dahoalitsch, thou shalt *or* wilt love me	K'dahoalihhenatsch, thou shalt *or* wilt love us
K'dahoalauchtsch, thou shalt *or* wilt love him	K'dahoalawaktsch, thou shalt *or* wilt love them.

IMPERATIVE MOOD.

Ahoalil, love thou me	Ahoalineen, love thou us.

SUBJUNCTIVE MOOD.

Present.

Ahoaliyanne, if *or* when thou lovest me	Ahoaliyenke, if *or* when thou lovest us
K'dahoalanne, if *or* when thou lovest him	K'dahoalachte, if *or* when thou lovest them.

Preterite.

Ahoaliyannup, if *or* when thou didst love me	Ahoaliyenkup, if *or* when thou didst love us
Ahoalannup, if *or* when thou didst love him	K'dahoalachtup, if *or* when thou didst love them.

Pluperfect.

Ahoaliyanpanne, if *or* when thou hadst loved me	Ahoaliyenkpanne, if *or* when thou hadst loved us
Ahoalanpanne, if *or* when thou hadst loved him	K'dahoalachtuppanne, if *or* when thou hadst loved them.

Future.

Ahoaliyannetsch, if *or* when thou shalt *or* wilt love me	Ahoaliyenketsch, if *or* when thou shalt *or* wilt love us
Ahoalachtetsch, if *or* when thou shalt *or* wilt love him	Ahoalachtütetsch, if *or* when thou shalt *or* wilt love them.

THIRD TRANSITION.

PARTICIPLES.

Ehoalid, he who loves me
Ehoalat, he who loves him
Ehoalquenk, he who loves us
Ehoalquek, he who loves you
Ehoalquichtit, he who loves them.

INDICATIVE MOOD.

Present.

N'dahoaluk, he loves me
K'dahoaluk, he loves thee
W'dahoalawall, he loves him
W'dahoalguna, he loves us
W'dahoalguwa, he loves you
W'dahoalawak, he loves them.

Preterite.

N'dahoalgunep, he loved me
K'dahoalgunep, he loved thee
W'dahoalap, he loved him
N'dahoalgunap, he loved us
K'dahoalguwap, he loved you
W'dahoalapannik, he loved them.

Future.

N'dahoalauchtsch, he shall *or* will love me
K'dahoalauchtsch, he shall *or* will love thee
W'dahoalauchtsch, he shall *or* will love him
N'dahoalgunatsch, he shall *or* will love us
W'dahoalguwatsch, he shall *or* will love you
W'dahoalawaktsch, he shall *or* will love them.

SUBJUNCTIVE MOOD.

Present.

Ahoalite, if *or* when he loves me
Ahoalquonne, if *or* when he loves thee
Ahoalate, if *or* when he loves him
Ahoalquenke, if *or* when he loves us
Ahoalqueque, if *or* when he loves you
Ahoalachtite, if *or* when he loves them.

Preterite.

Ahoalitup, if *or* when he loved me
Ahoaliyonnup, if *or* when he loved thee
Ahoalatup, if *or* when he loved him
Ahoalquenkup, if *or* when he loved us
Ahoalquekup, if *or* when he loved you
Ahoalachtitup, if *or* when he loved them.

Pluperfect.

Ahoalitpanne, if *or* when he had loved me
Ahoalanpanne, if *or* when he had loved thee
Ahoalatpanne, if *or* when he had loved him
Ahoalquenkpanne, if *or* when he had loved us
Ahoalquekpanne, if *or* when he had loved you
Ahoalachtitpanne, if *or* when he had loved them.

Future.

Ahoaletsch, if *or* when he shall *or* will love me
Ahoalquonnetsch, if *or* when he shall *or* will love thee
Ahoalechtetsch, if *or* when he shall *or* will love him
Ahoalquenketsch, if *or* when he shall *or* will love us
Ahoalquequetsch, if *or* when he shall *or* will love you
Ahoalechtitetsch, if *or* when he shall *or* will love them.

FOURTH TRANSITION.

INDICATIVE MOOD.

Present.

K'dahoalenneen, we love thee
N'dahoalawuna, we love him
K'dahoalohummena, we love you
N'dahoalowawuna, we love them.

Preterite.

K'dahoalennenap, we loved thee
N'dahoalawunap, we loved him
K'daholohummenap, we loved you
N'dahoalawawunap, we loved them.

Future.

K'dahoalohhenatsch, we shall *or* will love thee
N'dahoalawunatsch, we shall *or* will love him
K'dahoalohummenatsch, we shall *or* will love you
N'dahoalawawunatsch, we shall *or* will love them.

SUBJUNCTIVE MOOD.

Present.

K'dahoalenk, if *or* when we love thee
Ahoalanque, if *or* when we love him
Ahoaleque, if *or* when we love you
Ahoalawonque, if *or* when we love them.

Preterite.

Ahoalenkup, if *or* when we loved thee
Ahoalankup, if *or* when we loved him
Ahoalekup, if *or* when we loved you
Ahoalawawonkup, if *or* when we loved them.

Pluperfect.

K'dahoalenkpanne, if *or* when we had loved thee
Ahoalankpanne, if *or* when we had loved him
Ahoalekpanne, if *or* when we had loved you
Ahoalawonkpanne, if *or* when we had loved them.

Future

Ahoalenquetsch, if *or* when we shall *or* will love thee
Ahoalanquetsch, if *or* when we shall *or* will love him
Ahoalequetsch, if *or* when we shall *or* will love you
Ahoalawonquetsch, if *or* when we shall *or* will love them.

FIFTH TRANSITION.

INDICATIVE MOOD.

Present.

K'dahoalihhimo, ye love me
K'dahoalanewo, ye love him
K'dahoalihhena, ye love us
K'dahoalawawak, ye love them.

Preterite.

K'dahoalihhimoap, ye loved me
K'dahoalanewoap, ye loved him
K'dahoalihhenap, ye loved us
K'dahoalawapannik, ye loved them.

Future.

K'dahoalihhimotsch, ye shall *or* will love me
K'dahoalanewotsch, ye shall *or* will love him
K'dahoalihhenatsch, he shall *or* will love us
K'dahoalawawaktsch, ye shall *or* will love them.

IMPERATIVE MOOD.

Ahoalik, love you me
Ahoalo, love you him
Ahoalineen, love you us
Ahoalatam, love you them.

SUBJUNCTIVE MOOD.

Present.

Ahoaliyeque, if *or* when ye love me
Ahoalaque, if *or* when ye love him
Ahoaliyenke, if *or* when ye love us
Ahoalachtike, if *or* when ye love them.

Preterite.

Ahoaliyekup, if *or* when ye loved me
Ahoalachtup, if *or* when ye loved him
Ahoaliyenkup, if *or* when ye loved us
Ahoalachtiyekup, if *or* when ye loved them.

Pluperfect.

Ahoaliyekpanne, if *or* when ye had loved me
Ahoalekpanne, if *or* when ye had loved him
Ahoaliyenkpanne, if *or* when ye had loved us
Ahoalachtitpanne, if *or* when ye had loved them.

Future.

Ahoaliyequetsch, if *or* when ye shall *or* will love me
Ahoalaquetsch, if *or* when ye shall *or* will love him
Ahoaliyenquetsch, if *or* when ye shall *or* will love us
Ahoalachtiquetsch, if *or* when ye shall *or* will love them.

SIXTH TRANSITION.

INDICATIVE MOOD.

Present.

N'dahoalgenewo, they love me
K'dahoalgenewo, they love thee
W'dahoalanewo, they love him
N'dahoalgehhena, they love us
K'dahoalgehhimo, they love you
W'dahoalawawak, they love them.

Preterite.

N'dahoalgenewoap, they did love me
K'dahoalgenewoap, they did love thee
W'dahoalgenewoap, they did love him
N'dahoalgehhenap, they did love us
K'dahoalgehhimoap, they did love you
W'dahoalawapannik, they did love them.

Future.

N'dahoalgenewotsch, they shall *or* will love me
K'dahoalgenewotsch *or* k'dahoalgetsch, they shall *or* will love thee
W'dahoalanewotsch, they shall *or* will love him
N'dahoalgehhenatsch, they shall *or* will love us
K'dahoalgehhimotsch, they shall *or* will love you
W'dahoalawawaktsch, they shall *or* will love them.

SUBJUNCTIVE MOOD.

Present.

Ahoalinke, if *or* when they love me
Ahoalquonne, if *or* when they love thee
Ehoalinde, if *or* when they love him
Ehoalquenke, if *or* when they love us
Ehoalqueque, if *or* when they love you
Ehoalachtite, if *or* when they love them.

Preterite.

Ehoalinkup, if *or* when they loved me
Ehoalquonnup, if *or* when they loved thee
Ehoalindup, if *or* when they love him
Ehoalquenkup, if *or* when they loved us
Ehoalquekup, if *or* when they loved you
Ehoalachtitup, if *or* when they loved them.

Pluperfect.

Ehoalinkpanne, if *or* when they had loved me
Ehoalquonpanne, if *or* when they had loved thee
Ehoalindpanne, if *or* when they had loved him
Ehoalquenkpanne, if *or* when they had loved us
Ehoalquekpanne, if *or* when they had loved you
Ehoalachtitpanne, if *or* when they had loved them.

Future.

Ehoalinketsch, if *or* when they shall *or* will love me
Ehoalquonnetsch, if *or* when they shall *or* will love thee
Ehoalindetsch, if *or* when they shall *or* will love him
Ehoalquenketsch, if *or* when they shall *or* will love us
Ehoalquequetsch, if *or* when they shall *or* will love you
Ehoalachtitetsch, if *or* when they shall *or* will love them.

PERSONAL FORMS.—NEGATIVE.

FIRST TRANSITION.

INDICATIVE MOOD.

Present.

K'dahoalowi*, I do not love thee
N'dahoalawi, I do not love him
K'dahoalohhumo, I do not love you
N'dahoalawiwak, I do not love them.

Preterite.

K'dahoalellowip, I did not love thee
N'dahoalawip, I did not love him
K'dahoalohhumowip, I did not love you
N'dahoalawipannik, I did not love them.

* Atta or Matta prefixed throughout.

Future.

K'dahoalellowitsch, I shall *or* will not love thee	K'dahoalohhumowitsch, I shall *or* will not love you
N'dahoalawitsch, I shall *or* will not love him	N'dahowalawiwaktsch, I shall *or* will not love them.

The Pluperfect and the Subjunctive are not given in any of the Transitions.

SECOND TRANSITION.

INDICATIVE MOOD.

Present.

K'dahoaliwi, thou dost not love me	K'dahoaliwuneen, thou dost not love us
K'dahoalawi, thou dost not love him	K'dahoaliwiwak, thou dost not love them.

Preterite.

K'dahoaliwip, thou didst not love me	K'dahoaliwunenap, thou didst not love us
K'dahoalawip, thou didst not love him	K'dahoaluwipannik, thou didst not love them.

Future.

K'dahoaliwitsch, thou shalt *or* wilt not love me	K'dahouliwuneentsch, thou shalt *or* wilt not love us
K'dahoalawitsch, thou shalt *or* wilt not love him	K'dahoalawiwaktsch, thou shalt *or* wilt not love them.

THIRD TRANSITION.

INDICATIVE MOOD.

Present.

N'dahoalguwi, he does not love me	N'dahoalguwuneen, he does not love us
K'dahoalguwi, he does not love thee	K'dahoalguwawi, he does not love you
W'dahoalawi, he does not love him	W'dahoalwiwak, he does not love them.

Preterite.

N'dahoalguwip, he did not love me	N'dahoalguwunenap, he did not love us
K'dahoalguwip, he did not love thee	K'dahoalguwawip, he did not love you
W'dahoalawip, he did not love him	W'dahoalawipannik, he did not love them.

Future.

N'dahoalguwitsch, he shall *or* will not love me	N'dahoalguwuneentsch, he shall *or* will not love us
K'dahoalguwitsch, he shall *or* will not love thee	K'dahoalguwawitsch, he shall *or* will not love you
W'dahoalawitsch, he shall *or* will not love him	W'dahoalawiwaktsch, he shall *or* will not love them.

FOURTH TRANSITION.

INDICATIVE MOOD.

Present.

K'dahoalowuneen, we do not love thee
N'dahoalawuneen, we do not love him
K'dahoalohhummowuneen, we do not love you
N'dahoalawunena, he does not love them.

Preterite.

K'dahoalowunenap, we did not love thee
N'dahoalawunenap, we did not love him
K'dahoalohhummowunenap, we did not love you
N'dahoalawawunenap, we did not love them.

Future.

K'dahoalowuneentsch, we shall *or* will not love thee
N'dahoalawuneentsch, we shall *or* will not love him
K'dahoalohhummowuntsch, we shall *or* will not love you
N'dahoalawunanetsch, we shall *or* will not love them.

FIFTH TRANSITION.

INDICATIVE MOOD.

Present.

K'dahoalihhimowi, ye do not love me
K'dahoalawiwa, ye do not love him
K'dahoaliwunena, ye do not love us
K'dahoalawiwak, ye do not love them.

Preterite.

K'dahoalihhimowip, ye did not love me
K'dahoalawiwoap, ye did not love him
K'dahoalihhimowunap, ye did not love us
K'dahoalawipannik, ye did not love them.

Future.

K'dahoalihhinowitsch, ye shall *or* will not love me
K'dahowalawiwatsch, ye shall *or* will not love him
K'dahoaliwuneentsch, ye shall *or* will not love us
K'dahoalawiwaktsch, ye shall *or* will not love them.

SIXTH TRANSITION.

INDICATIVE MOOD.

Present.

N'dahoalguwiwak, they do not love me
K'dahoalguwiwak, they do not love thee
W'dahoalawiwak, they do not love him
N'dahoalguwuneen, they do not love us
K'dahoalguwunewo, they do not love you
W'dahoalawiwak, they do not love them.

Preterite.

N'dahoalgewipannik, they did not love me
K'dahoalgewipannik, they did not love thee
W'dahoalawipannik, they did not love him
N'dahoalguwunenap, they did not love us
K'dahoalguwunenap, they did not love you
W'dahoalawawipannik, they did not love them.

Future.

N'dahoalguwiwaktsch, they shall *or* will not love me
K'dahoalguwiwaktsch, they shall *or* will not love thee
W'dahoalawiwaktsch, they shall *or* will not love him

N'dahoalguwuneentsch, they shall *or* will not love us
K'dahoalguwunewotsch, they shall *or* will not love you
W'dahoalawawiwaktsch, they shall *or* will not love them.

RECIPROCAL FORM.—POSITIVE.

INFINITIVE MOOD.

Ahoaltin, to love one another.

INDICATIVE MOOD.

Present.

Present.

N'dahoaltineen, we love one another
K'dahoaltihhimo, ye love one another
Ahoaltowak, they love one another.

Preterite.

N'dahoaltihhenap, we loved one another
K'dahoaltihhimmoap, ye loved one another
Ahoaltopannik, they loved one another.

Future.

Ahoaltineentsch, we shall *or* will love each other.
K'dahoaltihhimotsch, ye shall *or* will love each other
Ahoaltowaktsch, they shall *or* will love each other.

IMPERATIVE MOOD.

Singular.

Ahoaltik, love ye each other

Plural.

Ahoaltitam, let us love each other.

SUBJUNCTIVE MOOD.

Present.

Ahoaltiyenk, that we may love each other
Ahoaltiyek, that ye may love each other
Ahoaltichtit, that they may love each other.

Preterite.

Ahoaltiyenkup, that *or* as we have loved each other
Ahoaltiyekup, that *or* as ye have loved each other
Ahoaltichtitup, that *or* as they have loved each other.

Pluperfect.

Ahoaltiyenkpanne, if *or* when we had loved each other
Ahoaltiyekpanne, if *or* when ye had loved each other
Ahoaltichtitpanne, if *or* when they had loved each other.

Future.

Ahoaltiyenketsch, as we shall *or* will love each other
Ahoaltiyeketsch, as ye shall *or* will love each other
Ahoaltichtitetsch, as they shall *or* will love each other.

NEGATIVE.

INFINITIVE MOOD.

Matta ahoaltin, not to love each other.

INDICATIVE MOOD.

Present.

Matta n'dahoaltiwuneen, we do not love each other
Matta k'dahoaltiwihhimo, ye do not love each other
Matta ahoaltiwiwak, they do not love each other.

Preterite.

Matta n'dahoaltiwunenap, we did not love each other
Matta k'dahoaltiwihhimmoap, ye did not love each other
Matta ahoaltiwipannik, they did not love each other.

Future.

Mattatsch n'dahoaltiwuneen, we shall *or* will not love each other
Mattatsch k'dahoaltiwihhimo, ye shall *or* will not love each other
Mattatsch ahoaltiwiwak, they shall *or* will not love each other.

IMPERATIVE MOOD.

(*Not given.*)

SUBJUNCTIVE MOOD.

Present.

Matta ahoaltiwenk, when *or* as we may not love each other
Matta ahoaltiwek, when *or* as ye may not love each other
Matta ahoaltichtik, when *or* as they may not love each other.

Preterite.

Matta ahoaltiwenkup, when *or* as we have not loved each other
Matta ahoaltiwekup, when *or* as ye have not loved each other
Matta ahoaltichtikup, when *or* as they have not loved each other.

Pluperfect.

Matta ahoaltiwenkpanne, if *or* when we had not loved each other
Matta ahoaltiwekpanne, if *or* when ye had not loved each other
Matta ahoaltichtikpanne, if *or* when they had not loved each other.

Future.

Mattatsch ahoaltiwenk, when *or* as we shall *or* will not love each other
Mattatsch ahoaltiwek, when *or* as ye shall *or* will not love each other
Mattatsch ahoaltichtik, when *or* as they shall *or* will not love each other.

The Reciprocal Forms of Verbs are distinguished by their Infinitive termination in *tin*, as in the following examples:

Pendawachtin, to hear each other
Pennawachtin, to look at each other
Nostawachtin, to understand each other
Neuchtin, to see each other
Mochtenalittin, to fight with each other
Schinginawachtin, schingaltin, to hate each other
Pakantin, to box (fight with fists) with each other
Nilchtin, to strike each other dead
Eenhawachtin, to pay, satisfy each other
Witahentin, to help each other
N'galtin, to quit each other
Pakitatamawachtin, to forgive each other
Wulaptonaltin, to be reconciled to each other
Aptonaltin, to speak with each other

Littin, to say to *or* among each other
Mattaptonaltin, to scold, abuse each other
Nawalittin, to pursue each other
Wipantin, to eat with each other
Menachtin, to drink, tipple with each other
Witawentin, to live *or* dwell with each other
Gettemagelentin, to be kind, merciful to each other
Miguntin, to remind each other
Manschaltin, to keep each other in remembrance
Sachgaguntin, to lead each other
Wipentin, to lie *or* sleep with each other
Ntutemawachtin, to question each other
Gettschihhilalittin, to betray each other
Wentschintin, to call each other
Ndoochtawachtin, to inquire of each other
Achgachemawachtin, to share with each other
Waletittin, to inform, advise each other, &c.

Sixth Conjugation.

Luen, to say *or* tell.

ACTIVE FORM.—POSITIVE.

INFINITIVE MOOD.

Luen, to say
Luehund, one says
Luehundi, they say *or* it is said.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'dellowe, I say	N'delloweneen, we say
K'dellowe, thou sayest	K'dellowehhimo, ye say
W'dellowe, he says	W'dellowenewo, they say.

Preterite.

Singular.	*Plural.*
N'dellowenep, I said	N'dellowehhenap, we said
K'dellowenep, thou saidst	K'dellowehhimoap, ye said
W'dellowenep, he said	W'dellowenewoap, they said.

Future.

Singular.	*Plural.*
N'dellowentsch, I shall *or* will say	N'dellowehhenatsch, we shall *or* will say
K'dellowentsch, thou shalt *or* wilt say	K'dellowehhimotsch, ye shall *or* will say
W'dellowentsch, he shall *or* will say	W'dellowenewotsch, they shall *or* will say.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Lueya, if *or* when I say	Lueyenk, if *or* when we say
Lueyane, if *or* when thou sayest	Lueyek, if *or* when ye say
Luete, if *or* when he says	Luechtit, if *or* when they say.

Preterite.

Singular.	*Plural.*
Lueyakup, if *or* when I said	Lueyenkup, if *or* when we said
Lueyannup, if *or* when thou saidst	Lueyekup, if *or* when ye said
Luetup, if *or* when he said	Luechtitup, if *or* when they said.

Pluperfect.

Singular.	*Plural.*
Lueyakpanne, if *or* when I had said	Lueyenkpanne, if *or* when we had said
Lueyankpanne, if *or* when thou hadst said	Lueyekpanne, if *or* when ye had said
Luetpanne, if *or* when he had said	Luechtitpanne, if *or* when they had said.

Future.

Singular.	*Plural.*
Lueyaktsch, if *or* when I shall *or* will say	Lueyenktsch, if *or* when we shall *or* will say
Lueyanetsch, if *or* when thou shalt *or* wilt say	Lueyektsch, if *or* when ye shall *or* will say
Luetetsch, if *or* when he shall *or* will say	Luechtitsch, if *or* when they shall *or* will say.

The negative voice of this verb is not given in this Grammar, nor is the Imperative Mood in the positive.

PERSONAL FORMS.—POSITIVE.

FIRST TRANSITION.

INDICATIVE MOOD.

Present.

K'dellell, I say to thee	K'dellohumo, I say to you
N'dellan, I say to him	N'dellawak, I say to them.

Preterite.

K'dellenep, I said to thee	K'dellohumoap, I said to you
N'dellap, I said to him	N'dellapannik, I said to them.

Future.

K'delletsch, I shall *or* will say to thee	K'dellohummotsch, I shall *or* will say to you
N'dellantsch, I shall *or* will say to him	N'dellawaktsch, I shall *or* will say to them.

SUBJUNCTIVE MOOD.

Present.

Lellane, if *or* when I say to thee	Lelleque, if *or* when I say to you
Lake, if *or* when I say to him	Lakpanne, if *or* when I say to them.

Preterite.

Lellanup, if *or* when I said to thee	Lellekup, if *or* when I said to you
Lakup, if *or* when I said to him	Lekpanne, if *or* when I said to them.

[SIXTH CONJUGATION.]

Pluperfect.

Lellanpanne, if *or* when I had said to thee
Lakuppanne, if *or* when I had said to him
Lellekpanne, if *or* when I had said to you
Lakpanne, if *or* when I had said to them.

Future.

Lellanetsch, if *or* when I shall *or* will say to thee
Laketsch, if *or* when I shall *or* will say to him
Lellequetsch, if *or* when I shall *or* will say to you
Lakpannetsch, if *or* when I shall *or* will say to them.

SECOND TRANSITION.

INDICATIVE MOOD.

Present.

K'delli, thou sayest to me
K'dellan, thou sayest to him
K'dellineen, thou sayest to us
K'dellawak, thou sayest to them.

Preterite.

K'dellineep, thou saidst to me
K'dellanep, thou saidst to him
K'dellinenap, thou saidst to us
K'dellapannik, thou saidst to them.

Future.

K'dellitsch, thou shalt *or* wilt say to me
K'dellantsch, thou shalt *or* wilt say to him
K'dellihhenatsch, thou shalt *or* wilt say to us
K'dellawawaktsch, thou shalt *or* wilt say to them.

IMPERATIVE MOOD.

Ill, say thou
Luel, say on, go on with your discourse
Lil, tell me
Lime, tell me at some particular time
Lo, say to him
Mauwi lo, go and say to him
Lineen, say to us
Litam, say to them.

SUBJUNCTIVE MOOD.

Present.

Liyane, if *or* when thou sayest to me
Latpanne, if *or* when thou sayest to him
Liyenkpanne, if *or* when thou sayest to us
Lakpanne, if *or* when thou sayest to them.

Preterite.

Liyannup, if *or* whon thou saidst to me
Latpannup, if *or* when thou saidst to him
Liyenkpannup, if *or* when thou saidst to us
Lakpannup, if *or* when thou saidst to them.

Future.

Liyannetsch, if *or* when thou shalt *or* wilt say to me
Latpannetsch, if *or* when thou shalt *or* wilt say to him
Liyenquetsch, if *or* when thou shalt *or* wilt say to us
Lakpannetsch, if *or* when thou shalt *or* wilt say to them.

THIRD TRANSITION.

INDICATIVE MOOD.

Present.

N'delluk, n'dellgun, he says to me
W'dellan, w'dellawall, he says to thee
K'dellgun, k'dellak, he says to him

N'dellguna, lukguna, he says to us
K'dellguwa, k'dellgehhimo, he says to you
W'dellawak, he says to them.

Preterite.

N'dellgop, he said to me
K'dellgop, he said to thee
W'dellanep, he said to him

N'dellgunenap, n'dellgehhenap, he said to us
K'dellguwap, k'dellgehhimoap, he said to you
W'dellapannik, he said to them.

Future.

N'dellgetsch, he shall *or* will say to me
K'dellgetsch, he shall *or* will say to thee
W'dellantsch, he shall *or* will say to him

N'dellgunatsch, lukgunatsch, he shall *or* will say to us
K'dellguwatsch, k'tellgehhimotsch, he shall *or* will say to you
W'dellawaktsch, he shall *or* will say to them.

SUBJUNCTIVE MOOD.

Present.

Lite, if *or* when he says to me
Lukquonne, if *or* when he says to thee
Late, if *or* when he says to him

Lukquenke, if *or* when he says to us
Lukqueque, if *or* when he says to you
Lakhittite, if *or* when he says to them.

Preterite.

Litup, if *or* when he said to me
Lukquonnup, if *or* when he said to thee
Latup, if *or* when he said to him

Lukquenkup, if *or* when he said to us
Lukquekup, if *or* when he said to you
Laachtitup, if *or* when he said to them.

Future.

Litetsch, if *or* when he shall *or* will say to me
Lukquonnetsch, if *or* when he shall *or* will say to thee
Latetsch, if *or* when he shall *or* will say to him

Lukquenketsch, if *or* when he shall *or* will say to us
Lukqueketsch, if *or* when he shall *or* will say to you
Laachtitetsch, if *or* when he shall *or* will say to them.

FOURTH TRANSITION.

INDICATIVE MOOD.

Present.

K'delleneen, we say to thee
N'dellaneen, we say to him

K'dellohhena, we say to you
N'dellawawuna, we say to them.

Preterite.

K'dellenenap, we said to thee
N'dellawunakup, we said to him
K'dellohhumoakup, we said to you
N'dellawawapannik, we said to them.

Future.

K'delleneentsch, we shall *or* will say to thee
N'delleneentsch, we shall *or* will say to him
K'dellohhenatsch, we shall *or* will say to you
N'dellawawaktsch *or* n'dellawunantsch, we shall *or* will say to them.

SUBJUNCTIVE MOOD.

Present.

Lellanque, if *or* when we say to thee
Lanke, if *or* when we say to him
Lellenque, if *or* when we say to you
Lenke, if *or* when we say to them.

Preterite.

Lellankup, if *or* when we said to thee
Lankup, if *or* when we said to him
Lellenkup, if *or* when we said to you
Lenkup, if *or* when we said to them.

Future.

Lellanquetsch, if *or* when we shall *or* will say to thee
Lanketsch, if *or* when we shall *or* will say to him
Lellenquetsch, if *or* when we shall *or* will say to you
Lenketsch, if *or* when we shall *or* will say to them.

FIFTH TRANSITION.

INDICATIVE MOOD.

Present.

K'dellihhimo, ye say to me
K'dellanewo, ye say to him
K'dellihhena, ye say to us
K'dellawawak, ye say to them.

Preterite.

K'dellihhimoakup, ye said to me
K'dellanewoap, ye said to him
K'dellihhenakup, ye said to us
K'dellawoapannik, ye said to them.

Future.

K'dellihhimotsch, ye shall *or* will say to me
K'dellanewotsch, ye shall *or* will say to him
K'dellihhenatsch, ye shall *or* will say to us
K'dellawawaktsch, ye shall *or* will say to them.

SUBJUNCTIVE MOOD.

Present.

Liyeque, if *or* when ye say to me
Leque, if *or* when ye say to him
Liyenque, if *or* when ye say to us
Leke, if *or* when ye say to them.

Preterite.

Liyekup, if *or* when ye said to me	Liyenkup, if *or* when ye said to us
Lequekup, if *or* when ye said to him	Lekup, if *or* when ye said to them.

Future.

Liyequetsch, if *or* when ye shall *or* will say to me	Liyenquetsch, if *or* when ye shall *or* will say to us
Lequetsch, if *or* when ye shall *or* will say to him	Leketsch, if *or* when ye shall *or* will say to them.

SIXTH TRANSITION.

INDICATIVE MOOD.

Present.

N'dellge, they say to me	N'dellgeneen *or* n'dellgehhena, they say to us
K'dellge, they say to thee	K'dellgehhimo, they say to you
W'dellanewo, they say to him	W'dellanawak, they say to them.

Preterite.

N'dellgenep, they said to me	N'dellgenenap, they said to us
K'dellgenep, they said to thee	N'dellgehhimoap, they said to you
W'dellanewoap, they said to him	W'dellawawapannik, they said to them.

Future.

N'dellgetsch, they shall *or* will say to me	N'dellgeneentsch *or* n'dellgehhenatsch, they shall *or* will say to us
K'dellgetsch, they shall *or* will say to thee	K'dellgehhimotsch, they shall *or* will say to you
W'dellanewotsch, they shall *or* will say to him	W'dellawawaktsch, they shall *or* will say to them.

SUBJUNCTIVE MOOD.

Present.

Lichtinke *or* linke, if *or* when they say to me	Lukquenke, if *or* when they say to us
Lukquonne, if *or* when they say to thee	Lukqueque, if *or* when they say to you
Lachtinke *or* linde, if *or* when they say to him	Lachtitpanne, if *or* when they say to them.

Preterite.

Lichtinkup *or* linkup, if *or* when they said to me	Lukquenkup, if *or* when they said to us
Lukquonkup, if *or* when they said to thee	Lukquekup, if *or* when they said to you
Luchtinkup *or* lindup, if *or* when they said to him	Lachtitpannup, if *or* when they said to them.

Future.

Linketsch, if *or* when they shall *or* will say to me	Lukquenquetsch, if *or* when they shall *or* will say to us
Lukquonnetsch, if *or* when they shall *or* will say to thee	Lukquequetsch, if *or* when they shall *or* will say to you
Lindetsch, if *or* when they shall *or* will say to him	Lachtitetsch, if *or* when they shall *or* will say to them.

[SIXTH CONJUGATION.]

PERSONAL FORMS.—NEGATIVE.

FIRST TRANSITION.

INDICATIVE MOOD.

Present.

K'dellowi*, I do not say to thee	K'dellohhumowi, I do not say to you
N'dellawi, I do not say to him	N'dellawiwak, I do not say to them.

Preterite.

K'dellowip, I did not say to thee	K'dellohhumowap, I did not say to you
N'dellawip, I did not say to him.	N'dellawipannik, I did not say to them.

Future.

K'dellowitsch, I shall *or* will not say to thee	K'dellohhumowitsch, I shall *or* will not say to you
N'dellawitsch, I shall *or* will not say to him	N'dellawiwaktsch, I shall *or* will not say to them.

The Subjunctive Mood is wanting throughout.

SECOND TRANSITION.

INDICATIVE MOOD.

Present.

K'delliwi, thou sayest not to me	K'delliwuneen, thou sayest not to us
K'dellawi, thou sayest not to him	K'dellawiwak, thou sayest not to them.

Preterite.

K'delliwip, thou didst not say to me	K'delliwunenap, thou didst not say to us
K'dellawip, thou didst not say to him	K'dellawipannik, thou didst not say to them.

Future.

K'delliwitsch, thou shalt *or* wilt not say to me	K'delliwuneentsch, thou shalt *or* wilt not say to us
K'dellawitsch, thou shalt *or* wilt not say to him	K'dellawiwaktsch, thou shalt *or* wilt not say to them.

IMPERATIVE MOOD.

Katschi liyeketsch, say not to me	Katschi liyenketsch, say not to us
Katschi liyannetsch, say not to him	Katschi liyanketsch, say not to them.

* Atta or Matta prefixed throughout.

THIRD TRANSITION.

INDICATIVE MOOD.

Present.

N'dellguwi, he says not to me
K'dellguwi, he says not to thee
W'dellawi, he says not to him
N'dellguwuneen *or* lukguwuneen, he says not to us
K'dellguwawi, he says not to you
W'dellawiwak, he says not to them.

Preterite.

N'dellguwip *or* lukuwip, he did not say to me
K'dellguwip, he did not say to thee
W'dellawip, he did not say to him
Lukguwuneenep, he did not say to us
Lukguwawip, he did not say to you
W'dellawipannik, he did not say to them.

Future.

N'dellguwitsch, he shall *or* will not say to me
K'dellguwitsch, he shall *or* will not say to thee
W'dellawitsch, he shall *or* will not say to him
Lukguwuneentsch *or* n'dellgunwuneentsch, he shall *or* will not say to us
Lukguwawitsch, he shall *or* will not say to you
W'dellawiwaktsch, he shall *or* will not say to them.

FOURTH TRANSITION.

INDICATIVE MOOD.

Present.

K'dellowuneen, we do not say to thee
N'dellawuneen, we do not say to him
K'dellohhummowuneen, we do not say to you
N'dellawawuna, we do not say to them.

Preterite.

K'dellowuneenap, we did not say to thee
N'dellawunap, we did not say to him
K'dellohhummowunap, we did not say to you
N'dellawawunapannik, we did not say to them.

Future.

K'dellowuneentsch, we shall *or* will not say to thee
N'dellawunatsch, we shall *or* will not say to him
K'dellohhummowunatsch, we shall *or* will not say to you
N'dellawunanatsch, we shall *or* will not say to them.

FIFTH TRANSITION.

(Not given.)

SIXTH TRANSITION.

INDICATIVE MOOD.

Present.

N'dellgewi, they do not say to me	N'dellgeweneen, they do not say to us
K'dellgewi, they do not say to thee	K'dellgewunewo, they do not say to you
W'dellawiwak, they do not say to him	W'dellawiwawall, they do not say to them.

Preterite.

N'dellgewip, they did not say to me	N'dellgewunenap, they did not say to us
K'dellgewip, they did not say to thee	K'dellgehhimowi, they did not say to you
W'dellawipannik, they did not say to him	W'dellawiwapannik, they did not say to them.

Future.

N'dellgewitsch, they shall *or* will not say to me	N'dellgewuneentsch, they shall *or* will say to us
K'dellgewitsch, they shall *or* will not say to thee	K'dellgewunewotsch, they shall *or* will say to you
W'dellawiwaktsch, they shall *or* will not say to him	W'dellawiwawaktsch, they shall *or* will say to them.

RELATIVE FORM.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
Eloweya, as *or* what I say	Eloweyenk, as *or* what we say
Eloweyan, as *or* what thou sayest	Eloweyek, as *or* what ye say
Elowit, as *or* what he says	Elowechtit, as *or* what they say.

Preterite.

Singular.	*Plural.*
Eloweyakup, as *or* what I said	Eloweyenkup, as *or* what we said
Eloweyannup, as *or* what thou saidst	Eloweyekup, as *or* what ye said
Elowetup, as *or* what he said	Elowechtitup, as *or* what they said.

Pluperfect.

Singular.	*Plural.*
Eloweyakpanne, as *or* what I had said	Eloweyenkpanne, as *or* what we had said
Eloweyanpanne, as *or* what thou hadst said	Eloweyekpanne, as *or* what ye had said
Elowetpanne, as *or* what he had said	Elowechtitpanne, as *or* what they had said.

The Future

Is like the present, adding *tsch.*

TRANSITIONS.—FIRST TRANSITION.

INDICATIVE MOOD.

Present.

Elen, as *or* what I say to thee	Elek, as *or* what I say to you
Elak, as *or* what I say to him	Elachkup, as *or* what I say to them.

SECOND TRANSITION.

Eliyan, as *or* what thou sayest to me	Eliyenk, as *or* what thou sayest to us
Elan, as *or* what thou sayest to him	Elachtup, as *or* what thou sayest to them.

THIRD TRANSITION.

Elit, as *or* what he says to me	Elquenk, as *or* what he says to us
Elquon, as *or* what he says to thee	Elquek, as *or* what he says to you
Elat *or* elguk, as *or* what he says to him	Ellatup, as *or* what he says to them.

FOURTH TRANSITION.

Elenk, as *or* what we say to thee	Elek, as *or* what we say to you
Elank, as *or* what we say to him	Elanquik, as *or* what we say to them.

FIFTH TRANSITION.

Eliyek, as *or* what ye say to me	Eliyenkup, as *or* what ye say to us
Elatup, as *or* what ye say to him	Elaachtup, as *or* what ye say to them.

SIXTH TRANSITION.

Elink, as *or* what they say to me	Elgeyenk, as *or* what they say to us
Elquonnik, as *or* what they say to thee	Elgeyek, as *or* what they say to you
Elachtit, as *or* what they say to him	Elachtitup, as *or* what they say to them.

RECIPROCAL FORM.

INFINITIVE MOOD.

Littin, to say to each other	Littinep, to have said to each other.

[SIXTH CONJUGATION.]

INDICATIVE MOOD.

Present.

Littineen *or* littihhena, we say to *or* among each other

Littihhimo *or* k'delltihhimo, ye say to *or* among each other

Littowak, they say to *or* among each other.

Preterite.

Littenenap *or* littihhenap, we said to *or* among each other

Littihhimoap *or* k'dellihhimoap, ye said to *or* among each other

Littopannik, they said to *or* among each other.

Future.

Littihhenatsch, we shall *or* will say to *or* among each other

Littihhimotsch, ye shall *or* will say to *or* among each other

Littowaktsch, they shall *or* will say to *or* among each other.

SUBJUNCTIVE MOOD.

Present.

Littiyenk, if *or* when we say to *or* among each other

Littiyek, if *or* when ye say to *or* among each other

Littichtit, if *or* when they say to *or* among each other.

Preterite.

Littiyenkup, if *or* when we said to *or* among each other

Littiyekup, if *or* when ye said to *or* among each other

Littichtitup, if *or* when they said to *or* among each other.

The Future

Is formed from the present, *tsch* suffixed.

REFLECTED FORM.

This form is used in the Singular as follows:

N'della n'hakey, I say to myself

K'della k'hakey, thou sayest to thyself

W'dellawall hakeyall, he says to himself.

N'dahowala n'hakey, I love myself

K'dahowala k'hakey, thou lovest thyself

W'dahowalawall hakeyall, he loves himself.

N'pennauwelema n'hakey, I take care of myself

Pennauwelem k'hakey, take care of thyself.

Pennauwelemawal hakeyall *or* lachauwelemawall hakeyall, he is anxious about himself (*or* troubled in mind)

Pennauwelemo hakeyuwa, be anxious about yourselves (*or* troubled in mind)*.

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* *Note by the Translator.*—This expression, which probably was first introduced by the missionaries in their sermons, has nothing very *spiritual* in it; the ideas of *body* and *mind* will appear here to be strangely confounded. But the most polished nations of antiquity have hardly been more successful in their endeavours to express ideas that are not perceptible to our senses. The words *πνεῦμα*, *spiritus*, are at best metaphors drawn from sensible objects, and the same result will probably be found in all languages if we recur to the etymology of the words which are meant to express *soul, mind*, &c. See the note above, p. 166.

Seventh Conjugation.

MILTIN, to give*.

This verb has no simple active voice; we cannot say, I give, thou givest, he gives, &c., but the personal forms must be used, I give to thee, him, &c. It is the same in the passive voice.

There is an active verb, however, which expresses the idea of giving away, or parting with something, without recurring to the personal forms; thus we say *n'meken*, I give away, *k'meken*, thou givest away, *meken*, he gives away, &c. Preterite, *mekenep*, I have given away. Imperative, *meek*, give away†.

ACTIVE VOICE.

PERSONAL FORMS.—POSITIVE.

INFINITIVE MOOD.

Miltin, to give to some body *or* make a present of.

PARTICIPLES.

Milit, he who gives to me
Milat, he who gives to him
Milquenk, he who gives to us
Milqueek, he who gives to you
Milquichtit, he who gives to them.

FIRST TRANSITION.

INDICATIVE MOOD.

Present.

K'milell‡, I give to thee
N'milan, I give to him
K'milellohhumo, I give to you
N'milawak *or* n'milanewo, I give to them.

* *Note by the Translator.*—The Author gives only this example of the Seventh Conjugation, and does not tell us whether all the verbs belonging to it want the abstract forms active and passive, or whether this defect is peculiar to some of them. I have sought in vain for an explanation of this difficulty, which I am not qualified to solve.

† *Note by the Translator.*—The verbs ending in *en* do not appear to be classed with any of the eight conjugations. From a comparison of the forms, it would appear that they belong to the first, ending in *in*. In an unwritten language the vowels are easily mistaken for one another, and it is difficult to preserve a consistent orthography. Thus the Author writes sometimes *Getannitowit*, (God), and sometimes *Kitannitowit*. Similar inconsistencies will appear in the course of this work, which the judicious reader will easily account for.

‡ *Note by the Translator.*—The Author writes *gemilell, nemilan*, &c.; it is evident that he uses the *g*, instead of the *k*, to indicate the inseparable pronoun of the second person. For this

[SEVENTH CONJUGATION.]

Preterite.

K'milellanep, I gave to thee
N'milap, I gave to him
K'milellohhumoap, I gave to you
N'milapannik, I gave to them.

Future.

K'milletsch, I shall *or* will give to thee
N'milantsch, I shall *or* will give to him
K'milellohhumotsch, I shall *or* will give to you
N'milawaktsch, I shall *or* will give to them.

SUBJUNCTIVE MOOD.

Present.

K'milellane, if *or* when I give to thee
N'milachke, if *or* when I give to him
N'mileque, if *or* when I give to you
Milatpanne, if *or* when I give to them.

Preterite.

K'milannup, if *or* when I gave to thee
N'milachkup, if *or* when I gave to him
N'milekup, if *or* when I gave to you
N'milawakup, if *or* when I gave to them.

Pluperfect.

K'milenpanne, if *or* when I had given to thee
N'milachkpanne, if *or* when I had given to him
N'milekpanne, if *or* when I had given to you
N'milakpanne, if *or* when I had given to them.

Future.

K'milellannetsch, if *or* when I shall *or* will give to thee
N'milaketsch, if *or* when I shall *or* will give to him
N'milequetsch, if *or* when I shall *or* will give to you
N'milachtiquetsch, if *or* when they shall *or* will give to them.

SECOND TRANSITION.

INDICATIVE MOOD.

Present.

K'mili, thou givest to me
K'milan, thou givest to him
K'milineen *or* k'milihhena, thou givest to us
K'milowak *or* k'milanewo, thou givest to them.

Preterite.

K'milihump, thou hast given to me
K'milap, thou hast given to him
K'milihhenap, thou hast given to us
K'milapannik, thou hast given to them.

---

he gives as a reason, in one of the printed works, that his printer not having a sufficiency of *k's*, he was obliged to employ the letter *g* in its stead. Like the *e* which follows, it is meant to represent the sheva or mute sound between the two consonants, which elsewhere is represented by the apostrophe, and sometimes is not at all designated, as the interval between the consonants is sufficiently apparent.

Future.

K'miletsch, thou shalt *or* wilt give to me
K'milantsch, thou shalt *or* wilt give to him
K'milihhenatsch, thou shalt *or* wilt give to us
K'milawaktsch, thou shalt *or* wilt give to them.

IMPERATIVE MOOD.

Mil, give
Milil, give me
Milau, give him
Milineen, give us
Milo, give them
Milatom, let us give
Miltin, it is given.

SUBJUNCTIVE MOOD.

Present.

Miliyanne, if *or* when thou givest to me
Milanne, if *or* when thou givest to him
Miliyenke, if *or* when thou givest to us
Milawawanne, if *or* when thou givest to them.

Preterite.

Miliyannup, if *or* when thou hast given to me
Milannup, if *or* when thon hast given to him
Miliyenkup, if *or* when thou hast given to us
K'milannik, if *or* when thou hast given to them.

Pluperfect.

Miliyanpanne, if *or* when thou hadst given to me
Milanpanne, if *or* when thou hadst given to him
Miliyenkpanne, if *or* when thou hadst given to us
Milawatpanne, if *or* when thou hadst given to them.

Future.

Miliyannetsch, if *or* when thou shalt *or* wilt give to me
Milannetsch, if *or* when thou shalt *or* wilt give to him
Miliyenketsch, if *or* when thou shalt *or* wilt give to us
K'milachtitetsch, if *or* when thou shalt *or* wilt give to them.

THIRD TRANSITION.

INDICATIVE MOOD.

Present.

N'miluk, he gives to me
K'miluk, he gives to thee
Milan, milgol, milawall, he gives to him
N'milguneen, n'milguna, he gives to us
K'milguwa, he gives to you
Milawak, he gives to them.

Preterite.

N'milgap, he gave *or* has given to me
K'milgap, he gave *or* has given to thee
Milap, he gave *or* has given to him
K'milgunenap, he gave *or* has given to us
K'melguwap, he gave *or* has given to you
Milapannik, he gave *or* has given to them.

Future.

N'miluktsch, he shall *or* will give to me
K'miluktsch, he shall *or* will give to thee
Milgotsch *or* milauchtsch, he shall *or* will give to him
N'milgunatsch, he shall *or* will give to us
K'milguwatsch, he shall *or* will give to you
Milawaktsch, he shall *or* will give to them.

SUBJUNCTIVE MOOD.

Present.

Milite, if *or* when he gives to me
Milquonne, if *or* when he gives to thee
Milate, if *or* when he gives to him
Milquenke, if *or* when he gives to us
Milqueque, if *or* when he gives to you
Milachtite, if *or* when he gives to them.

Preterite.

Militup, if *or* when he has given to me
Milquonnup, if *or* when he has given to thee
Milatup, if *or* when he has given to him
Milquenkup, if *or* when he has given to us
Milquekup, if *or* when he has given to you
Milachtitup, if *or* when he has given to them.

Pluperfect.

Militpanne, if *or* when he had given to me
Milquonpanne, if *or* when he had given to thee
Milatpanne, if *or* when he had given to him
Milquenkpanne, if *or* when he had given to us
Milquekpanne, if *or* when he had given to you
Milachtitpanne, if *or* when he had given to them.

Future.

Militetsch, if *or* when he shall *or* will give to me
Miliquonnetsch, if *or* when he shall *or* will give to thee
Milatetsch, if *or* when he shall *or* will give to him
Milquenketsch, if *or* when he shall *or* will give to us
Milqueketsch, if *or* when he shall *or* will give to you
Milachtitetsch, if *or* when he shall *or* will give to them.

FOURTH TRANSITION.

INDICATIVE MOOD.

Present.

K'milenneen *or* k'milohhena, we give to thee
N'milohhena, we give to him
K'milohhumo, we give to you
N'milawawuna *or* n'milawawak, we give to them.

Preterite.

K'milohhenap *or* k'milonnenap, we gave *or* have given to thee
N'milawunap, we gave *or* have given to him
K'milohhummenap, we gave *or* have given to you
N'milawawunap, we gave *or* have given to them.

Future.

K'mileneentsch, we shall *or* will give to thee
N'mileneentsch, we shall *or* will give to him
K'milohhumotsch, we shall *or* will give to you
N'milawawunatsch, we shall *or* will give to them.

SUBJUNCTIVE MOOD.

Present.

Milenore, if *or* when we give to thee
N'milanque, if *or* when we give to him
Mileque, if *or* when we give to you
Milinde, if *or* when we give to them.

Preterite.

Milenkup, if *or* when we gave *or* have given to thee	Milekup, if *or* when we gave *or* have given to you
Milankup, if *or* when we gave *or* have given to him	Milawankup, if *or* when we gave *or* have given to them.

Pluperfect.

Milenkpanne, if *or* when we had given to thee	Milekpanne, if *or* when we had given to you
Milankpanne, if *or* when we had given to him	Milindpanne, if *or* when we had given to them.

Future.

Milenquetsch, if *or* when we shall *or* will give to thee	Milequetsch, if *or* when we shall *or* will give to you
Milanquetsch, if *or* when we shall *or* will give to him	Milindpanne, if *or* when we shall *or* will give to them.

FIFTH TRANSITION.

INDICATIVE MOOD.

Present.

K'milihhimo, ye give to me	K'milihhena ye give to us
K'milanewo, ye give to him	K'milawawak, ye give to them.

Preterite.

K'milihhimoap, ye gave *or* have given to me	K'milihhenap, ye gave *or* have given to us
K'milanewoap, ye gave *or* have given to him	K'milawawak, ye gave *or* have given to them.

Future.

K'milihhimotsch, ye shall *or* will give to me	K'millihhenatsch, ye shall *or* will give to us
K'milanewotsch, ye shall *or* will give to him	K'milawawaktsch, ye shall *or* will give to them.

SUBJUNCTIVE MOOD.

Present.

Miliyeque, if *or* when ye give to me	Miliyenque, if *or* when ye give to us
Milaque, if *or* when ye give to him	Milachtique, if *or* when ye give to them.

Preterite.

Miliyekup, if *or* when ye gave *or* have given to me	Miliyenkup, if *or* when ye gave *or* have given to us
Milakup, if *or* when ye gave *or* have given to him	Milachtikup, if *or* when ye gave *or* have given to them.

Pluperfect.

Miliyekpanne, if *or* when ye had given to me	Miliyenkpanne, if *or* when he had given to us
Milakuppanne, if *or* when ye had given to him	Milachtiyekpanne, if *or* when ye had given to them.

Future.

Miliyequetsch, if *or* when ye shall *or* will give to me
Milaquetsch, if *or* when ye shall *or* will give to him
Miliyenquetsch, if *or* when ye shall *or* will give to us
Milachtiyequetsch, if *or* when ye shall *or* will give to them.

SIXTH TRANSITION.

INDICATIVE MOOD.

Present.

N'milge, they give to me
K'milge, they give to thee
Milanewo, they give to him
K'milgeneen, they give to us
Kmilgehhimo, they give to you
Milawawall *or* milawawak, they give to them

Preterite.

N'milgenep, they gave *or* have given to me
K'milgenep, they gave *or* have given to thee
Milapannik, they gave *or* have given to him
N'milgenenap, they gave *or* have given to us
K'milgehhimoap, they gave *or* have given to you
Milawawapannik, they gave *or* have given to them.

Future.

N'milgetsch, they shall *or* will give to me
K'milgetsch, they shall *or* will give to thee
Milawawaltsch, they shall *or* will give to him
N'milgeneentsch, they shall *or* will give to us
K'milgehhimotsch, they shall *or* will give to you
Milanewotsch, they shall *or* will give to them.

SUBJUNCTIVE MOOD.

Present.

Milinke, if *or* when they give to me
Milgeyane, if *or* when they give to thee
Milachtite, if *or* when they give to him
Milgeyenke, if *or* when they give to us
Milgeyeke, if *or* when they give to you
Milaachtite, if *or* when they give to them.

Preterite.

Milinkup, if *or* when they gave *or* have given to me
Milgeyannup, if *or* when they gave *or* have given to thee
Milachtitup *or* milintup, if *or* when they gave *or* have given to him
Milgeyenkup, if *or* when they gave *or* have given to us
Milgeyekup, if *or* when they gave *or* have given to you
Milaachtitup, if *or* when they gave *or* have given to them.

Pluperfect.

Milinkpanne, if *or* when they had given to me
Milgeyanpanne, if *or* when they had given to thee
Milachtitpanne *or* milintpanne, if *or* when they had given to him
Milgeyenkpanne, if *or* when they had given to us
Milgeyekpanne, if *or* when they had given to you
Milaachtitpanne, if *or* when they had given to them.

Future.

Milinketsch, if *or* when they shall *or* will give to me	Milgeyenketsch, if *or* when they shall *or* will give to us
Milgeyannetsch, if *or* when they shall *or* will give to thee	Milgeyeketsch, if *or* when they shall *or* will give to you
Milachtitetsch, if *or* when they shall *or* will give to him	Milaachtitetsch, if *or* when they shall *or* will give to them.

The Negative Forms are not given.

PASSIVE VOICE.—POSITIVE.

INFINITIVE MOOD.

Milgussin, to have (something) given to one.

PARTICIPLES.

Singular.	*Plural.*
Milgussit, he to whom is given	Milgussitschit, they to whom is given

Future.

Milgussitpannik, they to whom will be given.

PERSONAL FORMS.—FIRST TRANSITION.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'milgussi (*Lat.* mihi datur), it is given to me	Milgussineen, it is given to us
K'milgussu, it is given to thee	Milgussihhimo*, it is given to you
Milgussu, it is given to him	Milgussowak, it is given to them.

Preterite.

Singular.	*Plural.*
N'milgussihump, it was given to me	Milgussihhenap, it was given to us
K'milgussihump, it was given to thee	Milgussihhimoap, it was given to you
Milgussop, it was given to him	Milgussopannik, it was given to them.

Future.

Singular.	*Plural.*
N'milgussitsch, it shall *or* will be given to me	Milgussihhenatsch, it shall *or* will be given to us
K'milgussitsch, it shall *or* will be given to thee	K'milgussihhimotsch, it shall *or* will be given to you
Milgussutsch, it shall *or* will be given to him	Milgussowaktsch, it shall *or* will be given to them.

* *Note by the Translator.*—The double *hh*, here and in other places, does not indicate a particular sound or stronger aspiration, but only that the preceding vowel *i* is to be pronounced short. This mode of writing is borrowed from the orthography of the German language.

[SEVENTH CONJUGATION.]

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
N'milgussiya, if *or* when it is given to me	Milgussiyenk, if *or* when it is given to us
Milgussiyanne, if *or* when it is given to thee	Milgussiyek, if *or* when it is given to you
Milgussite, if *or* when it is given to him	Milgussichtit, if *or* when it is given to them.

Preterite.

Singular.	*Plural.*
Migussiyakup, if *or* when it was given to me	Milgussiyenkup, if *or* when it was given to us
Milgussiyannup, if *or* when it was given to thee	Milgussiyekup, if *or* when it was given to you
Milgussitup, if *or* when it was given to him	Milgussichtitup, if *or* when it was given to them.

Pluperfect.

Singular.	*Plural.*
Milgussiyakpanne, if *or* when it had been given to me	Milgussiyenkpanne, if *or* when it had been given to us
Milgussiyankpanne, if *or* when it had been given to thee	Milgussiyekpanne, if *or* when it had been given to you
Milgussitpanne, if *or* when it had been given to him	Milgussichtitpanne, if *or* when it had been given to them.

Future.

Singular.	*Plural.*
Milgussiyatsch, if *or* when it shall *or* will be given to me	Milgussiyenketsch, if *or* when it shall *or* will be given to us
Milgussiyannetsch, if *or* when it shall *or* will be given to thee	Milgussiyeketsch, if *or* when it shall *or* will be given to you
Milgussitetsch, if *or* when it shall *or* will be given to him	Milgussichtitetsch, it shall *or* will be given to them.

Note by the Translator.—The other Transitions are not given, and the negative form of this Transition is given only in the Subjunctive Mood, as follows:

NEGATIVE FORM.—FIRST TRANSITION.

SUBJUNCTIVE MOOD.

Present.

Singular.	*Plural.*
Matta milgussiwak, if *or* when it is not given to me	Matta milgussiwenk, if *or* when it is not given to us
Matta milgussiwonne, if *or* when it is not given to thee	Matta milgussiwek, if *or* when it is not given to you
Matta milgussique, if *or* when it is not given to him	Matta milgussichtik, if *or* when it is not given to them.

Preterite.

Singular.	*Plural.*
Matta milgussiwakup, if *or* when it was not given to me	Matta milgussiwenkup, if *or* when it was not given to us
Matta milgussiwonnup, if *or* when it was not given to thee	Matta milgussiwekup, if *or* when it was not given to you
Matta milgussikup, if *or* when it was not given to him	Matta milgussichtikup, if *or* when it was not given to them.

Pluperfect.

Singular.	*Plural.*
Matta milgussiwakpanne, if *or* when it had not been given to me	Matta milgussiwenkpanne, if *or* when it had not been given to us
Matta milgussiwonpanne, if *or* when it had not been given to thee	Matta milgussiwekpanne, if *or* when it had not been given to you
Matta milgussikpanne, if *or* when it had not been given to him	Matta milgussichtikpanne, if *or* when it had not been given to them.

Future.

Singular.	*Plural.*
Matta milgussiwaktsch, if *or* when it shall *or* will not be given to me	Matta milgussiwenketsch, if *or* when it shall *or* will not be given to us
Matta milgussiwonnetsch, if *or* when it shall *or* will not be given to thee	Matta milgussiweketsch, if *or* when it shall *or* will not be given to you
Matta milgussiquetsch, if *or* when it shall *or* will not be given to him	Matta milgussichtiketsch, if *or* when it shall *or* will not be given to them.

Eighth Conjugation.

No. I.

PETON, to bring.

INDICATIVE MOOD.

Present.

Singular.	*Plural.*
N'peton, I bring	N'petoneen, we bring
K'peton, thou bringest	K'pettohhumo, ye bring
Peton, he brings	Petonewo, they bring.

Preterite.

Singular.	*Plural.*
N'petonep, I have brought	N'petonenap, we have brought
K'petonep, thou hast brought	K'petohhumoap, ye have brought
Petonep, he has brought	Petonewoap, they have brought.

Future.

Singular.	*Plural.*
N'petontsch, I shall *or* will bring	N'petoneentsch, we shall *or* will bring
K'petontsch, thou shalt *or* wilt bring	K'petohhumotsch, ye shall *or* will bring
Petontsch, he shall *or* will bring	Petonewotsch, they shall *or* will bring.

IMPERATIVE MOOD.

Singular.	*Plural.*
Petol, bring thou	Petook, bring ye.

Note by the Translator.—The Subjunctive of this verb is not given. except in the Personal forms, which follow :

PERSONAL FORMS.—FIRST TRANSITION.

INDICATIVE MOOD.

Present.

K'petolen, I bring to thee	K'petolohhumo, I bring to you
N'petawan, I bring to him	N'petawawak, I bring to them.

Preterite.

K'petolenep, I brought to thee	K'petolohhumoap*, I brought to you
N'petawap, I brought to him	N'petawapannik, I said to them.

Future.

K'petolentsch, I shall *or* will bring to thee	K'petolohhumotsch, I shall *or* will bring to you
N'petawantsch, I shall *or* will bring to him	N'petawawaktsch, I shall *or* will bring to them.

SUBJUNCTIVE MOOD.

Present.

K'petolanne, if *or* when I bring to thee	N'petoleque, if *or* when I bring to you
N'petawake, if *or* when I bring to him	N'petawawake, if *or* when I bring to them.

Preterite.

N'petolanup, if *or* when I have brought to thee	N'petolekup, if *or* when I have brought to you
N'petawannup, if *or* when I have brought to him	N'petawawannup, if *or* when I have brought to them.

Future.

N'petolannetsch, if *or* when I shall *or* will bring to thee	N'petolequetsch, if *or* when I shall *or* will bring to you
N'petawannetsch, if *or* when I shall *or* will bring to him	N'petawawaketsch, if *or* when I shall *or* will bring to them.

* *Note by the Translator.*—This is by contraction from *k'petolohhummoakup*, which is the most correct form; but is generally contracted in speech.

SECOND TRANSITION.

INDICATIVE MOOD.

Present.

K'petawi, thou bringest to me
K'petawa, thou bringest to him
K'petawineen, thou bringest to us
K'petawawak, thou bringest to them.

Preterite.

K'petawinep, thou broughtest to me
K'petawap, thou broughtest to him
K'petawinenap, thou broughtest to us
K'petawapannik, thou broughtest to them.

Future.

K'petawitsch, thou shalt *or* wilt bring to me
K'petawatsch, thou shalt *or* wilt bring to him
K'petawihhenatsch, thou shalt *or* wilt bring to us
K'petawawaktsch, thou shalt *or* wilt bring to them.

IMPERATIVE MOOD.

Petawil, bring to me now
Petawime, bring me at a future time
Petawik, bring ye to me
Petawineen, bring to us.

SUBJUNCTIVE MOOD.

Present.

K'petawiyane, if *or* when thou bringest to me
K'petawanne, if *or* when thou bringest to him
K'petawiyenke, if *or* when thou bringest to us
K'petawawanne, if *or* when thou bringest to them.

Preterite.

K'petawiyannup, if *or* when thou hast brought to me
K'petawannup, if *or* when thou hast brought to him
K'petawiyenkup, if *or* when thou hast brought to us
K'petawawakup, if *or* when thou hast brought to them.

Future.

(Not given.)

THIRD TRANSITION.

INDICATIVE MOOD.

Present.

N'petagun, he brings to me
K'petaguk, he brings to thee
Petagol, he brings to him
N'petaguneen, he brings to us
K'petaguwa, he brings to you
Petawawak, he brings to them.

[EIGHTH CONJUGATION.]

Preterite.

N'petagop, he brought to me	N'petagunap, he brought to us
K'petagop, he brought to thee	K'petaguwap, he brought to you
Petawap, he brought to him	Petawapannik, he brought to them.

Future.

N'petaktsch, he shall *or* will bring to me	N'petageneentsch, he shall *or* will bring to us
K'petaguktsch, he shall *or* will bring to thee	K'petaguwatsch, he shall *or* will bring to you
Petagoltsch *or* petawatsch, he shall *or* will bring to him	Petawawaktsch, he shall *or* will bring to them.

SUBJUNCTIVE MOOD.

Present.

Petawite, if *or* when he brings to me	Petaquenke, if *or* when he brings to us
Petaquonne, if *or* when he brings to thee	Petaqueke, if *or* when he brings to you
Petawate, if *or* when he brings to him	Petawachtite, if *or* when he brings to them.

Preterite.

Petawitup, if *or* when he brought to me	Petaquenkup, if *or* when he brought to us
Petaquonnup, if *or* when he brought to thee	Petaquekup, if *or* when he brought to you
Petawatup, if *or* when he brought to him	Petawachtitup, if *or* when he brought to them.

Future.

Petawitsch, when *or* if he shall bring to me	Petaquenktsch, when *or* if he shall bring to us
Petaquonnetsch, when *or* if he shall bring to thee	Petaquektsch, when *or* if he shall bring to you
Petawatsch, when *or* if he shall bring to him	Petawachtitsch, when *or* if he shall bring to them.

FOURTH TRANSITION.

INDICATIVE MOOD.

Present.

K'petoleneen, we bring to thee	K'petolohhena, we bring to you
N'petawaneen, we bring to him	N'petawawuna, we bring to them.

Preterite.

K'petolenenap, we have brought to thee	K'petolohhenap, we have brought to you
N'petawanenap, we have brought to him	N'petawawunap, we have brought to them.

Future.

K'petolenneentsch, we shall bring to thee	K'petolohhenatsch, we shall bring to you
N'petawaneentsch, we shall bring to him	N'petawawunatsch, we shall bring to them.

SUBJUNCTIVE MOOD.

Present.

Petolenque, when *or* if we bring to thee	Petaquonquek, when *or* if we bring to you
Petawonque, when *or* if we bring to him	Petawawonque, when *or* if we bring to them.

Preterite.

Petolenkup, when *or* if we brought to thee
Petawonkup, when *or* if we brought to him
Petaquekup, when *or* if we brought to you
Petawawonkup, when *or* if we brought to them.

Future.

Petolenketsch, when *or* if we shall bring to thee
Petawonketsch, when *or* if we shall bring to him
Petaquenketsch, when *or* if we shall bring to you
Petawawanketsch, when *or* if we shall bring to them.

FIFTH TRANSITION.

INDICATIVE MOOD.

Present.

K'petawihhimo, you bring to me
K'petawanewo, you bring to him
K'petawihhena, you bring to us
K'petawawawak, you bring to them.

Preterite.

K'petawihhimoap, you brought to me
K'petawanewap *or* k'petawanewakup, you brought to him
K'petawihhenap *or* k'petawihummenakup, you brought to us
K'petawapannik *or* k'petawanewakup, you brought to them.

Future.

K'petawihhimotsch, you shall bring to me
K'petawanewotsch, you shall bring to him
K'petawihhenatsch, you shall bring to us
K'petawawawaktsch, you shall bring to them.

SUBJUNCTIVE MOOD.

Present.

Petawiyek, when *or* if you bring to me
Petaquek, when *or* if you bring to him
Petaquiyek, when *or* if you brought to us
Petawaque *or* petawachtique, when *or* if you brought to them.

Preterite.

Petawiyekup, when *or* if you brought to me
Petaquekup, when *or* if you brought to him
Petaquiyekup, when *or* if you brought to us
Petawaquekup, when *or* if you brought to them.

Future.

Petawiyektsch, when *or* if you shall bring to me
Petaquektsch, when *or* if you shall bring to him
Petaquiyektsch, when *or* if you shall bring to us
Petawaquektsch, when *or* if you shall bring to them.

SIXTH TRANSITION.

INDICATIVE MOOD.

Present.

N'petake, they bring *or* one brings to me	Petakeneen, they bring *or* one brings to us
K'petake, they bring *or* one brings to thee	K'petakenewo, they bring *or* one brings to you
Petawanewo, they bring *or* one brings to him	Petawawanewo, they bring *or* one brings to them.

Preterite.

N'petakep, they brought to me	N'petakenenap, they brought to us
K'petakep, they brought to thee	K'petakenewap, they brought to you
Petawanewap, they brought to him	Petawawapannik, they brought to them.

Future.

N'petaketsch, they shall bring to me	N'petakeneentsch, they shall bring to us
K'petaketsch, they shall bring to thee	K'petakenewotsch, they shall bring to you
Petawanewotsch, they shall bring to him	Petawawanewotsch, they shall bring to them.

SUBJUNCTIVE MOOD.

Present.

Petamichtite, when *or* if they bring to me	Petaquenke, when *or* if they bring to us
Petakeyanne, when *or* if they bring to thee	Petaqueque, when *or* if they bring to you
Petawachtite, when *or* if they bring to him	Petawawachtite, when *or* if they bring to them.

Preterite.

Petamichtitup, when *or* if they brought to me	Petaquenkup, when *or* if they brought to us
Petakeyannup, when *or* if they brought to thee	Petaquekup, when *or* if they brought to you
Petawachtitup, when *or* if they brought to him	Petawawachtitup, when *or* if they brought to them.

Pluperfect.

Petamichtitpanne, when *or* if they had brought to me	Petakeyenkpanne, when *or* if they had brought to us
Petakeyanpanne, when *or* if they had brought to thee	Petakeyekpanne, when *or* if they had brought to you
Petawachtitpanne, when *or* if they had brought to him	Petawawachtitpanne, when *or* if they had brought to them.

Future.

Petamichtitsch, when *or* if they shall bring to me	Petaquenketsch, when *or* if they shall bring to us
Petakeyannetsch, when *or* if they shall bring to thee	Petaquequetsch, when *or* if they shall bring to you
Petawachtitsch, when *or* if they shall bring to him	Petawawachtitsch, when *or* if they shall bring to them.

[EIGHTH CONJUGATION.]

Note by the Translator.—In another part of this Grammar, the following partial forms of this verb are given:

INDEFINITE TRANSITION.

INDICATIVE MOOD.

Present.

N'peschogun, one brings to me	N'peschoguneen, one brings to us
K'peschogun, one brings to thee	K'peschguwa, one brings to you
Peschogol, one brings to him	Peschguwawak, one brings to them.

ANIMATE FORM.—FIRST TRANSITION.

INDICATIVE MOOD.

Present.

N'peschuwa, I bring to him	N'peschuwaneen, we bring to him
K'peschuwa, thou bringest to him	K'peschuwanewo, you bring to him
Peschuwa, he brings to him	Peschuwawak, they bring to him.

This last form is only used when speaking of animals, as for instance, *nenayunges n'peschuwa*, I bring the horse to him*.

No. II.

OLHATTON *or* WULATTON, to have *or* possess something *or* have it in one's custody.

INFINITIVE MOOD.

Present.

Olhatton *or* wulatton, to have *or* possess.

Preterite.

Olhattonep *or* wulattonep, to have had *or* possessed.

INDICATIVE MOOD.

Present.

Nolhatton *or* nulatton, I have *or* possess	Nolhattoneen *or* nulattoneen, we have *or* possess
Kolhatton *or* kulatton, thou hast *or* dost possess	Kolhattonewo *or* kulattohhumo, you have *or* possess
Olhatton *or* wulatton, he has *or* possesses	Olhattonewo *or* wulattonewo, they have *or* possess.

* *Note by the Translator.*—This is all that is said in this grammar respecting the animate and inanimate forms of the verbs, which distinction is very general in the language. The following verb, *olhatton*, is in the inanimate form. In the animate it is *olhalla*. *Nenayunges nolhallau*, I have a horse (a horse I have him). See Heckew. Corresp. p. 438.

Preterite.

Nolhattoneep *or* nulattonep, I had
Kolhattoneep *or* kulattonep, thou hadst
Olhattoneep *or* wulattonep, he had

Nolhattonenakup *or* nulattonenap, we had
Kolhattonewoakup *or* kulattohhumoap, you had
Olhattonewoakup *or* wulattonewoap, they had.

Future.

Nolhattontschi, I shall have
Kolhattontschi, thou shalt have
Olhattontschi, he shall have

Nolhattoneentsch, we shall have
Kolhattonewotsch, you shall have
Olhattonewotsch, they shall have.

IMPERATIVE MOOD.

Present.

Sing. Wulhattol, wulattol, have, keep, preserve

Plur. Wulhattook, wulattook, do you have, keep, preserve.

Future.

Sing. Wulattaketsch, he must, shall have, keep, preserve

Plur. Wulattschitetsch, they must, shall have, keep, preserve.

SUBJUNCTIVE MOOD.

Present.

Nulattawak, when *or* if I have
Kulattawonne, when *or* if thou hast
Wulattaque, when *or* if he have

Nulattayenke, when *or* if we have
Wulattayeque, when *or* if you have
Wulattochtite, when *or* if they have.

Preterite.

Nulattawakup, when *or* if I had
Kulattawonnup, when *or* if thou hadst
Wulattakup, when *or* if he had

Nulattakenkup, when *or* if we had
Wulattaquekup, when *or* if you had
Wulattochtitup, when *or* if they had.

Pluperfect.

Nulattakpanne, when *or* if I had had
Kulattawonpanne, when *or* if thou hadst had
Wulattakpanne, when *or* if I had had

Nulattawenkpanne, when *or* if we had had
Wulattaquekpanne, when *or* if you had had
Wulattochtitpanne, when *or* if they had had.

The Future

Is formed from the present as above mentioned.

NEGATIVE FORM.

INDICATIVE MOOD.

Present.

Sing. Nulattowi, kulattowi, wulattowi
Plur. Nulattowuneen, kulattowihhimo, wulattowunewo.

Preterite.

Sing. Nulattowip, kulattowip, wulattowip
Plur. Nulattowunenap, kulattowihhimoap, wulattowunewoap.

Future.

Sing. Nulattowitsch, kulattowitsch, wulattowitsch

Plur. Wulattowunnentsch, kulattowihhimotsch. wulattowunewotsch.

The other Moods are not given.

In the same manner with this verb the following are conjugated with very little variation.

Maniton, to make*.
Wuliton, to make something well.
Palliton, to spoil something, to do it wrong.
Matschiton, to do mischief.
Kschiechton, to wash, clean. N'gieschiechton, kischiechton, guschiechton, I clean, thou cleanest, he cleans, *or* I wash, &c.
Gischiton, to make, prepare something. N'gischiton, I prepare, has all the tenses, but not the personal forms.
Pakantschiechton, to fulfil, complete.
Pakandhatton, to repair something, to make it whole.
Poniton, to let something be *or* remain.
Pakiton, to throw away.
Palaton, to earn, to acquire.
Nipachton, to raise *or* set up something, as a post *or* pole.
Nitaton, to do *or* be able to do something.
Niskiton to dirty, to bewray.
Schellachton, to hang up.
Pagachtschaton, to fill.
Logillachton, to tear, to destroy.
Hatton, to place *or* fix something.
Gaton, to conceal, hide.
Apachtschiechton, to display, to spread, to set†.

* *Note by the Translator.*—From this word probably comes *manitto, manitou*, God, the creator, the maker. *Patamawos*, another name for God, comes from *pataman*, to pray; the one to whom we pray.

† *Note by the Translator.*—In the original manuscript there is in this place a number of paradigms of verbs and parts of verbs not classed under their different conjugations, but mostly belonging to the first. In the translation which I made for the Philosophical Society I inserted them under the head of *additional verbs*. On examining them afterwards more closely, I found several were deficient in moods and tenses, and were clearly considered by the author only as materials to be made use of in a revision of his work. Among them were repetitions of verbs already given, but in some respects more complete, containing moods and tenses, which in the first examples were wanting. It will be seen in the verbs, particularly of the first conjugation, that they are not all carried through their different voices, forms, moods, and tenses, so that one often supplies the deficiencies of the others. If the author had lived, it is probable that he would have brought his work to a greater degree of perfection. This I could not undertake to do: but I thought it unnecessary to swell this grammar with these additional verbs and fragments of verbs thus inserted without order or method. I therefore left out all that belonged to the first conjugation, already full enough, contenting myself with extracting what was wanting in the first paradigms, in order to complete them as much as possible. Of the other additional verbs I have inserted two or three under their proper conjugations, leaving out the remainder, which I am satisfied was not intended to remain in its present form.

IRREGULAR VERBS,

OR, VERBS THAT ARE DEFICIENT IN PERSONS OR TENSES.

Note by the Translator.—These are chiefly of the class which we call *impersonal;* but they do not all belong to it, as will be seen by the examples. Therefore the denomination of the author has been preserved. Of those which are called irregular in the ancient and modern languages of Europe, that is to say, of which the several tenses and moods appear to have sprung from different roots, as in Latin *sum, eram, fui,* in French *aller, je vais, j'irai,* and in English *I go, I went,* he gives no examples; and probably there are none in this language. It is a fact worthy of some attention. Among the examples the author had included some of the adjective verbs hereafter mentioned, which we have transferred to their proper head.

EXAMPLES OF IRREGULAR VERBS.

Sokelan, it rains
Sokelaneep, it rained
Sokelantschi, it will rain
Sokelanke, if it rains
Sokelanketsch, when it will rain
Sokelankpanne, if it had rained.
K'schilan, it rains hard
K'schilaneep, it rained hard
Popetelan, it rains now and then, by showers, by starts
Popetelanep, it rained now and then
Alhacquot, it rains a general rain (extending over a large surface of country)
Achkikalan, it sleets.

Wineu, it snows
Wineep, it snowed
Wineuchtschi, it will snow
Wineke, if *or* when it snows
Winekpanne, if it had snowed.

Topan, it freezes a white frost
Topaneep, it did freeze a white frost.

K'schakan, the wind blows hard
K'schakaneep, the wind blew hard
K'schachinke, when *or* if it blows hard
Tamseetsch* kschakan, it will perhaps blow hard
Apitchanehelleu, it blows a contrary wind
Apitchanehellewak, they have a contrary wind
Wundschun, the wind comes from (a particular quarter)
Wundschenneep, the wind did come from, &c.
Wundschinke, when *or* if the wind comes from.

Moschhaquat, the river clears up, is getting free from ice
Moschhaquachteep, the river cleared up
Massipook, the river drifts ice
M'chaquiechen, the water is high
M'chaquiecheneep, the water was high
M'chaquiechinke, when *or* the water is high
M'chaquiechinkpanne, when *or* if the water was *or* had been high
Petaquiechen, the water is rising
Petaquiecheneep, the water was rising.

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* *Note by the Translator.*—This word is compounded of *tamse* sometimes, *eet* perhaps, and the future termination *tsch.*

[IRREGULAR VERBS.]

Wulandeu, it is fine clear weather
Wulandeep, it was fine clear weather
Wulandeuchtschi, it will be fine clear weather
Wulandeke, when it is fine clear weather
Wulandekpanne, if *or* when it was fine clear weather.

Moschhacquat, the weather clears up
Moschhacquachteep, the weather was clear.

Achgumhocquat, it is cloudy weather
Achgumhocquachtop, it was cloudy weather.

Wundeu, it boils
N'wiechen, I boil
Wundeep, it boiled
Wiechenin, to boil, cook the food
Wundpeu, it leaks, drops—*Negat.* Wundpewi
Wundpewall, they leak, drop, boil over.

Tepiken, it is ripe, full grown—*Negat.* Tepikenewi
Tepikeneep, it was ripe
Tepikenol, they are ripe
Tepikentschi, it will be ripe enough.

Winu, it is ripe (applied to maize *or* Indian corn)
Winop, it was ripe
Winike, when *or* if it is ripe—*Negat.* Winiwi, when *or* if it is not ripe.

Winxu, it is ripe (applied to fruit on the tree)—*Negat.* Winxiwi
Winxuwak, they are ripe
Winxop, it was ripe*.

Saken, it shoots *or* springs up (the seed)—*Negat.* Sakenowi
Sakenoll, they shoot up (the beans)
Sakenop, it sprang up.

Luteu, it burns (from lussemen, to burn)
Luteuchtschi, it will burn
N'lussi, I burn
Lussop, he has burned.

K'schippehelleu, the water runs off
K'schippehelleup, the water ran off.

Petschihilleu, he is coming on
Petschihilleep, he came on.

Natchaque†, I fetch wood, thou fetchest wood, he fetches wood, we fetch wood, you fetch wood, they fetch wood
Natachtu, he fetches wood.

Hattau, he has, it has, it is there
Hatteep, he had, it was there
Negat. Atta hattewi, he has not, it is not there
Hattawawu, when *or* if I was there
Ika *or* yun hattol, have it there, put it there.

N'gatta, I will (from gattamen, to want, will, desire)
K'gatta, thou willest
Gotta, he willeth
Gottalineen, we will
Gattati, come! be willing!
Gattatook, be ye willing!

N'gatta linxumen, I will melt it.

Linxumen, to melt something
Linkten, it melts
Linktup, it melted, was melted.

Gandhatton, to hide, conceal
N'gandhatton, I hide, conceal
N'gandattoneep, I hid, concealed
In all other cases *gandhatton* is unalterably used.

Mayawiechen, it agrees, it is right, it suits—*Negat.* Mayawiechenowi
Pret. Mayawiechenep.

Aski, must, has neither persons nor tenses, and must be used in the following manner:
Aski n'witschema, I must help him
Aski n'witschemap, I was obliged to help him
Aski witschemepannik, they were obliged to help him
Aski sachgapenawall, I must lead him
Aski nayumap, I was forced to carry him
Aski n'pehawall, I must wait for you.

* *Note by the Translator.*—The above are properly adjective verbs; but they have been left here out of their proper place in order to shew the variety of ways in which the Indians express the same thing in relation to different objects. Had these words been carried to the following list of adjective verbs, they must have been separated in the different classes.

† *Note by the Translator.*—This word is compounded from *naten*, to fetch and *tachan*, wood.

OF ADJECTIVE VERBS.

Note by the Translator.—The author observes here that he hesitated long whether he should class adjectives by themselves or include them all under the head of verbs. On the one hand he could not but observe that there are in this language pure adjectives, which receive different forms when employed in the verbal sense, such as *wulit, wulik, wulisso,* good, handsome, pretty; *wulilissu,* he, she, or it is good, pretty, or handsome, and several others of which the author gives examples, as for instance (Class I.) in *sabbeleechen,* sparkling, glittering, whence *sabbeleu,* it sparkles, glitters. But these are not very numerous. A great number of them are impersonal verbs in the third person of the singular of the present tense, while others are conjugated through various persons, moods, and tenses, as appears from the following examples. He determined, at last, after presenting a few under the head of adjectives, above page 103, to include them all in a list of verbs of this description, which the Translator has called *adjective verbs,* as he has denominated *adverbial verbs* those which are formed by or derived from them. It is to be regretted that the venerable missionary did not more particularly distinguish the pure adjectives from the others, and did not enter more fully into this subject. It is most certain that all the adjectives of the Delaware language are not verbs; but a rule or principle of discrimination is wanting, and the Translator cannot undertake to establish it.

The Author here exhibits a list of adjective verbs, divided into eleven classes according to their termination, which in the three first is that of the third person singular of the indicative mood of the first conjugation. The first is in *eu;* the second in *wi;* the third in *u* or *o;* the fourth in *on* or *an;* the fifth in *ot, at;* the sixth in *to;* the seventh in *i;* the eighth in *it, ik, et;* the ninth in *en;* the tenth in *en* or *on;* and the eleventh in *in.* This last appears to belong to the first conjugation, and its termination is that of the infinitive mood. It is conjugated through several moods, persons, and tenses.

ADJECTIVE VERBS.

CLASSED ACCORDING TO THEIR TERMINATIONS.

Class I.—In eu.

Kschitteu, warm, hot (it is)	Atta kschittewi*, it is not warm
Kschittep, it was warm	Atta kschittewip, it was not warm.

* *Note by the Translator.*—The termination *wi* is not here adverbial; it is employed in a negative sense, as in the verbs. See above, page 166, k'pendolen, I hear thee, atta k'pendolowi, I hear thee not, and in most other negative forms of the verbs.

Kineu, it is sharp
Kineep, it was sharp.

Guneu, long (it is)
Guneep, it was long
Guneuchtschi, it will be long.

Kschiecheu, clean (it is)
Kschiecheep, it was clean.

Machkeu, red (it is)
Machkeep, it was red.

M'cheu, big, large
M'chap, it was big.

Gachteu, dry
Gachteep, it was dry.

Teu, it is cold
Teep, it was cold
Teuchtschi, it will be cold.

Poquihilleu, it is broken
Poquihilleep, it was broken.

Pimeu, pimiecheu, oblique
Pimihilleu, it is oblique
Pimihilleep, it was oblique.

Pisgeu, it is dark
Pisgeep, it was dark.

Takpeu, wet, damp
Takpeep, it was wet
Takpeuchtschi, it will be wet.

Winkteu, winkteek, it is quite done, boiled
Winkteep, it was boiled
Winkteke, if *or* when it is boiled.

Wisaweu, wisaweek, yellow.

Waktscheu, crooked.

Woapeu, white
Woapeleechen, it appears white.

Suckeu, black
Suckeleecheu, it appears black
Suckeep, it was black.

Wtackeu, soft, delicate
Wtackeep, it was soft, delicate
Wtackeuchtschi, it will be soft, delicate.

Acheweu, bushy.

Achgameu, broad
Achgameeke, if it was broad.

Achgiguwen, to be lively, jocular
N'gagiguwe, I am lively
Kagiguwe, he is lively
N'gagiguweneen, we are lively
Kagiguwenewo, you are lively
Achgiguwewak, they are lively.

Achginche, to be quick of hearing
N'gaginche, I am quick of hearing
Kaginche, thou art quick of hearing
Achgincheu, he is quick of hearing.

Achgumeu, dull cloudy weather.

Gischachteu, it is clear, light
Gischachteep, it was clear
Gischachteke, if *or* when it was clear
Gischachtekpanne, if it had been clear.

Gischhatteu, it is ready
Gischhatteep, it was ready
Gischhatteke, if it was ready
Gischhattekpanne, if it had been ready.

Gischuteu, warm, lukewarm
Gischuteep, it was lukewarm
Gischuweu, it is warm
Gischuweep, it was warm
Gischuweuchtsch, it will be warm.
Gischuweke, if it was warm

Kschillandeu, it is hot (weather)
Kschillandeep, it was hot
Kschillandeke, if it was hot.

Moschachgeu, bald, bare
Moschantpeu, bald headed.

Pimochqueu, turned, twisted.

Sabbeleu, it sparkles, glitters
Sabbeleechen, sparkling, glittering.

Schauwutteu, it is faded
Schauwutteep, it was faded
Schauwutteke, when *or* if it is faded.

Wapaneu, easterly
Wundchenneu, westerly
Lowaneu, northerly
Schawaneu, southerly
Gachpatteyeu, south easterly.

Tihhilleu, it is cool (the meat)
Tihhille, I am cool (after being heated)
Tihhilleu, he is cool.

Tschitaneu, strong (it is)
Tschitaneep, it was strong
Tschitaneke, if it was strong.

Waseleu, woacheyeu, clear, light.

Wtackaneu, it is mild (weather)
Wtackaneke, when it is mild
Wtackanup, it was mild
Wtackaneuchtsch, it will be mild.

Achgepinque, to be blind

INDICATIVE MOOD.

PRESENT TENSE.

Singular.

N'gagepinque, I am blind
Kagepinque, thou art blind
Achgepinque, he is blind

Plural.

N'gagepinqueneen, we are blind
Kagepinquenewo, you are blind
Achgepinquewak, they are blind

PRETERITE TENSE.

Singular.

N'gagepinquep, I was *or* have been blind
Kagepinquep, thou wast *or* hast been blind
Achgepinquep, he was *or* has been blind

Plural.

N'gagepinquep, we were *or* have been blind
Kagepinquenewoap, you were *or* have been blind
Achgepinquewapannil, they were *or* have been blind.

Achgepchoan, to be deaf
N'gagepchoa, I am deaf
Kagepchoa, thou art deaf
Achgepcheu, he is deaf.

Achsinnigeu, stony, stony land.

Piskeu, it is dark (night)
Piskeep, it was dark
Achwipiskeu, quite dark
Achwipiskeep, it was quite dark.

Memeechaitin, to be barefooted
N'memechaitin, I am barefooted
K'memechaitin, thou art barefooted
Memeechxiteu, he is barefooted.

Mesitcheyeu, whole, entire.

Pagatschateu, full, to fill.

Penquon, dry
Penquihilleu, it is dry
Penquihilleep, it was dry.

Pikihhilleu, it is torn
Pikihhillup, it was torn.

Pimachtelinque, squint eyed
Pimachtelinqueu, he is squint eyed.

Poquihilleu, it is broken
Poquihilleep, it was broken.

Chitqueu, chuppecat, deep water
Chuppeachtop, it was deep water.

Schachachgen, straight, even.
Wschacheu, wschachan, smooth, glossy
Wschachihilleu, it is smooth, glossy
Wschachihilleep, it was smooth, glossy.

Schauwipachteu, it is faded
Schauwipachteep, it was faded.

Tachanigeu, woody, full of wood
Taachanigeep, it was woody.

Tonquihilleu, it is open.

Tsachgihilleu, it is torn off
Tschachpihilleep, it was torn off.

Tschetschpihilleu, split, broken off
Tschetschpihillewall, they are split
Tschetschpihilleep, it was split.

Wulelemileu, it is wonderful
Wulelemileep, it was wonderful

These words are compounded from *wulelemelendam* I wonder, and *leu* it is so.

Scappeu, it is wet
Scappewall, they are wet (speaking of things)
Scapewak, they are wet (speaking of persons).

Wulamoe, he says true *or* the truth
Wulamoyu, it is true, right
Kulamoe, thou art right, correct
Wulamoe, he is right
Nulamoeneen, we are right
Kulamoehhimo, you are right
Wulamowak, they are right.

Assiskuyu, marshy, muddy
Gundassikuyu, deeply marshy.

Wulapeyu, honourable, upright.

Wuskiyeyu, it is new.

N'chowiyeyu, it is old.

Class II.

Contains only the pure adjectives in *wi*, which see above page 104.

Class III.—In u *or* o.

Schahachgekhasu, long, straight, striped.

Sassapeekhasu, speckled.

Psacquitchasu, crucified (he is)
Psacquitchasoop, he was crucified.

Wiyagaskau, fickle.

Wtacksu, soft, tender, supple.

Wschewinaxu, wschewinaquot, painful.

Waliechtschessu, puchtschessu, hollow (a tree).

Tachpachaxu, little, mean.

Schiphasu *or* schipenasu, spread out, extended, from *schiphammen*, to spread, extend
Schipenasike, when it is stretched, spread out, extended
Schipenasop, it was stretched, spread out, extended.

Piselisso, it is wrinkled
Piselid tulpe, a large sea tortoise, so called because its shell is soft and its skin wrinkled.

Pimochkhasu, stirred, moved
Pimochkhasoop, it was stirred, moved
Pimochkhasike, if it was stirred, moved.

Machtu, machtitso, bad
Machtitso sipo, a bad creek (to cross)
Machtitsoop, it was bad.

Machtississi, thou art ugly, dirty looking
Machtississu, he is ugly, dirty looking.

Gischambeso, bound.

Aschukiso, to be poor, worth nothing, to be a beggar
N'daschuki, I am poor
K'daschuki, thou art poor
W'daschuku, he is poor
Aschukiso, one who is poor
W'daschukuwak, they are poor
Aschukoop, to have been poor
Note.—Although the Indians often apply this word to themselves, yet it is an insult if applied to them by another.

Wulisso, good, handsome
Wulilissin, to be good

INDICATIVE MOOD.

PRESENT TENSE.

Singular.
Nulilissi, I am good
Kulilissi, thou art good
Wulilissu, he is good

Plural.
Wulilissihummena, we are good
Wulilissihimo, you are good
Wulilissowak, they are good

PRETERITE TENSE.

Singular.
Nulilissip, I was good
Kulilissip, thou wert good
Wulilissop, he was good

Plural.
Nulilissihummenakup, we were good
Kulilissihummoakup, you were good
Wulilissopannik, they were good.

Walhasu, buried (he is).

Tschingalsu, stiff, unbending.

Papesu, patient.

Messiau, naked.

Sopsu, soopsu, naked, from *sopsin*, to be naked.

Messissu, whole.

Lusasu, burned
Lusasike, if it was burned.

Linxasu, melted
Linxasike, if it was melted.

Leekhasu, lekhasik, it is written
Leekhasoop, it was written
Elekhasik, as appears written.

[ADJECTIVE VERBS.]

Kpaskhasu, stopped
Kpahasu, to stop
Kpahasop, it was stopped
Kpahasike, if it was stopped.

Gaschsasu, dried.

Wapsu, white
N'wapsi, I am white
Wapsi, thou art white
Wapsu, he is white
Wapelechen, it is white
Wapsid, a white person
Wapsitschik, the white people.

Auchzu, wild, untractable—
This is said of beasts; as applied to men it means avaricious, difficult to deal with, hard, stingy.

Wisu, fat (he is)
Wisop, he was fat.

Kihnsu, from *kineu*, sharp: as for instance, your discourse is sharp, biting, harsh
N'kihnsi, I am sharp, jealous
Kihnsi, thou art sharp, jealous
Kihnsu, he is sharp, jealous
Kihnsop, he has been sharp, jealous
As for instance—
N'kihnsi ni Getannitowit, I am a jealous God.

Winn, it is ripe, fit to eat: as for instance, the Indian corn
Winike, when it is ripe
Winoop, it was ripe
Winuchtschi, it will be ripe.

Aloku, lean.

Wipiechku, rotten wood.

Windasu, mentioned, named
Windasike, if it was mentioned, named
Windasop, it was mentioned, named
Windasutsch, it will be mentioned, named.

Class IV.—In on *or* an.

Schwon, salt tasted, sour
Schwonnoop, it was salt tasted, sour.

Achewon, strong, spirituous
Achewonnoop, it was strong, spirituous.

Kschuppan, blunt, dull.

Ksuequon, hard, difficult
Ksuequonnool, they are hard (things).

Lachcan, it is sharp tasted.

Langan, easy (it is)
Langannool, they are easy (things)
Langannoop, it was easy.

Thitpan, bitter.

Wingan, good tasted, good to eat
Winganool, they were good tasted, good to eat, (apples, &c.)

Kopachkan, thick (a board, plank)
Kopachkisso, thick (a skin, hide).

Wiquon, dull, blunt, not sharp.

Wschappan, woasgeyen, thin.

Penquon, dry
Penquihhilleu haki, the earth is dry.

Class V.—In ot, at.

Gulucquot, lame.

Apuat, easy (to do)
Apuattop, it was easy.

Achgepinquot, blind
Gegepinquot, a blind man *or* person.

Gegepchoat, a deaf person.

Achpequot, wounded.

Achowat, hard, painful, troublesome.

Gunalachgat, deep (a hole in the earth, or the canoe is deep)
Tepalachgat, deep enough
The latter of these two words is formed from *tepi*, an adverb, which means *enough*, the former from *guneu*, an adjective, *long*, both combined with *walak*, a hole.

Ayandamolquot, gachtalquot, it is to be wished.

Class VI.—In to.

Chawachto, dear (it is)
Talawachto, how dear is it? how much does it cost?

Apuawachto, cheap, from *apuat*, easy.

Achgepchoa, deaf.

Tepawachto, from *tepi*, enough, and *chwawachto*, a just, equitable price, *it is not too dear*.

Tangawachto, cheap, low priced.

Class VII.—In i.

Wuski, new.

Amangi, great, big, large
Amangewall, (namessal), the fishes are large.

Macheli, m'chelit, much, many
Machelook, they are many
Machelopannik, they were many.

Class VIII.—In it, ik, et.

Mequit mequik, m'hocquik, bloody.

Maechgilik, m'chakgilik, the great, the big.

Machtit, bad (it is).

Wulit, good

Wulittol, they are good
Wulittoop, it was good.

Alett, rotten
Alettot, they are rotten.

Machkalet, they are rusty, from *machkeu*, red.

Class IX.—In en.

Waseleechen, it is clear, light.

Tschitaniechen, it is strong.

Achewiechen, strong, spirituous: as for instance, strong lie.

Machkeleechen, red.

Wapeleechen, white.

Waktschiechen, the road is crooked.

Tsetschpiechen, it is separated.

Tenktschechen, it is open (say, the door).
Tauwiechen, it is open (the way thither).

Tacquiechen, joined together
Psacquiechen, close together.

Pequiechen, broken to pieces.

Class X.—In en, on, um.

Tacquatten, frozen (it is)
Tacquattenol, the potatoes, &c. are frozen

Pret. Sing. Tacquattenop, it was frozen
Plur. Tacquattenopannil, they were frozen

K'patten, it is frozen up (the river)
K'pattenop, it was frozen
K'pattentschi, it will be frozen
Tschitanatten, it is frozen hard.

Tepiken, it is ripe, full grown (say, the Indian corn)

Tepikanool, they are fully ripe, fit to pick (the beans, peas, &c.)

Packenum, dark.

Nolhand, to be lazy
Sing. Nolhando, he is lazy
Plur. Nolhandowak, they are lazy.

Class XI.—In in.

INFINITIVE MOOD.

Pawalessin, to be rich

PARTICIPLES.

Singular.

Pewallessit, a rich person

Plural.

Pewallessitschik, rich persons

INDICATIVE MOOD.

PRESENT TENSE.

Singular.

N'pawalessin, I am rich
K'pawallsi, thou art rich
pawalessu, he is rich

Plural.

N'pawallsihummena, we are rich
K'pawallsihhummo, ye are rich
Pawallesowak, they are rich

PRETERITE TENSE.

Singular.

N'pawallessihump, I was rich
K'pawallessihump, thou wast rich
Pawallessop, he was rich

Plural.

N'pawallsihummenakup, we were rich
K'pawallsihummoakup, ye were rich
Pawallsopannik, they were rich

FUTURE TENSE.

Singular.

N'pawallsitsch, I shall be rich
K'pawallsitsch, thou shalt be rich
Pawallessutsch, he shall be rich

Plural.

N'pawallsihummenatsch, we shall be rich
K'pawallsihhimotsch, ye shall be rich
Pawallsowaktsch, they shall be rich

IMPERATIVE MOOD.

Singular.

Pawallessil, be rich

Plural.

Pawalessik, be ye rich

The remainder follows as in the ordinary verbs:

EXAMPLE.

SUBJUNCTIVE MOOD.

PRESENT TENSE.

Singular.

Pawallsiyane, if *or* when I am rich
K'pawallsiyane, if *or* when thou art rich
Pawallessite, if *or* when he is rich

Plural.

Pawallsiyenke, if *or* when we are rich
Pawallsiyeque, if *or* when ye are rich
Pawallessichtite, if *or* when they are rich

The Preterite and Future as has been shewn in the verbs.

Thence comes further—

Pawallessohen, to make one rich

INDICATIVE MOOD.

PRESENT TENSE.

Singular.

N'pawallsohalgun, he makes me rich
K'pawallsohalgun, he makes thee rich
Pawallsohalgol, he makes him rich

Plural.

Pawallsohalguna, he makes us rich
K'pawallsohalguwa, he makes you rich
Pawallsohalawak, he makes them rich.

INFINITIVE MOOD.

Wulelensin, to be proud, haughty, high minded

INDICATIVE MOOD.

PRESENT TENSE.

Singular.

Nulelensi, I am proud
Kulelensi, thou art proud,
Wulelensu, he is proud

Plural.

Wulelensihummena, we are proud
Kulelensihummo, ye are proud
Wulelensowak, they are proud.

INFINITIVE MOOD.

Tschitanessin, to be strong

INDICATIVE MOOD.

PRESENT TENSE.

Singular.

N'tschitanessi, I am strong
K'tschitanessi, thou art strong
Tschitanessu, he is strong

PRETERITE TENSE.

Singular.

N'tschitanessihump, I was strong
K'tschitanessihump, thou wast strong
Tschitanessop, he was strong.

INFINITIVE MOOD.

Schaxin, to be avaricious

INDICATIVE MOOD.

PRESENT TENSE.

Singular.

N'schaxi, I am avaricious
K'schaxi, thou art avaricious
Schaxu, he is avaricious

Plural.

Schaxihummena, we are avaricious
Schaxihhumo, ye are avaricious
Schaxowak, they are avaricious.

Ktemaxin, gettemaxin, to be poor, miserable.

Soopsin, to be bare, naked
Soophalan, to make one bare, naked.

Poochpsin, to be weakly.

XV.—Of Adverbs.

Adverbs qualify the verb as adjectives qualify the substantive. They are the adjective of the verb. Hence adjectives proper are not unfrequently used in an adverbial sense, as when we say in English *he works hard.* The same takes place in the Delaware where the same word is sometimes employed in the twofold capacity of an adjective and an adverb.

In the following examples the adverbs are divided into classes for the facility of the student*.

* *Note by the Translator.*—This short heading is not in the text; but the division into classes has been made by the Author. It will be seen that several words which he includes in his lists are not properly adverbs, according to our notions of grammar; but it has not been thought proper to omit or transpose them, as the Author perhaps had reasons for placing them here, which the Translator will not undertake to judge of.

ADVERBS.

I.—*Of Place.*

These are of four kinds: 1. *Loci*; 2. *De Loco*; 3. *Ad Locum*; 4. *Per Locum.*

1. *Loci.*

Yun, here
Icku, talli, there
Nanne talli, even there
Undachqui, this *or* that way
Palliwi, elsewhere
Allami, allamiyey, in there
Allamunque, uchtschegunque, within
Wochgitschik, wochkunk, above, at the top
Wewundachqui, on both sides
Ta? tani? where?
Ta undachqui? where abouts?
Taktani, be it who it may
Wenni ta li, every where
Kotschemunk, without, abroad
Matta ta, nowhere.
Equiwi (hacking), under (the ground)
Li, to, to the, thither
Nada, yonder, to
Peschot, peschotschi, peschuwat, near
Wulik, yonder
Yawi, on one side.

2. *De loco.*

Yuwuntschi, from hence, is used also for therefore
Icka untschi, nanne untschi, na untschiyeg, from thence
Ta untschi? where from?
Wemi ta untschi, from every where
Palli untschi, from somewhere else
Takta untschi, from somewhere
Wahhelemat, far
Gochpiwi, from the water.

3. *Ad locum.*

Yu undachqui, yuchuall, hither
Ickali, thither
Enda, whither
Palli undachqui? whither else?
Nanne undachqui? towards where?
Wtellenuhawannink li, towards the right hand
Lennahawannink li, towards the right, to the right
Kotschemunk, out of doors, out of this place
Wapahamink, backwards, behind
Pennassiechen, where the road goes slanting down a hill
Menanschiwonink, to the left.

4. *Per locum.*

Yun (m'tamen) through here
Nanne talli (pomiechen aney)*, through there, that way
Schachachgeu, straight along
Schachgiechen, elemiechen, along the road.

II.—*Of Time.*

Yucke, now, presently
Yucke (gischquik) to day
Gigischquik, this day past
Ulaque, yesterday
Wulaquike, last night
Wulacaniwi, in the evening
Nischokunackat, two nights ago
Wapange, alappa, to morrow
Sedpok, ayapawe, to morrow morning
Wulaku, evening (in the)
Pachhacqueke, at noon
Tachpachihilla, in the afternoon
Tgauwitti, tgauwiwi, slowly
Abtschi, ngemewi, yanewi, always
Lappi, again
Abtschi, likhiqui, at all times
Likhiqui, about the time
Yucke likhiqui, about the present time
Gunigiseheek, daily
Loamissowe, lately

* *Note by the Translator.—Pomiechen*, from *pomissin*, to walk, and *aney*, a road, a walking road, a path. The Author here gives his explanation in Delaware, probably by inadvertence.

Wuski, a little while ago (this day)
Wusken, latterly
Gintsch, gentsch, gintsch linitti, a little while ago*
Pecho, soon
Pecho linitti, in a little time
Loamoe, long ago
Wtenk, afterwards
Wtenkuntschi, thereupon
Elemokunak, one of these days
Elemi gendowoacan, this week
Elemi kechocunak, in a few days
Metochimi, soon
Schawi, immediately, directly
Tschinge, when
Esquo, esquota, nelema, nelemago, nelemala, not yet
Aschite, then
Yabtschi, quayaqui, yet
Haschi, ever, at any time
Atta haschi, ikaschi, never
Tschigantschi, likhiqui, as soon as
Tamse keechen, sometimes, now and then
Tatamse, ametschimi, often
Elgiqui ametschimi, so often
Hilleu, commonly
N'dauwat, rarely, seldom
Amiga, long, a long time
Petschi, until
Yucke petschi, 'til now
Anena, anenawi, by little and little, by degrees.

III.—*Of Number.*

Mawat, only one
Nekti, the only one
Whence nukti, once more
Mamayauchsid, each one.

IV.—*Of Quantity.*

Mecheeli, mecheltol, much
Mecheelok, many
Mechelgik, a great many
Mechelit, much (applied to inanimate things)
Husca, very
Husca mecheli, very much
Allowiwi, more
Wsami, too much
Tepi, enough
Tatchittu, tatchen, little
Keechitti, a little
Alende, some
Ta keeche, some, a little
Wiacki, in abundance
Gunalachkat deep, (speaking of a hole, canoe, &c.)
Chitqueu, deep water
M'chaquiechen, high water (when it is swelled with rains)
Guneu, long
Achganeu, broad
Cobachean, thick
Taquetto, short
Sangettu, tangitti, small, little
Wschappan, waskeyek, thin
Mayauchsu, mauchsu, a person, one
Happi, with it, in the bargain.

V.—*Of Quality.*

Linaquot, elinaquot, elgiqui, so, so as
N'delgiqui, so as I
K'delgiqui, so as thou
W'delgiqui, so as he
Pallilinaquot, otherwise
Wulit, wulinaquot, well, good
Allowiwi wulit, better
Elewiwulik mayawi wulit, best, the best

* *Note by the Translator.*—There are undoubtedly shades of difference between these various expressions, but the Author has not explained them, except in the instance of *wuski*, which is confined to the space of a day,

[OF ADVERBS.]

Huska wulit, very well, very good
Machtit, machtitso, ill, bad
Apuat, easy, easily (some work to be done)
Langan, light, not heavy (speaking of weight)
Ksuequon, hard, hardly
Lilchpin, diligent (is a verb)
Wingi, fain, willingly
Nawingi, I fain (would, &c.)
Kuwingi, thou fain wouldst
Wawingi, he fain would
Wulisso, handsome (is a verb)
Lippoe, luppoe, wisely
Mayawi, right, rightly
Schachachgeu, right, exact, correct
Wosgeu, thin
Schachachgiechen, straight way
Nutschque, in vain
Schachachki, certain, certainly
Leu, true
Lennowinaquot, manfully
Kimi, secretly
Moschiwi, clearly, openly
Leppi, over again
Wiamochki, among each other
Mesitscheyen, wholly, entirely
Nischeleney, twofold
Nacheleney, threefold
Neweleney, fourfold
Cheveleleney, manifold
Tschitanek, fast, strong
Schawi, immediately, directly
Miechaninaquot, shameful
Temiki, something, be it what it will
Temiki koecu, something
Yawt, on one side
Welsid, the best (*Sing.*)
Welsitschik, the best (*Plur.*)
Moschachgen, clear, not turbid
Moschpecat, clear water.

VI.—*Of Interrogation.*

Gachane, whether, if
Quatsch, why
Quatsch eet, why perhaps
Koen untschi, for what reason *or* cause?
Quatsch atta, why not?
Ta wo, ta undachqui, towards where?
La untschi, whence, wherefrom?
Tchinge, when?
Tschingetsch (in the future)
Ta likhiqui, at what time?
Ta schacki, how long?
Ta ne liecken, how is it?
Ta linaquot, what is it like?
Koen eet, what may it be?
Ta hatsch (leu, how will it be?)

VII.—*Of Similitude.*

Elgiqui, as, like as
N'delgiqui, I am like
K'delgiqui, thou art like
W'delgiqui, he is like
Mallachsche, like unto.

VIII.—*Of Comparison.*

Allowiwi, more
Tschitsch, still more
Elinaquo, linaquot, as this, that, *or* the other
Tpisqui, exactly so.

IX.—*Of Extension.*

Husca, huscateek, very, very much so
Wtellgiqui, so much so
Elgiqui, as much so
Tschitsch, yet, still
Quayaqui, yabtschi, yet
Ikalissi, still further, still more
Pakantschi, fully, entirely.

X.—*Of Diminution.*

Tgauwitti, by little and little
Gachti, almost, nearly
Koechitti, a little
Mingachsa, a little better
Schuk, only
Schuk atta, but not, only not.

XI.—*Of Affirmation.*

Gohan, kehella, woak, yes
Bischik, yes indeed
Kitschiwi (leu) certainly, truly
Kitschikele, yes it is true
Nanne leu, it is certainly true
Schachacki, certainly
Huscateek, certainly true.

XII.—*Of Negation, Prohibition.*

Matta, atta, 'ta, no, not
Atta am, 'ta am, not at all
Atta haschi, no, never
Katschi, let it alone, don't do this
Matta tani, in no way
Attago, by no means
Ponito, let it alone (this is a verb)
Atta ihaschi, not at all
Atta ilewi, not at all true.

XIII.—*Of Doubt.*

Pit, piteet, eet, perhaps, may be
Na eet, perhaps
Taneek, perhaps I don't know
Taktani, perhaps some where, I don't know where.

XIV.—*Of Demonstration.*

Sche, Schela, see there! (a verb)
Schepella, see there! (a verb)
Penna, loquel, see thou (a verb)
Loqueek, see ye (a verb)
Elinaquot, also, likewise
Elgiqui, like that.

XV.—*Of Asseveration.*

Kitschiwi (leu) truly
Schachachki (leu), certainly true.

XVI.—*Of Restriction.*

Nà schachki, so far
Na yu pitschi, to here
Nachgiechen, contrary, against
Psacquiechen, close to each other.

XVII.—*Of Desire.*

Jukella, ah! that (it were so)
Ayema, if, if only (it were so).

XVIII.—*Of Exhortation.*

Gattati, (*Sing.*) well! *allons!*
Gattatook, (*Plur.*) well! *allons!*
Wischekill, (*Sing.*) on, briskly, go on with your work carefully, attentively.—Wischiksik, Wischiki, (*Plur.*)

XIX.—*Of Collection and Separation.*

Tpettawe, all together
Tachquiwi, together
Nechoha, alone
N'gutteli, singly
N'gutteleneyachgat, a single one
Limi, secretly
Tspiwi, tspat, separately
Mawuni, assembled.

XX.—*Of Exclusion.*

Schuk, Schukend, only
Tspat, strange, unusual
Pili, another
Miguipili, otherwise
Palliwi, elsewhere.

XXI.—*Of Order.*

Nigani, n'hitam, netamiechink, first, in the first place
Nischink, in the second place
Lappi, again, once more
Nechink, the third time
Wtenk untschi, thereupon, afterwards
Ickalin, further
Wtenk, lastly, at last.

ALPHABETICAL LIST OF ADVERBS.

A.

Amiga, long
Awossi, Awossiyey, beyond, over, the other side
Atta, no
Allamunk, allamunque, allami, allameyey, therein, in there
Alende, some
Alendemiyeek, some of you
Alendemiyenk, some of us
Alendeyuwak, some of them
Apitschi, by and by
Abtschi, always
Abtschi likhicqui, at all times
Auween, who, somebody
Atta keeku, nothing
Annawi, anenawi, by little and little
Ametschimi, often
Alacqui, 'tis pity
Ank, when (a conditional conjunction suffixed to verbs)
Attago, no, by no means
Attach, moreover

Alappa, to morrow
Awossi, over there, the other side
Awossake, behind the house
Awossenachk, that side of the house
Awossachtenne, over the hill, over there
Alod, there, yet
Atta haschi, never
Atta auween, no body
Auweeni, who is it?
Auweenik, who are they?
Achgameu, over against
Achparni, about.

B.

Bischi, bischik, yes, willingly.

C.

Chuppecat, deep, high water
Chitqueu, deep water
Chweli, much
Chwelit, much (water, meal).

E.

Eschiwi, through
Elemameek, every where
Eet, perhaps
Endchen, so often as
Endchi, so much as
Endchiyenk, as much as we have
Endchiyeek, as much as ye have
Endchichtit, as much as they have
Esquo, esquota, not yet
Elgiqui, so as, like
Eli, while
Eligischquik, to day
Ehelikhicqui, at which time
Ekee, ay!
Ekayah, ay! ay!
Es, yet
Eliwi, both
Elemiechink, long (on the way)
Elinquechin, before me, before my eyes
Elinquechinan, before thee, before thy eyes
Elinquechink, before him, before his eyes
Elinquechinink, before us, before our eyes
Elinquechinoak, before you, before your eyes
Elinquechenhittit, before them, before their eyes
Enda, where
Equiwi, under.

G.

Gamunk, over there, over the water
Gohan, yes
Gachti, almost, close by
Gintsch, gaschene, if
Gintsch linitti, directly, presently
Gunaweke, yet a while
Giechgi, near, by
Gatti, gachti, gagachti, near, almost
Gunih, a long while
Gopene, about, thereabouts
Gahan, shallow (water).

H.

Husca, much
Huscateek, very much
Hackung, above
Hacking, under
Haschi, ever, at any time.

I.

Ickali, ikali, thither
Ickatalli, there, over there
Icka, there
Ickalitti, a little way farther
Ili, though.

K.

Kitschiwi, certainly
Kehella, yes
Kotschemund, out
Ktschimine, as soon as
Keeku, something
N'telli, that I!
K'telli, that thou!
W'telli, that he!
Keechitti, a little
Keechi, keecha, how much?
Kechoak, kechowak, how many of them? (speaking of persons)
Keechennol, how many of them? (speaking of inanimate things)
Keechihhimo, how many of you?
Keechihhena, how many of us?
Katschi, no, no, let it alone
Keeku wuntschi, why?
Kimi, secretly.

L.

Lappi, again
Likhicqui, as, so as
Likhicquiechen, so as
Li, to (some place)
Lawat, long ago
Lannitti, a little while
Linaquot, as, like
Linaquachtop, (*Pret.*) it was so, like
Linaquachtool, they are like (speaking of inanimate things)
Lelawi, half way
Luqui, at this time.

[OF ADVERBS.]

M.

Matta, mattago, no
Miqui, far, far off
Miqui palliwi, quite different
Menewi, in a particular place
Metschi, already
Metschimi, soon, presently
Ma, there, there it is
Mayawi, alone, simple, right
Mayauchsu, mauchsu, one alone
Mayawat, mawat, one, only one (of inanimate things)
Mingachsu, better
Mallachsche, as if, as it were
Mechingui, large, big
Meyauchsit, one alone
Megungi, purely, quite alone
Memayauchsiyenk, each of us
Mekeniechink, on earth.

N.

Nischogunakat, two nights (days) ago
Nischogunakhacke, within two days
Nissahwi, by night
Nachpi, with
N'hittami, nigani, at first, the first
Nechoha, alone
Nihillatschi, self, one's own person
Nado, therein
N'gemeewi, always, constantly
N'telli, I (do, say, &c.) thus *or* so
K'telli, thou dost thus *or* so
W'telli, he does thus *or* so
Newentschi, therefore
Na tchi, so much
Nall ne tchi, it is so much, that is all
Nanne untschi, from thence
Nachwena, thereupon, after
Nagayeek, by and by
Nagewitti, in a little while
Nutschque, in vain
Nahik, under the water
Nahiwi, above the water
Nutchen, nolltchen, that is all
Nutschi, at the beginning
Ndauwat, rare, rarely
Nelema, nelemata, nelemago, not yet
Netami, the first
N'hittami, at first
Netamieechen, the first
Nallahik, nallahiwi, the water here above
Nekti, the only one, single
Nahanne, so, so it is
N'titechta, n'titechquo, then, while.

P.

Pechot, soon
Pechuwat, pechuwiwi, near
Pechotschi, much more
Petschi, 'til there, so far
Palliwi, elsewhere
Peki, perhaps then
Pit, pitut, perhaps
Packantschi, fully, enough
Poquewi, straight way, directly
Pili, other, another
Pili keeku, something else
Pili auween, somebody else
Pemmi, as far as
Pachsiwi, half, the half
Pitschi, unwillingly.

Q.

Quatsch, why?
Quatscheet, why perhaps?
Quonna, however, nevertheless
Quonnagetsch, it will be indifferent
Quayaqui, yet, yet more
Quin, long
Quenek, short.

S.

Sayewi, at first
Schawi, immediately
Schi, schita, or
Shacki, so far as
Seki, so long
Schuk, only, but
Schukand, but then
Sedpok, to morrow morning
Schepage, (*Pret.*) this day early
Schigi, pretty
Sche, schela, see there
Schingi, unwillingly
N'schingi, I (do it) unwillingly
K'schingi, thou dost it unwillingly
W'schingi, he does it unwillingly
Schachachki, certainly
Schachachgek, just so.

T.

Tschigantschi, full, enough, all
Tangitti, small, little
Taquetto, tangetto, short
Tachtachean, thick, steep (a hill)
Tachquiwi, together
Tetauwiwi, between
Tepi, enough
Temiki, a single one (thing)
Temikikeeku, a single thing
Tschinge? when?
Ta? where?
Ta talli? whitherwards?
Tani? how?
Ta elgiqui? how soon?
Tpisqui, just so
Tawonni, although
Tamse, sometimes
Tachtamse, now and then, often

Ta tchen? how many? (inanimate)
Tatchittu, little
Ta haschi, never
Taat, as if
Tackan, another
Takeet, perhaps I don't know
Taktani, I don't know well
Tschetschpi, tschetschpat, differently
Thagitti, a little while
Tpittawe, altogether
Tschitsch, once more
Talli, there
Tatchendo, very little
Tgauwitti, by little and little.

U.

Untschi, of, by, therefore
Undach, here, this way
Undach litti, a little this way
Undachgameu, this side the water
Undachqui, hither.

W.

Wapange, to morrow
Wulaque, yesterday
Wulaquike, this evening
Welaquike, last evening
Wulaguniwi, in the evening
Wak, and, also
Wtenk, at last, the last
Wtenk untschi, thereon, thereafter
Weeski, sometime to day
Wiechgawotschi, unexpectedly
Wottalauwin, wotsche anenk, by the way
Wotschi, near by
Wiemochki, among each other
Wemi, all
Wemi auween, every man
Wentschi, therefore, for this reason
Witschi, with, at the same time
Wtscheyunque, within
Wsami, wsamiechen, too much
Wulamoe, long ago
Wulamissowe, a little while ago
Wuli, there
Wingi, willingly
N'wingi, I —— willingly
K'wingi, thou —— willingly
Wawingi, he —— willingly
Wochgitschik, up there, above
Wiacki, wiackat, enough and to spare
Wuntschi, of, on account of
Wtellgiqui, likewise
Wiwuntschi, before this
Wiwuntschkamik, very long ago.

Y.

Yucke, now
Yucke gischquik, to day
Yun, yutalli, yuntalli, here, there
Yucke untschi, here
Yucke likhicqui, to this time
Yucke petschi, 'til now
Yanewi, always
Yuch, yuchnook, well! *allons*
Yuwuntschi, from hence
Yulak, there
Yukella, O! that (it were so)
Yuketeek, (*Plur.*) O! that it (those things) were so
Yapewi, on the river bank
Yapeechen, along the bank
Yabtschi, yet.

ADVERBIAL VERBS,

OR, VERBS FORMED FROM ADVERBS.

I.—*From* Schingi, *unwillingly*.

Schingelendam, I dislike, it is against my will *or* my inclination
N'schingelendam, it goes against the grain, I hate it
K'schingelendam, thou hatest it
W'schingelendam, he hates it
Schinginamen, to hate something
Schingattam, to be unwilling about something
Schingalan, to hate a person
Schingsittam, to hear something with displeasure
Schingoochwen, to go somewhere unwillingly
Schingachpin, to be somewhere unwillingly
Schingimikemossin, to work unwillingly
Schinghakiheen, to plant unwillingly
Schingiglistam, to hear unwillingly
Schingtschenamen, to hate something to excess, not to be able to bear something.

II.—*From* Wingi, *willingly.*

Wingsittam, to hear somebody willingly
Winginamen, to be pleased with
Wingachpin, to be willingly somewhere
Wingoochwen, to go willingly somewhere
Wingipendam, to hear (something) willingly
Wingallawin, to hunt willingly
Wingilauchsin, to live willingly in a particular manner
Wingelendam, to love *or* be pleased with something
Wingelawemen, to do a pleasure
Wingelawossi, you have a good fire.

III.—*From* Eschiwi, *through.*

Eschoochwen, to go, pass through
Eschoochweyu petschindehenk, it penetrates through the heart
Eschoochwalan, to help *or* carry one through
Eschoochwalukgun, he has brought me through.

IV.—*From* Gunih, *long.*

Gunelendam, to think one long
Gunagen, to stay out long
Gunaquot, it is long
Gunaxin, to be long, tall of stature
Gunaquachtol, they are long (the fishes).

V.—*From* Lappi, *again.*

Lappilenin, to come again together
Laphatton, to restore something to its former state
Laphachken, to replant
Lappiechsin, to repeat something over.

VI.—*From* Mayawi, *right.*

Mayawiechton, to do something right, as it ought to be
Mayawihilleu, it is well as it is
Mayawelendam, to be fixed *or* settled in mind.

VII.—*From* Mayauchsu, *single.*

Mayauchsuwi (*Adj.*), of one mind, united
Mayauchsuwin, to be of one mind
Mayauchsohen, to make of one mind.

VIII.—*From* Nipahwi, *by night.*

Nipawoochwen, to go, travel by night.

IX.—*From* Pechuwat, *near.*

Pechuwelendam, to think one's self near

Pechuwihhilleu, the time is near.

X.—*From* Nechoha, *alone.*

Nechohanne, nechohalennin, to be alone
Nechoochwen, to go, travel alone

Nechoheteu, the house is empty.

XI.—*From* Nekti, *the only one.*

Nektilenin, to be quite alone (somewhere).

XII.—*From* Nahik *or* Nahiwi, *down, below.*

Nahimen, to go down the water (river, creek)
Nahihilleen, to sail down the water

Nahimenke, if *or* when we go down
Nahoochwen, to go down *or* below.

XIII.—*From* N'gutti, *one.*

N'guttitehin, to be one, to agree.

XIV.—*From* Nallahik, *above (the water).*

Nallahhemen, to sail up (the water, river)

Nallahoochwen, to go up (the water, river).

XV.—*From* Petschi, *until, unto.*

Petschihilleu, he is coming
Petscholtin, they are coming
Petschimuin, to escape to
Petapan, the day breaks, it dawns
Petisgauwan, to hunt *or* drive beasts to
Petauchsin, to live till now, to this day

Petaquiecheu, the water has risen up to him
Petachdonamen, to come to seek something
Peteuchtummen, to come weeping
Petschitchen, to press so far
Atta auwen petschitchewi, no body can think so far.

XVI.—*From* Pachsiwi, *half.*

Pachsenummen, to divide equally in two parts.

XVII.—*From* Shacki, *so far, so long.*

Shackoochwen, to go so far off and no further.

XVIII.—*From* Palliwi, *otherwise.*

Pallilissin, to do wrong
Palliaan, to go away
Palliaal, go away (*Imper.*)
Pallatschimain, to speak otherwise than the truth
Palliwochwen, to go elsewhere
Pallanummen, pallilenemen, to do *or* attempt something wrong.

XIX.—*From* Schachachki, *certain.*

Schachachgelendam, to be sure of a thing
Schachachgennemen, to make straight (what is crooked)
Schachachkoochwen, to go straight, follow the straight way
Schachachkatschimo, to say, relate the truth
Schachachkaptonen, to speak the exact truth, tell a true straight story
Schachachgapewin, to be true, correct, upright.

XX.—*From* Tangitti, *small, little.*

Tangelendam, tangitehen, to think little of one's self
Tangelensin, to be humble
Tangelensoochwen, to walk humbly
Tangenensin, to vouchsafe, condescend
Tangawachto, cheap.

XXI.—*From* Tepi, *enough.*

Tepihilleu, it is enough
Tepilawehan, to satisfy one
Tepikeu, it is ripe, full grown
Tepawachte, it is reasonable, not too dear
Tepilaweechgussin (*Passive*) to be satisfied, to have received satisfaction.

XXII.—*From* T'pisgauwi, *just so.*

T'pisgauwichton, to do something just so
T'pisquihhilleu, the time draws near.

XXIII.—*From* Tschetschpi, *different, not alike.*

Tschetschpihillen, to be split off, separated from one another
Tschetschpissin, to be unlike.

XXIV.—*From* Untschi, Wuntschi, *or* Wentschi, *of, from, on account of, for the sake of.*

Untschihilleu, it comes from somewhere
Undochwen, to go somewhere for the sake *or* purpose of something
Wundanunxin, to be angry at *or* for something
Wuntschimen, to call some one hither
Wundchen, the wind comes from thence
Wundanglen to do something, for the sake of something
Wundaptonen, to speak of something
Wundelemuin, to boast of something
Undauchsin, to live for something.

XXV.—*From* Wemi, *all.*

Wemihilleu, it is all over
Wemoltin, wemoltowak, they are all going out, forth, abroad
Wemiten (*Infin.*), to go all out
Wemihawak, they have made an end of them, they are all destroyed
Wemihawak awessiwak, they have destroyed all the ground.

XXVI.—*From* Wapange, *to morrow.*

Wapanacheen, good morrow
K'wapanacheen hummo, good morrow to you
Tamsa matta wapanachewi, he will not perhaps live 'til to morrow, or until morning.

XXVII.—*From* Wulakik *or* Wulaku, *evening.*

Kulakween, good evening
Kulakween hummo, good evening to you.

XXVIII.—*From* Gischi, *ready, done.*

Gischapan, it is day, it is day light
Gischiecheu, it is ready, done, finished
Gischikin, born, to be born
Gischikheen, to make a house ready, put a house in order
Gischitoon, to make something ready
Gischileu, it has proved true
Gischachpoanku, the bread is ready, it is baked
Gischachgenutasu, it is concluded, settled, determined
Gischalogen, to finish a work
Gischaloge, the work is finished
Gischackiheen, ready to plant
Gischatten, it is there ready
Gischuwallen, is ready packed, ready laden
Gischeenachk, the fence is ready
Gischamocholheu, the canoe is ready
Gischitehen, to be determined
Gischenaxin, to be ready, prepared
N'gischipenauwelendam, I have considered of it, I have made up my mind, I am ready.

XXIX.—*From* Machtit, Machtitso, *bad.*

Matschiton, to spoil something
Mattoochwen, to travel badly
Machtatenamin, machtatenamohen, to be unfortunate
Mattelendam, to be uneasy, troubled in mind
Matteleman, to despise one
Mattachgeniman, to accuse one
Machtittonhen, mattaptoonen, to abuse, scold.

XXX.—*From* Pitschi, *accidentally, by chance.*

Pitenummen, to commit a mistake
Pitaptonen, to blunder in speaking
N'pitschi, I blunder accidentally
K'pitschi, thou blunderest accidentally
Pitschi, he blunders accidentally
N'pitschi lissin, I have not done it wilfully *or* designedly.

XXXI.—*From* Witschi, *with, to go with.*

Witep, to go with
Witschinden, to put on with hands
Witalogen, to work with (somebody)
Witawendin, to work together
Witoschwen, to go *or* travel with
Widhomen, to go in a canoe with (some one).

V.—Of Prepositions.

PREPOSITIONS are particles which are placed before nouns or verbs, to express an accessory idea in connexion with them.

EXAMPLES.

Li, liwi, to
Tuppisgauwi, tpisqui, against, over
Yu undach, this side
Ta pemi, about
Tetauwiwi, between
Eli, because
Pechotschi, gieschgi, near, by, close by
Wtenk, after, at last
Untschi, of, by, from
Newentschi, therefore
Yun, here
Yu schacki, so far as here
Yu seki, so long
Seki, petschi, until
Techi, quite*
Techi matta, not at all, quite, absolutely not
Pakantschi, fully, entirely
Alike, but, for
Ayema, if, if only.

Prepositions are frequently compounded with nouns and verbs, as in the following examples:—

From Wochgitschi, *above, on the top, or on the surface of.*

Wochgidhackamique, on the earth
Wochgitaque, on the top of the house.

* *Note by the Translator.*—This is more properly an adverb; but the Author not unfrequently confounds the different parts of speech, which is not extraordinary in a language in which they are so strangely intermixed. Besides, it is evident he intended a revising of this work.

From Lappi, *again.*

Laphatton, to restore, replace
Laphacki, to replant
Lappilenin, to be again together
Lappiechsin, to repeat.

From Witschi, *with.*

Witen, to go with
Witachpin, to live, dwell with
Witonquam, to lodge at one's house, board with one
Witschingen, to help, (in German *mit helfen*)
Witschendin, to help one another
Witalogen, to work with
Witatschimolsin, to advise with
Witschimachke, to put on with hands
Wipengen, wipenditam, to lie, sleep with another.

From Kimi, *secretly.*

Kimixin, to go secretly somewhere
Kimingehsin, kimochwen, to steal away privately
Kiminatlan, to make some one escape secretly.

From Untschi, *of, therefrom.*

Undaptonen, to speak thereof
Undochwen, to come for *or* on account of something
Untschihillen, to come from somewhere
Wundenummen, wundelemuin, to flow that way.

From Awossi, *that side.*

Awossenachk, that side the fence
Awossakihakan, that side the plantation
Awossenuppeque, over the lake
Awosschakque, that side the stump *or* the tree.
Awossachtenne, over *or* beyond the hill.

VI.—Of Conjunctions.

CONJUNCTIONS are of different sorts:—

1. *Copulative.*

Wak, and, also
Schi, schitta, or, either
Nanne wak, as also.

2. *Disjunctive.*

Schak, but
Wak atta, nor, neither.

3. *Conditional.*

These are severally compounded with the verbs active and passive in the Conjunctive Mood; they are *ane*, *anup*, *anpanne*, when, if, as, &c.

4. *Adversative.*

Schuk, but
Iyabtschi, yabtschi, yet, though
Bischi, to be sure, true
Auwiyewi, yet.

5. *Concessive.*

A, am, well indeed
Quonna, although
Leke (a verb), true (it is*).

6. *Causative.*

N'titeschquo, for
Eli, wentschi, because
N'telli, that I
K'telli, that thou
W'telli, that he.

7. *Conclusive.*

Newentschi, yuwuntschi, therefore
Nanne wantschi, nahanne wentschi, for this reason
Nanne wuntschi, therefore.

8. *Ordinative.*

Woak lappi, repeatedly, again
Ickalissi, farther
Nall, at last
Nan wtenk, hereafter
Yucke petschi, 'til here, 'til now.

VII.—Of Interjections.

INTERJECTIONS are particles, sometimes a mere exclamation to express the different emotions of the mind.

1. *Of Joy*, as

Hoh! hohok! yu! anischik, quek.

2. *Of Laughter*, as

Ha! ha! he! he!

3. *Of Sorrow*, as

Ihik! iwi! ihih! auwik! ekih! kih!

4. *Of Indignation*, as

Sa, gissam, niskelendam (which is a verb), gissa, ekisch.

5. *Of Blandishment*, as

Nitsch, my child†.

* *Note by the Translator.*—From this verb is formed *nanne leketsch*, Amen, so be it! *Nanne* means this *or* that, *leketsch* is the adjective verb *leke* in the future tense, and here is meant in a potential sense, *may this or that be true*, that is to say, *happen*. Thus *Amen*, in Delaware, is an adverb in the future tense.

† *Note by the Translator.*—"My little friend," from *nitis*, friend, my friend.

6. *Of Calling, as*

Hu! yuhuh!

7. *Of Answering, as*

Yu! yo! oh! oho!

8. *Of Approbation, as*

Eh! eh! kehella! gohan!

9. *Of Admiration, as*

Ekayah? hoh! quatschee! ekee! ekisah!

10. *Of Exclamation, as*

Ohoh, ho! wo!

CONCLUDING NOTE BY THE TRANSLATOR.

THIS Grammar exhibits a language, entirely the work of the children of nature, unaided by our arts and sciences, and what is most remarkable, ignorant of the art of writing. Its forms are rich, regular, and methodical, closely following the analogy of the ideas which they are intended to express; compounded, but not confused; occasionally elliptical in their mode of expression; but not more so than the languages of Europe, and much less so than those of a large group of nations on the Eastern Coast of Asia, I mean the Chinese and those which possess analogous idioms. The terminations of their verbs, expressive of number, person, time, and other modifications of action and passion, while they are richer in their extension than those of the Latin and the Greek, which we call emphatically the *learned* languages, appear to have been formed on a similar but enlarged model, without any aid than that which was afforded by nature operating upon the intellectual faculties of man. To what cause are these phenomena to be attributed?

I hope I shall be excused for saying that this question, which I think of the highest importance, as it leads immediately to that of the origin of the variety of human languages, and perhaps of language itself, has not received, either in America or Europe, all the attention that it deserves. In Europe, an idea appears generally to prevail, that the grammatical forms of languages have proceeded, if not entirely, at least in a very great degree, from the operation or influence of the art of writing, which is saying, in other words, that these forms have been produced or essentially modified by *the arts of civilization*. A celebrated French philologist, to whose varied talents and extensive acquirements no man pays a more willing homage than myself, M. Abel Remusat, expresses himself thus on this subject: "I do not only speak of those forms, the object of which is to point out the relations of words and the mechanism of which, simple or complicated, ingenious or confused, attests the more or less successful efforts of the *writers* who first *gave laws* to language*".

This learned author, whose exquisite sense and sound judgment leave no room to suppose that it ever occurred to him that his proposition might be contradicted, appears evidently to have considered it as one of those philological axioms which have been so long and so universally established that no one even thinks of calling them in question. And so it has appeared to many other European writers, and it seems, in fact, to be an opinion generally received in that part of the world. I must own that to me it seems inconsistent with the facts which this Grammar exhibits, and which all point to nature and not to art as the source from whence have proceeded the various grammatical forms of the languages of men.

I have not room to develop here this conclusion, more than I have done incidentally in the preface; I have thought it right, however, to point it out specifically as the principal result which, in my opinion, the publication of this Grammar will produce. It appears to me that after a careful reading of the work and a comparison of this language with those of civilized nations, the mind must be necessarily drawn to the following inferences:

1. That the grammatical forms of a language constitute what may be called its *organization*.

2. That this organization is the work of nature, and not of civilization or its arts.

3. That the arts of civilization may *cultivate*, and by that means *polish* a language to a certain extent; but can no more alter its organization, than the art of the gardener can change that of an *onion* or a *potato*.

4. That the contrary opinion is the result of the pride of civilized men; a passion inherent in our nature, and the greatest obstacle that exists to the investigation of truth.

In thus expressing my opinion with all the clearness and precision that I am capable of, I do not by any means intend to establish these propositions as axioms; but merely to submit them as *questions* to the investigation of the learned, if they shall be thought worthy of the attention to which it appears that the subject entitles them. That new facts, or facts already known in part, but now more clearly made apparent, should produce new opinions is what may naturally be expected, and he will be, I hope, acquitted of presumption, who simply expresses his sentiments on this new subject, without any other pretension than that of eliciting the

* Je ne parle pas seulement de ces formes destinées à marquer les rapports des mots, et dont le mécanisme, simple ou compliqué, ingénieux ou embrouillé, atteste les efforts plus ou moins heureux des *écrivains* qui ont les premiers donné des loix au langage.—*Recherches sur les langues Tartares, Discours Préliminaire*, p. xvj.

thoughts of men better qualified than himself to trace it to all its important consequences.

To what degree nature and art have respectively contributed to the formation of languages, or their improvement, appears to me to be a question highly deserving of deep consideration; I am afraid the part of nature will be found to be the lion's share. If it be true that the poems attributed to Homer were composed at a time when the Greeks were ignorant of the art of writing, we have the true measure of nature's share in the formation of this beautiful language. The Romans, who could write, did not prove by their idiom the superiority of art.

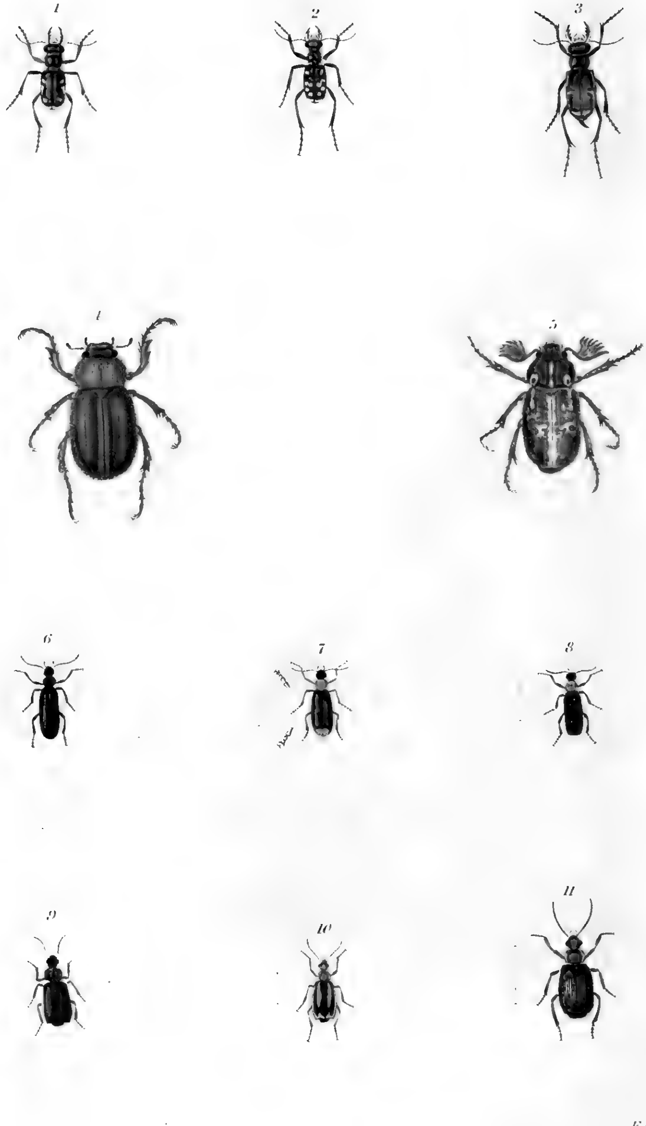
Many observations, arising from the details of this Grammar, and which would considerably tend to the elucidation of its contents, have suggested themselves to my mind while this volume was passing through the press; some of them I have subjoined in the form of notes, and the rest I must reserve for another opportunity.

I ought to observe, however, before I finally conclude, that the Author writes the termination of the third person plural of the Perfect Tense of the Indicative, indifferently *pannik* or *pannil*, without any apparent rule of discrimination. This was noticed by Vater, who published a few Delaware conjugations (under the name of *Chippeway*) from some loose sheets of Zeisberger's own manuscript, which I had transmitted to him. The learned professor was of opinion that *pannik* was the correct reading, and I have, in consequence, adopted it throughout this Grammar. Perhaps the difference arises from the variety of dialects. See *Analekten der Sprachenkunde, Zweytes Heft*, p. 50, *in note*.

ERRATA.

This mark (†) shews that the lines are to be counted from the top, and this (‡) from the bottom. The running titles are not to be reckoned.

Page 67, line 22†, for "17th" *read* "19th"
" 67, line 26†, for "19th" *read* "20th"
" 99, line 17†, for "melat" *read* "milat"; and for "eternal life" *read* "he gives (to him) eternal life"
" 100, line 6†, for "noon" *read* "noom"
" 111, line 17†, for "Nowikin" *read* "N'wikin"
" 116,—In the Future of the Subjunctive Mood, lines 1st, 3d, and 5th of that tense, for "achpiwenque, achpiweke, achpichtique" *read* "achpiwenke, achpiweque, achpichtite"
" 120,—In the Present of the Subjunctive, line 5th of that tense, for "lissichtique" *read* "lissichtite"
" 130, line 10†, for "Pommauchsichtique" *read* "Pommauchsichtite"
" 134, line 8†, for "N'dellunchsohalguneen" *read* "N'dellauchsohalguneen"
" 155, line 14‡, for "Wulelendawichtikup" *read* "Wulelendamichtitup"
" 171, line 12†, for "atta n'pendamawunap" *read* "atta n'pendawawunap"
" 235, line 14†, for "koecu" *read* "keeku".



N.M.Hentz Del^t

F. Kearny Sc

No. III.

Description of Eleven New Species of North American Insects. By N. M. Hentz, Professor of Modern Languages in the University of North Carolina.—Read November 2d, 1827.

Cicindela.

1. C. *denticulata.* Bright green; mandibles slender, longer than the head; elytra polished, with a subsutural series of impressed punctures, a subhumeral dot, intermediate triangular spot and terminal lunule white; pectus, postpectus, and front in the male, hairy.

Length half an inch.

Inhabits Massachusetts.

From C. 6-*guttata* this species may be easily distinguished by its elongated mandibles, its pectus and postpectus very hairy, and the head also, in the male. The punctures on the elytra of this species are exceedingly minute and distant, whilst they are deep in C. 6-*guttata*. To Dr T. W. Harris I am indebted for this and the next species. That gentleman, whose knowledge and labours are not less remarkable than his disinterestedness, has furnished me also with the following

Varieties.

α—Elytra purplish blue; spots as in the species.

β—Anterior dot of the elytra wanting.

γ—Anterior dot wanting; triangular spot reduced to a transverse line; posterior lunule interrupted so as to form a fourth spot.

δ—Two anterior spots wanting.

ε—All the spots wanting except the terminal lunule which is merely an abbreviated transverse line.

ζ—All the spots wanting and terminal lunule obsolete.

2. C. *hæmorrhoidalis.* Hairy, dull cupreous or purple; elytra with a humeral dot, a round dot behind, a curved band, two dots behind, and a terminal lunule whitish. Deep purple beneath; venter ferruginous.

Length 9-20ths of an inch.

Inhabits Massachusetts.

This beautiful little insect, also communicated to me by my excellent friend Dr Harris, is very remarkable for its numerous markings, in all twelve, on the elytra. The head and thorax are marked with purple and green, the thighs are green, and the sides of the thorax, pectus and postpectus are hairy.

3. C. *splendida.* Bright green; disk of the elytra crimson or purple, with a submarginal subtriangular transverse line near the middle, and a terminal transverse line; whole margin green.

Length 6-10ths of an inch.

Inhabits North Carolina. Swarming in April.

This species is closely related to C. *marginalis* of Fab. C. *purpurea* of Olivier, and chiefly so to the variety β of Mr Say; but several reasons have induced me to consider it as a distinct species. The thorax of C. *marginalis* is sensibly transverse, in this species it is less so, and with the head entirely bright green: C. *marginalis* is quite hairy, this is slightly so. The former inhabits usually shady places near or in the grass; C. *splendida* is always found on barren dry clay or sand. The middle line is sometimes wanting, sometimes the terminal one is obsolete; and I have observed two specimens with a humeral whitish spot.

Lebia.

4. L. *grandis*. Ferruginous; elytra purple, venter piceous; thorax remarkably transverse, posterior angles sharp, nearly rectangular.

Length rather more than 9-20ths of an inch.

Inhabits North Carolina.

The remarkable size of this species will be sufficient to distinguish it from L. *atriventris*, Say, which it very much resembles; but it is nearly twice as large, being, I believe, enormous for this genus. The head is darker than the thorax, and the striæ of the elytra are deeper than in L. *atriventris*. I have never seen but two specimens, found at night, attracted by the light.

5. L. *borea*. Head dark green; disk of the thorax, tarsi, lower ends of the tibia, knees, and anterior thighs, piceous; elytra green, substriate; postpectus and venter ferruginous.

Length rather more than 5-20ths of an inch.

Inhabits Massachusetts.

This insect cannot be mistaken for L. *tricolor* of Mr Say. The striæ of the elytra cannot be seen by the naked eye, but with a lens they appear to be punctured and regular, though superficial. The margin of the thorax is ferruginous; the middle part of the tibia and upper part of the two posterior pairs of thighs are testaceous. The three first joints of the antennæ are ferruginous, darkening upwards, the rest are black.

6. L. *solea.* Testaceous; elytra with deep impunctured striæ, a common sutural band narrower near the middle, not reaching the apex, to which it is contiguous on each side, with a submarginal band which tapers towards the humerus.

Length hardly a quarter of an inch.

Inhabits Massachusetts.

This insect is quite distinct from L. *vittata*, which is larger and differs from this in many respects. I cannot see that the interstice between the black bands has ever been white, as no trace remains of that colour as in L. *vittata.* The body and feet are testaceous; the head bordering on the rufous; the antennæ are dusky with paler base. The interstitial lines on the elytra are convex, which is not the case with L. *vittata.*

Melolontha.

7. M. *porcina.* Densely covered with short yellow hair; clypeus emarginate; head piceous or black with a few hairs; antennæ and legs ferruginous; thorax punctured, very hairy, with a longitudinal black line formed by the absence of hair; elytra castaneous, pubescent.

Length little more than one inch.

Inhabits Massachusetts.

This must be a rare insect, as I never saw but one specimen, and it was new to my friend Dr Harris; the head and thorax are piceous or blackish, but the thorax is covered with so much yellow hair, that it gives it a pale greenish appearance. The hair which covers the insect is short except on the margin of the elytra and postpectus, where it is long.

8. M. *variolosa.* Covered with short white hair; clypeus subquadrate, broader at tip, entire, ferruginous; antennæ ferruginous, clava very long, seven laminæ; thorax blackish with three obsolete longitudinal impressed lines obsoletely marked

with white hair; elytra dark castaneous, with suture, humeral line, and irregular spots, and the disk white; postpectus with thick long yellow hair.

Length very little smaller than the preceding.

Inhabits Massachusetts.

This cannot be referred to *Melolontha* 10-*lineata* of Mr Say, which has its clypeus emarginate, and differs from it in other respects; both are somewhat related to M. *fullo* of Europe. I never saw but two specimens.

Pyrochroa.

9. P.? *infumata.* Black, hairy; head deep black, polished; antennæ and palpi ferruginous at base; thorax ferruginous, polished; disk black; elytra hairy, punctured.

Length nearly 3-10ths of an inch.

Inhabits Massachusetts.

10. P.? *elegans.* Slightly hairy; head deep black, polished; thorax, palpi and legs bright yellow, polished; elytra blue black, punctured, with a terminal yellow spot, polished, raised and impunctured.

Length not quite 3-10ths of an inch.

Inhabits Massachusetts.

The two last insects answer well to the characters of *Pyrochroa* as given by Latreille and Lamarck, and cannot be referred to any other genus mentioned in the books. The palpi in both have their last joint larger, subsecuriform. The penultimate article of the tarsi is remarkably bifid. Their antennæ have subcylindrical joints, and are inserted into a groove of the eye.

Nemognatha.

11. N. *nemorensis*. Black, hairy; mouth and thorax ferruginous, with three basal impressions black; elytra punctured, substriate; suture raised.

Length 3-10ths of an inch.

Inhabits the woods of North Carolina.

This interesting insect is probably rare, for I never saw but one specimen, found in May. The second joint of the antennæ is shorter than the first and the third; and all the joints are very hairy. The maxillæ which are usually bent under are nearly as long as the antennæ.

In the above descriptions it is not unimportant to observe that Dr T. W. Harris has found in the vicinity of Boston *Cicindela formosa*, which Mr Say described from specimens brought from the Missouri by Mr Nuttal. He and I have also found there *Clytus speciosus*, described by Mr Say, in the Appendix to Long's Expedition of 1823, as discovered on the banks of the Wisconsan, Prairie du Chien. I have seen in North Carolina a number of insects which he had found only in the west.

No. IV.

Description of Six New Species of the Genus Unio, embracing the Anatomy of the Oviduct of one of them, together with some Anatomical Observations on the Genus. By Isaac Lea.—Read before the American Philosophical Society November 2d 1827.

Preliminary Remarks.

IN the present contribution to the science of Conchology, I have endeavoured to be as brief as I thought the subject would permit.

I have often felt the great inconvenience sustained from too short and indefinite descriptions; and am therefore fully sensible of the necessity, for the proper distinction of the species, of a more minute notice of their characters than is usually given. In this Mr Barnes has shewn a laudable example, and he deserves the acknowledgments of the conchologist*.

It will be observed I have followed his plan of dividing the margin of the disk into eight parts, reversing his posterior and anterior margins.

* Swainson says, "Although Lamarck has described so many (Uniones), the short descriptions he has given, and the want of figures to elucidate them, render it impossible to determine accurately one half the species which he has enumerated."

The genus *Unio*, established by Bruguières, and placed by Cuvier* in his fourth class of mollusques, les acéphales, and second family, acéphales testacés, or the mytilacés; and by Lamarck in his eleventh class, conchiferes, first order, conchiferes dimyaires, thirteenth family, les nayades; is to the conchologist one of the most interesting of all the genera. Recent American writers on the subject have added many new species to this genus, and other new ones are almost daily discovered.

I propose now to add six species, which I believe to be distinct from any hitherto described. In doing which, I give very exact descriptions accompanied by drawings, with a hope they may not hereafter be confounded with other species.

The constant and perplexing changes which the species of this genus assume have led even the accurate Lamarck into the error of describing several varieties as different species; and it is not without due hesitation and caution that I am induced to add the present. It has been doubtful with some conchologists whether the species of the genus Unio are not the mere varieties of one species†. To the naturalist, who has had the opportunity of examining numerous specimens, the gradations are so interesting, and at the same time so perplexing, that he is lost in the maze of their changes, and he seeks almost in vain to draw a distinctive line between them; for even the tuberculated shells sometimes pass by almost insensible gradations into smooth ones. Although this line may not always be satisfactorily drawn, I think their division into species should be retained, if it were only for the sake of system.

The comparative anatomist finds in the animal of the Unio an organization very far advanced towards a state of perfection. Lamarck places it, in his scale of perfection, higher than insects, and we cannot be surprised at this, when we examine its structure and find it possessed of brain, heart, branchiæ,

* Règne Animal, vol. ii. p. 453.

† The following genera, separated from the genus Unio, dipsas (Leach), hyria (Lamarck), alasmadonta (Say), damaris (Leach), cannot in the opinion of Mr Swainson retain their station among the genera.

liver, intestines, and an arterial and venous circulation, so complete as to excite our greatest admiration.

Taking the natural position of the animal, I have reversed the anterior and posterior margins as used by Linnæus, Bruguières, Lamarck, Bosc, and others; and have followed Cuvier* and Blainville. That margin which has the ligament between it and the beaks is considered by Lamarck as the anterior margin, but it will be found on examination not entitled to be so considered, for two reasons: 1. The mouth over which is situated the brain is placed in the opposite margin. 2. When the animal is in progressive motion, this opposite margin is always pointed in the direction of its progress. I therefore follow Cuvier in his anterior and posterior margins, because they are founded in truth.

A recent and very accurate writer, Blainville, gives us so simple an explanation of the position in which a bivalve should be placed, that I am induced to extract it. He says—"We suppose the shell to cover the animal, and that it is passing from the observer, the head (mouth) in front. The beaks should be above—the ligament between the beaks and the observer. In this position the opposite side to the beaks would be the base, and the two extremes of the perpendicular diameter of this direction would be, the one anterior, the other posterior."

Of the habits of this animal we know little; future observations must open to us an interesting history of them. With regard to their food, it seems to be a matter of doubt upon what they subsist. I have strong reasons to believe they feed upon animalcula, which are ever found to exist in water and which they might separate from the constant stream, which they pass from the posterior part of the shell, and which must be taken in at another part. This interesting operation I witnessed frequently in a vessel in which I kept them for some months. If the water was not changed for twenty-four hours, I uniformly found my interesting captives perfectly quiet, but within

* Règne Animal, vol. ii. p. 472.

a few minutes after it was changed, they as uniformly commenced the passage of this constant stream. I cannot suppose this operation to be for the sole purpose of breathing, as there is no intermission in the stream of the water, and the quantity thrown out is too great for this purpose only. I believe it to be the result of the action of the separation of the animalcula from the water.

Lamarck informs us that the animal of the anadonta (which is essentially the same with the unio) is hermaphrodite and seems viviparous; for the eggs pass into the oviduct placed along the superior branchiæ, where the young are found with their shells complete. In the dissection of an anadonta undulata nearly three inches long, I met with the oviducts charged with about 600,000 (as nearly as I could calculate) young shells perfectly formed, both valves being distinctly visible with the microscope.

There cannot be a doubt that the two pairs of muscles, which support the foot and serve by their alternate action to give the animal locomotion, are entirely distinct from the great anterior and posterior muscles, which seem but to serve the purpose of closing the valves opened by the elasticity of the ligament. The cicatrices of the muscles of the foot, anteriorly, are placed *under* the great anterior cicatrix, posteriorly *over* the great posterior cicatrix, and are sometimes confluent with the great cicatrices, sometimes entirely distinct from them.

It is necessary to notice here another set of attaching muscles, which seem to have escaped attention. We find, on closely examining the region of the cardinal tooth, a small irregular row of muscular impressions. In those species which possess large lobed teeth, these will be found generally on the inner side of them and somewhat underneath. In the more fragile shells, possessing comparatively small teeth, such as the alatus, gracilis, &c. we find these impressions in the cavity of the valve beneath the beaks. To this part of the shell I found in many species the animal to be quite strongly attached. It seems to serve to support the mantle, branchiæ,

&c. by the centre, and in this certainly serves a very useful purpose.

Being exceedingly anxious to examine the animals of the various species of the Unio from the Ohio, my brother, T. G. Lea, kindly sent me thirteen species and many varieties, which, with the assistance of Mr Stewart, were carefully dissected. Those consisted of the species mytiloides and metanevra of Rafinesque; siliquoideus, triangularis, gibbosus and cornutus of Barnes; purpureus, alatus, ovatus of Say; Æsopus of Green; irroratus and ellipsis now first described. This examination furnished me with several interesting results. It confirmed me entirely in my belief that the oviducts of the irroratus were different from any other species yet examined; a drawing and description of which will be found in this paper. The prolongation of the sacks of the oviducts is peculiarly interesting. In some of the varieties of the cornutus, which seem to run into the Æsopus, we found the posterior and inferior parts of the shell unnaturally extended. The mark of the animal on the shell had its usually curved shape, while the mantle, quite callous, extended to a protruded and irregular margin.

It has been a matter of speculation how the calcareous matter was secreted to increase the outer margin of the teeth as well as their whole surface. In this examination we found the surface of the broad teeth, some of which were near half an inch thick, to be completely covered with a prolongation of the mantle, extending from the great anterior to the great posterior cicatrix; so that when the teeth closed they completely enveloped it. This part of the mantle is exceedingly thin and transparent.

In the study of this genus, we are naturally attracted by the beautiful rays which frequently are found in the epidermis. This to the unpractised eye would seem to be a sufficiently distinctive characteristic to mark a species. There is, however, no character more fleeting and various. The young of many species uniformly possess rays, and we sometimes find fine adult specimens of extreme beauty. The naturalist is therefore obliged to abandon this character as almost useless. In noticing the colouring of the epidermis we must not pass unobserved the peculiar spots which are found on the cylindricus of Say, the metanevra of Rafinesque, and triangularis of Barnes. These have generally the form of an arrow-head, but sometimes so much elongated as to form rays. The hair like rays of the cornutus of Barnes and its varieties are peculiarly beautiful in fresh and perfect specimens; and the spotted lines covering the irroratus over its whole disk will yield to none of the painted epidermides.

In the measurements I have adopted the plan of Barnes: the greatest transverse line is the *breadth*, the greatest line perpendicular to this is the *length*, and the greatest line perpendicular to those lines, that is, from the most ventricose part of one valve to the most ventricose part of the other, is the *diameter*. We thus have the three greatest measurements of the shell, and the marginal descriptions give the form. It should be remembered that different localities produce various sizes, and even the thickness of the shell is frequently changed from this circumstance.

In considering the word "Unio" as of the masculine gender, I have followed the American conchologists, in opposition to Lamarck and other Europeans, who consider it as feminine. Ainsworth, in that part of his dictionary appropriated to pure Latinity, gives the following definition:—

Unio, onis, *m.* (*ab* unus, quod in conchis nulli duo reperiantur indiscreti, *i. e.* similes,) *A pearl, called a union*, because, many being found in one shell, not any of them is like the other. Plin. 9, 35. Unionum conchæ, *mother of pearl.* Suet. Ner. 31.

In Ainsworth's "Index Vocum Vitandarum" is to be found the following definition:—

Unio, onis, *f.* (quod unum facit) *Union, concord, agreement;* the number of one, Theol. (*In this latter sense it must be* masculine, as ternio, senio, &c. *J. C.)

* J. C. John Carey, the editor of the last edition of Ainsworth's quarto dictionary.

It is evident, that the word explained by the former of these definitions is the most proper to express a genus of shells; and consequently, in *Conchology*, the word *Unio* is masculine.

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1. Unio Calceolus. Plate III. fig. 1.

Testâ inæquilaterali, transversâ, aliquantulùm cylindraceâ, tenuiter rugatâ; dente cardinali prominente.

Shell inequilateral, transverse, somewhat cylindrical, finely wrinkled; cardinal tooth prominent.

Hab. Ohio. T. G. Lea.

My Cabinet.

Cabinet of Prof. Vanuxem.

Diam. ·6, Length ·8, Breadth 1·5 inches.

Shell ventricose, cylindrical, transverse—substance of the shell thin, rather thicker anteriorly—beaks slightly elevated, undulated and touching; not decorticated—ligament short, partly concealed by the beaks—dorsal margin straight; posterior dorsal margin oblique and carinated; posterior margin angular; posterior basal margin curved; basal margin nearly straight; anterior and anterior dorsal and basal margins rounded—epidermis dark green at the margin and becoming lighter towards the beaks; rays indistinct—cardinal tooth of right valve prominent and somewhat pointed; the single tooth of this valve shuts in before the tooth of the left valve, instead of passing into it; the tooth of the latter valve is emarginate—lateral tooth very short and single in both valves—posterior cicatrices confluent, as are also the anterior ones—cavity of the beaks deep—nacre pearly, white and silvery, iridescent in the posterior margin.

Remarks.—This curious little shell is peculiar in its prominent curved tooth, shutting in before that of the other valve.

Its nacre is uncommonly silvery. It swells considerably along the posterior umbonial slope. This causes its greatest diameter to be semidistant between the beaks and posterior margin.

I have given a view of the right valve of this shell for the purpose of exhibiting its remarkable tooth. It might at first be considered as a malformation, but in the three specimens which I have seen this character has been uniform.

The calceolus approaches as nearly in its general appearance to the donaciformis as to any other species. It is however a thinner shell, and differs in the teeth as well as the colour of the epidermis.

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2. Unio Lanceolatus. Plate III. fig. 2.

Testâ transversim elongatâ, compressâ, posticè subangulatâ; valvulis tenuibus; umbonibus vix prominentibus; dente cardinali acuto, obliquo.

Shell transversely elongated, compressed, subangular behind; valves thin; beaks scarcely prominent; cardinal tooth sharp, oblique.

Hab. Tar River at Tarborough.
My Cabinet.
Professor Vanuxem's Cabinet.
Cabinet of the Academy of Natural Sciences.
Mr Nicklin's Cabinet.
Peale's Museum.

Diam. ·5, Length ·7, Breadth 1·7 inches.

Shell transversely elongated, elliptical—substance of the shell rather thin—beaks scarcely elevated, decorticated—ligament small, terminating between the beaks—dorsal margin slightly curved; posterior dorsal margin carinated; posterior margin subangular; posterior basal and basal margins curved; anterior and anterior dorsal and basal margins rounded—epidermis lemon-yellow and olive-yellow, with transverse lines of growth, glabrous—cardinal tooth compressed, crenulated and oblique—lamellar tooth straight, long and rather abrupt —posterior cicatrices confluent, anterior cicatrices distinct—

III.

Unio calceolus.

Unio lanceolatus.

Drawn on Stone & Pr by J. Drayton

cavity of the beaks shallow—nacre salmon colour and iridescent; colour stronger under the beaks, from which beautiful fine rays diverge to the margin.

Remarks.—This species, which I have seen only in Tar River, N. C., approaches more closely to the unio pictorum of Europe than any yet discovered in this country. When I first found it, I felt assured it was the same; but upon closer examination and comparison find it to be essentially different. The cavity of the beak is much less and the cardinal tooth shorter and more lobed.

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3. Unio Donaciformis. Plate IV. fig. 3.

Testâ inæquilaterali, transversâ, cuneatâ, rugatâ; dente cardinali prominente; umbonibus posticè angulatis; margine dorsali posteriori subcarinatâ.

Shell inequilateral, transverse, cuneiform, wrinkled; cardinal tooth very prominent; beaks angular behind; posterior dorsal margin subcarinate.

Hab. Ohio. T. G. Lea.

My Cabinet.

Diam. ·7, Length 1·0, Breadth 1·5 inches.

Shell not very thick, rounded before and pointed behind—substance of the shell not thick—beaks slightly elevated, not decorticated, almost touching; angulated by an oblique carina passing from the beaks to the posterior margin; this causes a slight concavity from the beaks towards the posterior margin—ligament passing to the point of the beaks—dorsal and posterior dorsal margins slightly curved, the latter sub-carinate; posterior margin acutely angular; posterior basal margin nearly straight; basal margin curved; anterior and anterior dorsal and basal margins rounded—epidermis olive, with green rays diverging from the beaks to all parts of the margin; surface glabrous and slightly wrinkled; has distinct marks of growth—cardinal tooth large, prominent, serrated; in the left valve deeply divided by the entering of the opposite tooth—lateral tooth abrupt—posterior cicatrices distinct, anterior cicatrices also distinct—cavity of the beaks rather deep—nacre pearly white and iridescent in the posterior margin.

Remarks.—The characteristics of this little shell are its angulated posterior slope giving it in some measure the form of a donax, and its large divided cardinal tooth. Its beautiful angulated beaks approach so closely together as scarcely to admit the edge of a piece of fine paper.

In its most prominent character, the peculiar angulated slope, it most resembles the ovatus of Say, but differs greatly in the size, the ovatus being four or five inches in breadth, and very much more inflated. The latter has a double cardinal tooth in each valve; the donaciformis only in the left valve.

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4. Unio Ellipsis. Plate IV. fig. 4.

Testâ figuram ellipseos habente, longitudinali, ventricosâ; valvulis crassis, umbonibus ferè terminalibus; dentibus grandibus et distinctis.

Shell elliptical, longitudinal, ventricose; valves thick; beaks nearly terminal; teeth large and well defined.

Hab. Ohio. T. G. Lea.

My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.
Cabinet of Mr Nicklin.
Peale's Museum.
Cabinet of the Academy of Natural Sciences.

Diam. 1·3, Length 1·7, Breadth 2·3 inches.

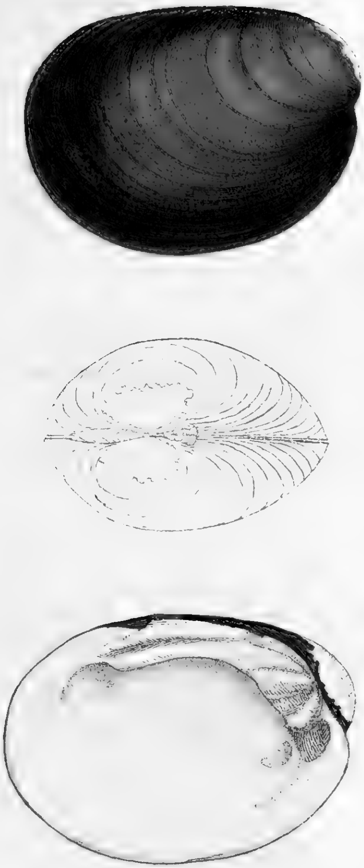
Shell very thick, ventricose, margin elliptical—substance of the shell thick and ponderous—beaks thick and projecting

IV

3

Unio donaciformis.

4

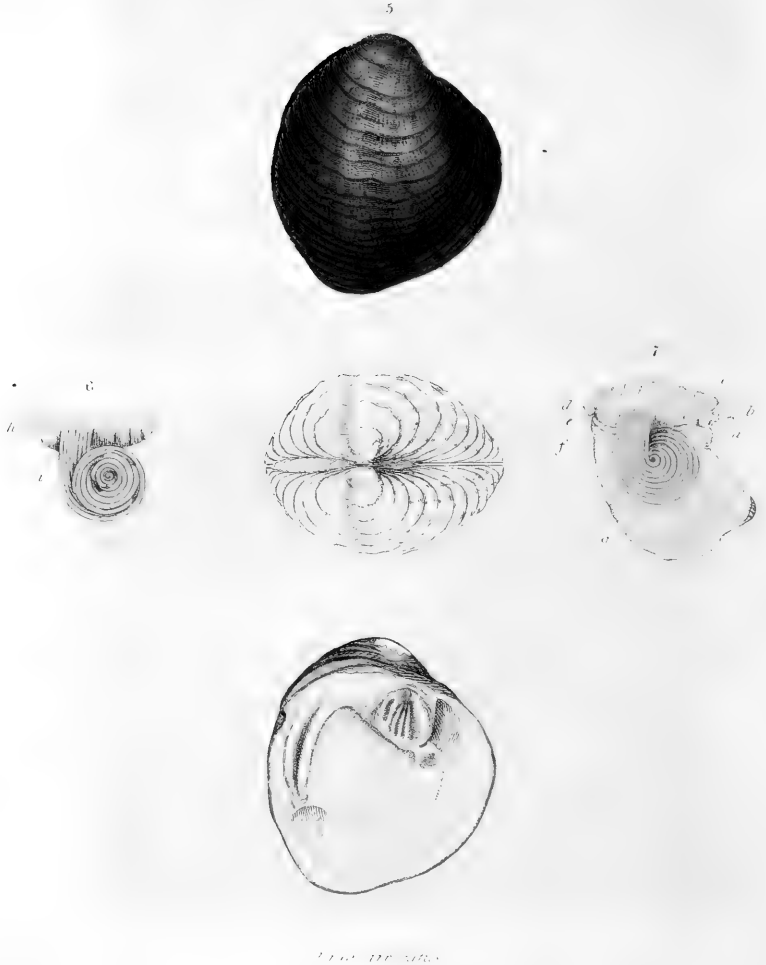


Unio ellipsis.

[illegible]

Drawn on Stone & Pr. by J. Drayton

V



[illegible]

Drawn by I Lea

I Drayton Aqf.

beyond the margin, nearly terminal, decorticated—ligament partly concealed by the beaks—epidermis reddish-brown, smooth—surface somewhat wrinkled—cardinal tooth thick, elevated, compressed at top, crenulated; direction same as lateral tooth—lateral tooth long, thick and slightly curved, abrupt—posterior cicatrices distinct, as are also the anterior ones—cavity of the beaks small—nacre pearly-white, silvery and iridescent in the posterior margin.

Var. a—red inside, rare.

Cabinet of the Academy of Natural Sciences.
My Cabinet.

Remarks.—The ellipsis approaches somewhat to a variety of the mytiloides of Rafinesque, but is more swollen and ponderous, and differs in always having an elliptical margin.

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5. Unio Irroratus. Plate V. fig. 5.

Testâ inæquilaterali, sub-orbiculatâ, longitudinali, tuberculatâ, rugosâ, longitudinaliter uni-sulcatâ; dente laterali abruptè terminante.

Shell inequilateral, suborbicular, longitudinal, tuberculated, wrinkled, longitudinally sulcated; termination of lateral tooth abrupt.

Hab. Ohio. T. Bakewell.

My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.
Cabinet of the Academy of Natural Sciences.
Mr Nicklin's Cabinet.

Diam. 1·3, Length 1·8, Breadth 1·6 inches.

Shell extremely thick and swollen—nearly round, slightly elongated—substance of the shell thick and ponderous—beaks somewhat elevated and recurved, decorticated—dorsal margin rounded; posterior, posterior dorsal and posterior basal margins rounded; basal margin slightly emarginate; anterior and anterior basal margins rounded; anterior dorsal margin slightly rounded—epidermis yellow, but filled completely over with numerous dark green spotted lines, running in a sweep from the beak to the margin. In the anterior part the crowding of these lines generally forms five or six bands, the largest being in the furrow in the middle of the shell; in the posterior part there are no bands—disks transversely and deeply wrinkled, with a slight longitudinal furrow from the beaks to the basal margin—tubercles slightly elevated and numerous, and generally situated on the wrinkles; cardinal tooth wide, depressed and sulcated; lamellar tooth slightly curved, thick, rather depressed, short and abrupt—posterior cicatrices very distinct, the smaller one being placed directly over the larger one and beneath the point of the lamellar tooth—anterior cicatrices distinct, the great one deep—cavity angular and exceedingly small for the size of the shell—nacre pearly white and silvery.

Remarks.—The very minute and delicate spotted lines which pass from the beaks to the margin of this species well characterize it. They are so fine and approach so nearly to each other as to give a general olive appearance to the disk, the ground of which is really yellow. I have not observed this to pervade completely the surface of any other species, and in this it is constant. The substance of the shell is exceedingly massive and ponderous, more so for its size than any other species which I have seen. The animal is the only one in the organization of which, during my examination of this genus, I have been able to detect any essential difference. From the shell being longitudinal and peculiarly massive, we might be led to suspect a conformation different from the other species, and such is the case.

By the exertion of my brother T. G. Lea, I have been fortunate enough to obtain three individuals of this species in a state of impregnation considerably developed. In those I observed an appendage, in form of a depressed cone, attached to the branchiæ on either side, and a very slight examination fully satisfied me these were the oviducts.

In all the other species which I have examined I have found the ovaries and oviducts as described by Cuvier, Bosc, Carus, &c. The oviducts in these lie in a direct line between the two great muscles, and are attached to the upper pair of branchiæ. In the irroratus this space is so small, as is also the cavity, that it seems to require a different conformation to accommodate the oviducts, and thus we find them *pendent*, and not placed along the plane of the branchiæ. The long sacks containing the ova are inserted about half way up the branchiæ and somewhat posterior to the centre. The number of these sacks in my three specimens consists of eight in two, and seven in the other. The posterior sack is the outer or surrounding one, and measured two inches; the second and fourth 2·2; the third 2·4; the fifth 1·9; the sixth 1·6; the seventh 1·4. In diameter the sacks are nearly the same size, the interior ones being rather smaller than the exterior, which measures one-twentieth of an inch.

These measurements were effected by separating the membranes which connect the sacks together and stretching them out. The diameter of the cone is ·6; its elevation ·2 of an inch. The outer sack terminates after making one revolution; the second advances one-third on the succeeding revolution, and each succeeding one obeys the same law until the last terminates in the centre, and the mass having performed three revolutions, the whole forms a depressed cone.

This curious arrangement of the sacks to form the depressed cone, which has its base resting on the region of the stomach, is admirably calculated by the economy of nature to harmonize with the construction of shell, which presents only at the centre of its disks room for the essential purpose of propagation. See plate V.

Fig. 6 represents the interior, fig. 7 the exterior of the oviduct, the mantle being removed.

a the mouth.

b the great anterior muscle.

c the superior right branchiæ.

d the great posterior muscle.
e the inferior right branchiæ.
f the right oviduct.
g the foot.
h the superior left branchiæ.
i interior view of the oviduct.

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6. Unio Lacrymosus. Plate VI. fig. 8.

Testâ sub-quadrangulari, inæquilaterali, posticè angulatâ, transversâ, tuberculatâ; dente laterali abruptè terminante.

Shell subquadrangular, inequilateral, angular behind, transverse, tuberculated; termination of lateral tooth abrupt.

Hab. Ohio. T. G. Lea.

My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.

Diam. ·9, Length 1·7, Breadth 1·8 inches.

Shell rather depressed and rounded anteriorly—substance of the shell thick—beaks slightly elevated with the ligament passing between them, recurved and almost touching, free from decortication, and covered with beautiful delicate raised points—when viewed on the back all the visible part is covered with them—dorsal margin oblique; posterior dorsal margin subangular, carinated; posterior margin angular; posterior basal margin emarginate; basal, anterior and anterior dorsal and basal margins rounded—epidermis yellow-green and very smooth, almost white at the point of the beaks, anteriorly slightly rayed—disks tuberculated, having a smooth channel, margined by two rows of tubercles or raised points, running from the point of the beaks, and diverging one to the basal, the other to the posterior margin—tubercles, enlarging towards the base, taking the form of flowing tears, and resembling coagulated gum; they are very minute at the point of the beaks—undulated delicately along the posterior dorsal mar-

8

Unio [illegible]

Drawn by I Lea

gin—have one distinct line of growth—cardinal tooth very wide, depressed and sulcated—lamellar tooth straight, short, crenated and abrupt—posterior cicatrices confluent; anterior cicatrices distinct, the great one deep and partly surrounding the cardinal tooth—cavity not deep, but angular, and extending under the cardinal tooth—double impression of the mantle very perceptible—nacre pearly white and silvery.

Remarks.—This rare shell forms without doubt the most beautiful and perfect species yet discovered of this genus. Its beautiful tubercles, lively colour and delicately pointed white beaks, together with its strikingly pure nacre, entitle it to a precedence over all that have yet found their way to our cabinets. The form of the tubercles is very peculiar and they distinctly mark this fine species. The specimen represented in the drawing is the largest of five which I have seen.

This species is more nearly allied to the metanevra of Rafinesque than to any other. It differs however, essentially, in its having a greater number and more distinct tubercles; its colour, and the tuberculous ridge of the latter being replaced by a smooth furrow, enlarging from the beaks to the posterior basal margin and bordered by two rows of small tubercles. The metanevra is also larger and more ponderous.

No. V.

On the Geographical Distribution of Plants. By C. Pickering, M.D.—Read October 19*th* 1827.

THE observations of travellers in every part of the globe, and our greatly increased knowledge of the species both of vegetables and animals, have of late years brought forward the interesting subject of their geographical distribution. The materials accumulated prior to the last half century were few, and insufficient to solve many questions which have since yielded to the labours of naturalists. Much has been accomplished by Humboldt, Brown, Schouw and others—the subject is continually receiving increased attention, but it is uniformly rendered intricate by attempting to reduce under the same laws both species and groups (as families, genera, &c.), while it is evident that the local causes, which, in the one instance, greatly influence their distribution, by no means affect the other. In this essay, species and groups are examined separately, the inquiry is directed more particularly to the former, and their range is followed as a guide in the arrangement here proposed.

Solar heat is evidently the principle which puts in motion the fluids of plants, and these vary in their relation to it, some requiring a temperature that destroys others; consequently, a plant being carried far north or south of its natural station meets a climate fatal to it, from a deficiency or excess of heat, marking its northern and southern limits.

A plant can thus exist only within two belts encircling the globe, one in the northern, the other in the southern hemisphere, in general coinciding with the parallels of latitude, but rendered irregular by the variation of climate at different meridians, elevation of the earth's surface, &c.

The breadth of these belts varies greatly in different species, and though experience has sufficiently demonstrated that it may be determined to within one degree of latitude, this has not yet been fully accomplished in a single instance. A careful examination of North American plants, and a comparison of authorities have yielded the following result. In a great part, perhaps one third, of the North American species, it does not exceed five degrees of latitude, and rarely attains twenty.

The range of plants is, however, far from being as extensive as *climate* would permit. The plants of the northern and southern hemispheres are different; the same may be said with respect to the plants of the eastern and western continents, except in the extreme north. Hence we must seek for some other cause restricting the diffusion of plants, and this will be found in the ocean, a great extent of which at once prevents farther progress.

Again, few plants stretch across the whole extent of the continents, in their wider parts, their range is usually still more limited. This leads to the examination of other causes which impede their diffusion.

By ascending above the level of the ocean, the temperature is found to be reduced in the same manner as on advancing towards the poles, and at the height of perpetual snow we find a polar climate. The relative mean proportion has been estimated at about six hundred feet of elevation to a degree of latitude. Accordingly, if a chain of mountains extends in the direction of the meridians, plants of cold regions, meeting a parity of climate, descend on their summits into lower latitudes. On the Rocky mountains, arctic plants reach the northern provinces of Mexico. Magellanic plants likewise exist on the Andes of Chili. In the southern parts of the United States, the low ridge of the Alleghanies (which rarely exceeds three thousand feet of elevation) affords a multitude of plants which avoid the low country, and are otherwise confined to the northern states.

Mountains thus introduce seeming confusion into our floras, while there exists in reality the most perfect order.

A lofty and unbroken chain likewise presents a barrier insurmountable to many plants. There is much difference in the vegetation between the northern and southern sides of the European Alps—the flora of Chili differs essentially from that of the country on the opposite side of the Andes.

A great river is also an obstacle to the diffusion of plants, apparently less easily overcome than a much more considerable extent of ocean. Many plants on either side of the Mississippi do not cross it. The great rivers of Siberia are known to exert a like influence on vegetation.

Water, with those substances it dissolves in the soil, is the the food of plants, and the quantity they require for the performance of their functions varies in different species. A plant can vegetate only in a soil containing a certain proportion of moisture. The seeds of aquatics will not germinate unless beneath the surface of water, while some plants flourish only in the most arid sands.

Difference in soil, so far as vegetation is concerned, is known to consist mainly in the quantity of water it is capable of absorbing, and its power of resisting evaporation, two qualities dependant on a variety of circumstances:—on the character of the rocks from which the mineral part is derived, whether such as resist decomposition, or yield to it, forming clay; or such as break down into gravel and sand, &c.—on locality, whether on plains and the summits of hills, or on declivities moistened by the filtering of water from higher places, or in low grounds perpetually saturated with it, thus forming marshes and bogs;—whether in the vicinity of, or at a distance from mountains;—whether exposed to the rays of the sun, or protected by forests, &c.

This relation of plants to water* confines them to particular situations, and any one plant can occupy but a small portion of the surface of the soil, while at the same time a great number of species can exist together within a limited space. Under certain circumstances, this may have considerable influence upon their range.

These phenomena, with many others which are continually presenting themselves, carry us at once to the supposition, that each species must have originated on a particular point of the earth's surface, from which, in the course of successive generations, it would have spread over the whole globe, but that it has been kept back and confined within narrow limits, by causes, of which the above mentioned are the most prominent. We find accordingly, that almost every practical botanist, conversant with the subject, has followed, often unconsciously, a mode of reasoning which ultimately leads to this conclusion.

That no species has originated on two different points of the earth's surface is proved by a variety of circumstances: most of the instances where a plant occurs in two distant and seemingly insulated places being readily accounted for by existing causes.

There has been much discussion relative to the quadrupeds common to the eastern and western continents; but it is now admitted, that those species only are *common*, whose range extends near to, or within, the arctic circle where the two continents closely approach each other.

The foregoing conclusion is also confirmed by the vegetation of islands. In those which are situated at the distance of from one to several miles from the main land, all the plants are common to the neighbouring continent; while if at a greater distance, they frequently afford some species not to be

* Maritime plants are confined to a soil impregnated with muriate of soda, and a few species appear to be peculiar to limestone rocks.

found there: and lastly, countries separated by a vast extent of ocean, and at the same time insulated by climate, do not possess in common a single phœnogamous plant*—as, the southern extremity of Africa with that of New Holland, or of South America.

Among the principal agents in conveying the seeds of plants to a distance from their original site, are the winds. and the currents of the ocean.

The seeds of West Indian plants are thrown by the gulf stream upon the coast of Northern Europe, and sometimes germinate there, but are destroyed by the frosts on the approach of winter. Accordingly, those species, which are common to countries separated by a great extent of ocean, are observed to be generally aquatic and marsh plants, especially maritime, whose seeds are formed to bear a long exposure to water.

Some estimate of the influence of the winds in distributing the seeds of vegetables may be formed, from the fact of the ashes of a volcano being frequently carried many hundred miles from its crater. Botanists have observed that the cryptogamia, especially lichens, in their geographical distribution, do not appear to follow the same laws with phœnogamous plants, many of the former being found in every part of the globe.—The excessive minuteness of the seeds of these plants authorizes the conjecture, that the winds alone have accomplished such an universal distribution.

The fact of the European Alps affording on their summits some arctic plants is not so readily disposed of, as the general direction of this chain of mountains is parallel with the equator, and there is a wide interval, of several hundred miles, between their most northern bend and the southern extremity of the mountains of the Scandinavian peninsula. Here, with the exception of the annual migration of birds, the winds appear to be the only agents left us, and it seems improbable

* Exceptions are extremely rare: among fifty thousand phœnogamous plants, now known, *Samolus valerandi* is the only well authenticated instance of a plant, which is common to almost every part of the globe.

that they should have conveyed the seeds of plants to *so great* a distance.—The Andes, in this respect, present a striking contrast with the mountains of the eastern continent. This great chain of mountains appears to extend, almost uninterruptedly, from near, or within, the arctic circle to Cape Horn: and arctic plants, which in the eastern continent do not reach the European Alps, have been here discovered as low as 40° N. lat., far south of those mountains—as, *Campanula uniflora, Saxifraga nivalis*, &c.

Great confusion has been occasioned in our floras by man himself carrying with him, in his migrations, a multitude of plants. In the more settled parts of the United States, the greater portion of the entire surface is covered with European vegetables: many have even wandered into the woods, so as frequently to perplex the botanist in determining, whether they have been introduced from Europe, or existed here previous to the discovery of the country. The flora of Pursh, which is usually appealed to as giving evidence of the number of species common to the two continents, contains upwards of one hundred and fifty species, now generally admitted by American botanists to have been introduced, but on which that author does not express an opinion, leaving the foreigner without any means of deciding, except that, being frequently indicated as found about fields and cultivated ground, they are of course liable to suspicion.

Thus, climate and the ocean are the two great powers which set bounds to the diffusion of plants, and at the same time, by insulating certain portions of land, divide the surface of the globe into several great botanical regions.

In this essay the following division has been adopted:

I. Greenland, Iceland, and the arctic regions of both continents.

II. The temperate portion of North America.

III. The temperate portion of the Eastern continent.

IV. The West Indies, and the intertropical regions of America.

V. Madagascar and the islands in the vicinity, the intertropical regions of Africa and of Arabia.

VI. The intertropical regions of Asia (Arabia excepted), of New Holland, the East Indies, New Guinea, New Caledonia, and most of the islands in the Pacific.

VII. The temperate portion of South America.

VIII. The southern extremity of Africa.

IX. Van Dieman's land, and the temperate portion of New Holland.

X. New Zealand.

XI. The Falkland Islands, Terra del Fuego, the South Shetland Islands, and the southern extremity of South America.

Some volcanic islands are situated in the midst of the ocean at a vast distance from land, and are so completely insulated, that they cannot be referred to any of the above regions:—such are the islands of Ascension, St Helena, Tristan d'Acunha, in the Atlantic; Amsterdam Island in the Indian Ocean, &c. The flora of islands of this description is restricted in the number of species, but highly deserving attention; and it would even appear that they possess species peculiar to themselves, an extremely interesting and important fact.

All the plants existing in either of the eleven regions here laid down are not invariably confined to it, a few being common to two or more of them; and we observe that if two of these regions approach each other at any point, several species are common to both;—thus, many species are to be found in the northern parts of the two continents, and in the intertropical parts of Africa and of Asia:—while to those which are most completely separated, no phœnogamous plant is common.

As the plan refers solely to the range of plants, it is liable to the objection of elevating a comparatively insignificant portion of southern Africa to the rank of a distinct region, while the whole of the northern and temperate part of the eastern continent, comprising more than a third of all the land upon the surface of the earth, forms but one; and if the intermediate portion of this continent had been originally covered by the ocean, the eastern and western extremities, according to the present system, would undoubtedly have ranked as two botanical regions: but, the land being continuous, plants have so intermingled that it is impossible to draw a line of distinction.

As few plants are diffused over the whole of the more extensive of these regions, subregions may be established, and the principal rivers and chains of mountains should be employed for that purpose as the natural boundaries, each subregion containing many peculiar species. This has been attempted in the second and third regions only.

The second region comprises four subregions:

1. *Flora Canadensis.* All Canada, from the Atlantic to the Pacific, and bounded south by the rivers Oregon, Missouri, and St Lawrence.

2. *Flora of the United States.* The country situated between the Atlantic and the Mississippi river.

3. *Flora Ludoviciana.* The country situated between the Mississippi and the northern Andes.

4. *Flora Californiana.* The country situated between the northern Andes and the Pacific.

The third region comprises six subregions:

1. *Flora Europea.* The north of Europe and western Siberia, bounded east by the river Yenisei, and south by the chain of the Alps, of Caucasus, &c.

2. *Flora Siberica.* The country situated between the Yenesei and the Pacific.

3. *Flora Mediterranea.* The south of Europe and north of Africa.

4. *Flora Persica.* Persia, Syria and the north of Arabia, bounded east by the Indus.

5. *Flora Thibetana.* Thibet and the north of Hindostan.

6. *Flora Chinensis.* China, Corea and the islands of Japan.

These four last do not correspond precisely with the three southern subregions of North America; as on the fortieth pa rallel of latitude, this continent, in breadth, hardly exceeds one third of the eastern.

It is not our purpose to examine in detail the geographical distribution of *forms*. In general, the intertropical regions should be contrasted with the remainder of the globe, and thus all forms will be either intertropical or extratropical. —The *Palmæ*, *Scitamineæ*, *Musaceæ*, *Bromeliaceæ*, *Aurantiaceæ*, *Guttiferæ*, *Sapoteæ*, *Piperaceæ*, *Malpighiaceæ*, *Melastomeæ*, *Meliaceæ*, *&c.* are intertropical forms.—The *Rhododendraceæ*, *Ericeæ*, *Saxifrageæ*, *Umbelliferæ*, *Amentaceæ*, *Coniferæ*, *Proteaceæ*, *Epacrideæ*, *Rosaceæ*, *Geraniaceæ*, *Caryophylleæ*, *Cistineæ*, *Cruciferæ*, *Ranunculaceæ*, *&c.* are extratropical forms.

Again, the northern and southern regions of the globe may be contrasted.—The *Proteaceæ*, *Epacrideæ*, *&c.* are peculiar to the southern; the *Cistineæ*, *&c.* to the northern portions of it.

Descending from superior to inferior group, we observe a continual tendency to become restricted to some one of the above botanical regions:—to some of which, entire natural orders are limited, and where orders are not, families or tribes are: descending still lower, many genera are found to be peculiar to each; and even if a genus be not so far restricted, a natural section of it, or some peculiarity in structure or habit, is frequently confined to one region. These facts are deserving of the greatest attention: it is to be observed, however, that from analogy of structure, a like relation to climate might be expected.

On the same principles, maps of the geographical distribution of quadrupeds, birds, reptiles, fishes, mollusca, crustacea, insects, &c. may be constructed; each of which classes will require particular modifications.

Thus, examining the distribution of land quadrupeds, we observe that their range is not so much influenced by temperature, as that of plants, and more so by the ocean:—unlike the seeds of plants, they cannot pass a great extent of water, while at the same time they roam through more degrees of latitude. For this reason, the intertropical position of New Holland must be restored to the remainder of this continent;—the northern part of Africa should, perhaps, be united with the intertropical part;—Madagascar, from the number of peculiar species, may deserve the rank of a distinct region, while New Zealand is almost a blank in the geography of land quadrupeds.

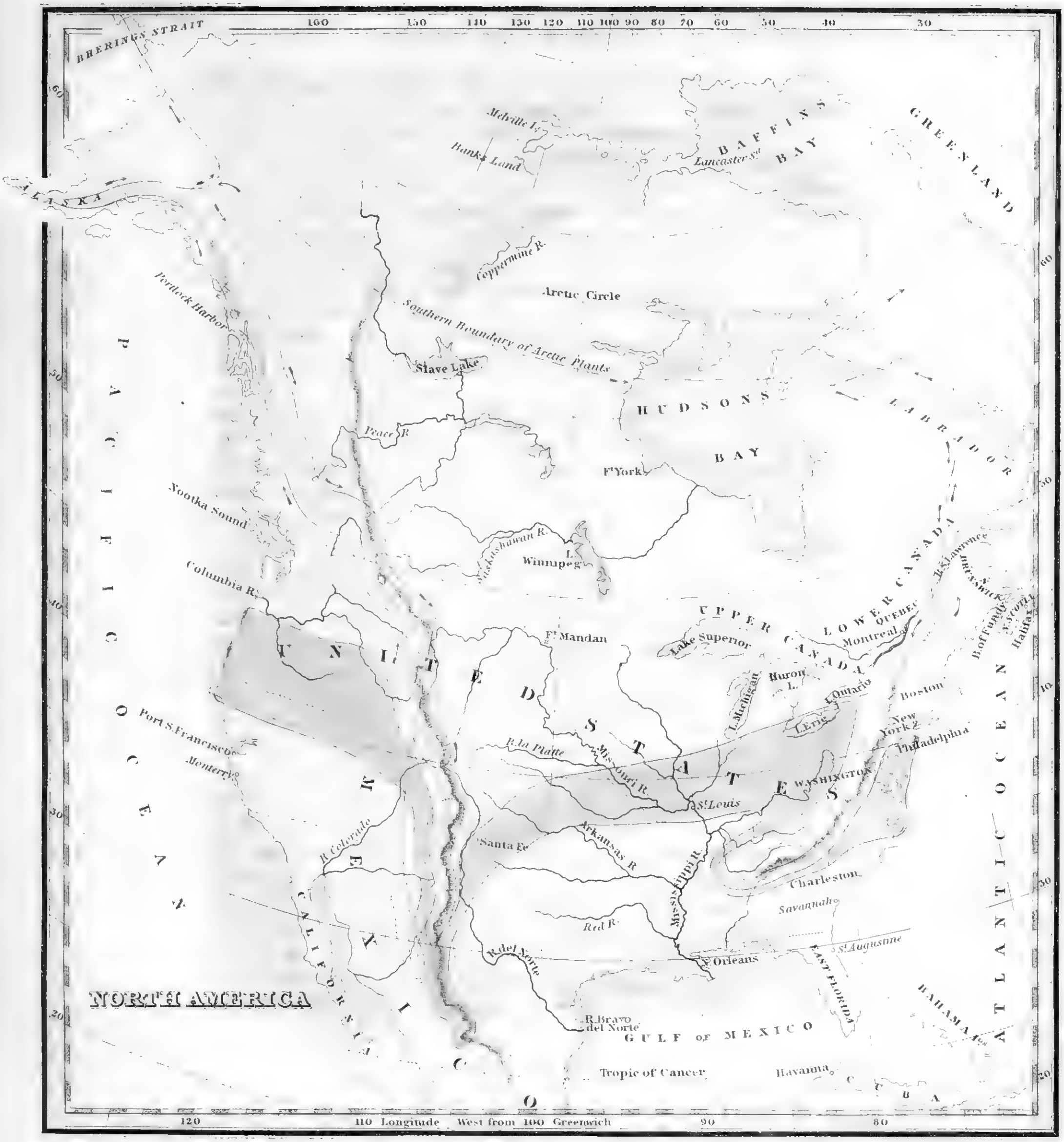
On the accompanying map of North America, the ranges of several plants are delineated. It is to be considered merely a sketch; as a large portion of the country has not yet been visited by a botanist, and even in those parts which are best known, observations are either unpublished, or too few to determine, with exactness, the range of a single species. Under these circumstances, we are forced, in some instances, to substitute conjecture for fact.

The southern boundary of the arctic plants. In the eastern part of this continent, these plants cannot descend lower than lat. 44°, on account of the inferior altitude of the Alleghany mountains south of that line. How low they descend on the northern Andes is not yet ascertained.—The following have been observed at the stations indicated on the map, *Rumex digynus, Silene acaulis, Polygonum viviparum, Trisetum subspicatum, &c.*

The coloured portion represents a fragment of a belt, beyond which certain plants cannot exist, and the irregularities and inflections into which it is thrown in this continent, by the inequality of climate and elevation of the surface: the transverse lines mark the cessation of certain species.—Thus, a few species do not appear to extend west of the Alleghanies;—others are confined to the summits of these mountains, as *Pinus pungens, Rhododendron Catawbiense, R. minus, Diphylleia cymosa, Pachysandra procumbens, Aconitum uncinatum, Galax aphylla, &c.*—westward of the Alleghanies, plants occur which do not reach the Atlantic;—

many are confined between the Mississippi and the northern Andes, as different species of *Pentstemon*, *Eriogonum*, *Psoralea*, *Gaura*, *Ænothera*, *&c.*—the summits of these mountains again present peculiar species:—the country west of this chain affords others still different, and some in the more northern parts, which are common to eastern Siberia.

Of maritime plants, some are peculiar to America, as *Uniola maritima*, *Spartina glabra*, *Gerardia maritima*, *Aster subulatus*, *A. sparsiflorus*, *Solidago lævigata*, *Uniola spicata*, *&c.* —while others are common to the eastern and western continents, as *Arundo arenaria*, *Salsola kali*, *Pisum maritimum*, *Glaux maritima*, *Statice Limonium*, *&c.*



NORTH AMERICA
BHERINGS STRAIT
ALASKA
Melville I.
Banks Land
BAFFINS BAY
Lancaster Sd.
GREENLAND
Coppermine R.
Arctic Circle
Southern Boundary of Arctic Plants
Slave Lake
Peace R.
HUDSONS BAY
Ft. York
LABRADOR
Nootka Sound
Columbia R.
Saskashawan R.
L. Winnipeg
PACIFIC OCEAN
UNITED STATES
Ft. Mandan
UPPER CANADA
LOWER CANADA
Lake Superior
Quebec
Montreal
Huron L.
L. Michigan
L. Ontario
L. Erie
Boston
New York
Philadelphia
WASHINGTON
Port S. Francisco
Monterey
R. la Platte
Missouri R.
St. Louis
MEXICO
R. Colorado
Santa Fe
Arkansas R.
Mississippi R.
Charleston
Savannah
Red R.
CALIFORNIA
R. del Norte
N. Orleans
St. Augustine
EAST FLORIDA
ATLANTIC OCEAN
BAHAMA Is.
R. Bravo del Norte
GULF of MEXICO
Tropic of Cancer
Havanna
CUBA
Halifax
110 Longitude West from 100 Greenwich

No. VI.

An Account of some Human Bones found on the Coast of Brazil, near Santas. Latitude 24° 30″ S. Longitude 46° W. By C. D. Meigs, M.D.—Read 7th December 1827.

THOSE members of the Philosophical Society who have read Mr Konig's account of the skeleton carried by Admiral Cochrane from Guadaloupe to England, and preserved in the British Museum, will find considerable interest in the specimens now on the table.

M. Cuvier has decided that not a single example of human bone has been found among the extraneous fossils of animals that are so profusely scattered over the face of the earth; and remarks that "human bones preserve equally well with those of animals when placed in the same circumstances"—whence arises the natural inference "that the human race did not exist in the *countries* in which the fossil bones of animals have been discovered, at the epoch when these bones were covered up; as there can not be a single reason assigned why men should have entirely escaped from such general catastrophes; or, if they also had been destroyed and covered over at the same time, why their remains should not now be found along with those of the other animals." This learned naturalist does not assert that man did not exist at those periods, but says he might have inhabited some narrow regions or countries which form the bottom of actual seas, where all his remains are buried.

The homo diluvii testis et theoscopos of Scheuchzer, and the mountain of similar debris described by Spallanzani as existing in Cerigo, have been proved not to belong to our race, and of the jaw dug up among the fossil bones at Cronstadt, Mr C. remarks that no sufficient notes or precautions were taken at the time of its discovery, so to its pretensions also there is a non liquet.

Granting that no human extraneous fossil exists, it is nevertheless admitted that such remains have been found, which, without having undergone any process of lapidification, are of an extremely ancient date, and the more ancient they are, the more interesting do they appear. Professor Blumenbach, for example, has a skull from an ancient Roman tomb, and it is in a good state of preservation. The Egyptian mummies of a very remote age have their osseous structure preserved in a perfect integrity, and there is in these mummies a circumstance which goes to shew that no limit could be properly assigned to the duration of bony organization. I allude to the facts recently published in relation to the dissection of those relics: in M. Passalqua's mummy, the diaphragm still retained its suppleness, though from a papyrus which was deciphered by M. Champollion, the subject was found to be daughter to an officer of the *Temple of Isis at Thebes.* In Dr Granville's dissection, the stomach, kidneys and ovaria were still discernible. Now if the fibrous and membranous structures are capable of being preserved for more than twenty centuries, why may we not suppose the osseous portions of the frame to endure for forty or sixty under favourable circumstances.

The present specimens are particularly interesting, inasmuch as they belong to the American continent, and as adding another link to that chain of testimony concerning the early occupation of this soil, of which the remains are so few and unsatisfactory, but of which another link or strong analogue exists in the Island of Guadaloupe, in a good measure neglected or disregarded on account of its loneliness or want of connection with similar facts.

These specimens were brought to this country in June last by Captain J. D. Elliott, of the U. S. navy. That officer, with a liberality which can not be too highly esteemed, both in reference to its intrinsic merit and the usefulness of the example, collected in his late cruise on the Brazilian station many interesting objects in natural history, arts, agriculture, &c., with which he has enriched his own country.

While riding along the banks of the river Santas, in his way from the port of Santas to the town of St Paul, he discovered a mound or elevation, whose area he thinks must exceed three acres, and whose height is about fourteen feet. The surface is covered with soil in which grow many large trees.

This mound or hillock is about four miles from Santas, and the little river Santas rises in the mountain of Cubiton, whose summit is elevated about 2500 feet, and stands at the distance of ten miles from the sea.

These bones were dug from the face of the hill where it was cut by the wash of the stream, and are parts of one skeleton out of many hundreds that are still lying in their bed of tufa.

Captain E. describes them as resting in the rock in an oblique direction; the heads uppermost, and the lower extremities dipping at an angle of from 20° to 25° below the horizon eastwards. This is a very curious fact, if compared with what M. Lavaysse says of the east and west direction of the Guadaloupe skeletons—a position which occasioned them to be regarded as the tenants of some ancient cemetery, though Mr Konig justly remarks that from the looseness of Lavaysse's account of the accompanying petrifactions, not much stress is to be laid on his description of this point.

There are in all nine pieces:

No. 1 is the largest, and consists of the left os temporis in a very entire state. To it is attached a portion of the parietal bone and a fragment of the occipital. The specimen is remarkable for the uncommon thickness of the squamous portion, which just above the petrous part is nearly half an inch through. I have seen, however, a recent skull thicker than this. The mastoid portion is entire.

The squamous and mastoid portions are invested externally with a stalactitic deposit of carbonate of lime, looking very much like mummified skin. The internal or cerebral surface is wholly destitute of any incrustation: whether it was filled with the gangue, or any other substance, I can not tell.

The petrous portion is entire, with the exception of a fragment near its point; the part broken off extended from the foramen innominatum obliquely to the upper orifice of the carotic canal, of which the floor or lower wall is nevertheless in a natural state. In every other respect it is whole. It is proper to remark that along the upper limit of the specimen an old fracture is to be seen, which was probably a fissure, and filled with a greenish matter, probably some ferruginous salt. The diploe is natural, having no lapidification whatever.

No. 2 is part of the superior maxillary bone, exhibiting a portion of its body with the alveoli and bony palate. To it is attached a part of the os palati; also three incisor teeth dislocated from their alveoles, but held nearly in contact with them by the gangue. Close to one of the teeth is a serpula and a piece of oyster shell.

No. 3 is part of the left greater wing of the sphenoid bone.

No. 4 is a remnant of the lower jaw, viz. the angle, the condyloid and coronoid processes, and part of the ramus as far forwards as the foramen for transmitting the nerve and vessels.

Nos. 5 & 6 are pieces of parietal bone.

No. 7 is a piece consisting of broken ribs.

No. 8 an incisor tooth remarkably worn by age.

No. 9 a specimen of the rock of which the mound is composed, and in which the skeletons are imbedded. It consists of fragments of shells united by a stalactitic matter. I beg leave to point out small nodules of carbonaceous matter, which are curious, inasmuch as similar masses are mentioned by Mr Konig as found in the Guadaloupe rock, and which detonated with nitre like gun powder.

The rock at Guadaloupe, which contains so many skeletons, is covered by high tides, and extends along the shore nearly a mile. Each skeleton seems encased in a large nodule of an oval shape, or in a mass resembling a nodule detached from a larger rock. The rock is described as an "aggregate, composed principally of zoophytic particles, and the detritus of compact limestone. It readily dissolves in diluted nitric acid without leaving any evident residue."—*Konig.*

Mr Konig's rock is "a greyish yellow passing into a yellowish grey. When more closely examined it is found to consist of yellowish grains, intermixed with others of a more or less deep flesh red colour. These grains, though minute, are in some parts of the mass perfectly defined, and in close contact with each other, although no cement is perceptible. In other parts they are, as it were, confluent, forming a more or less porous mass. In others, again, they form a compact mass, in which the former distinct concretions, especially the red ones, are only indicated by a difference of colour."

The specimen of rock before us is certainly a small one, and may, on that account, be an unfit subject for comparison with that described by Mr Konig. In regard to colour it is more nearly blueish grey passing into blue; some parts of it are yellowish: at a little distance from the eye it resembles a piece of dried mud filled with broken oyster shells. There are particles of a reddish, or rather Spanish brown colour, disseminated through it very sparsely.

This specimen is quite hard and heavy; it has numerous pores or interstices, some of which constitute a sort of very small geodic cavities lined by a drusy looking stalactitic carbonate. The Guadaloupe stone is harder than statuary marble, but I think this is considerably softer.

I can not discover in it a vestige of the yellowish grains described as making so large a part of the stone in the British

Museum; there are several laminæ of a yellowish substance, and some smaller portions of the same kind disseminated here and there—the larger are manifestly splinters and scales of bone, probably from crushed pieces of the skeleton; the latter I can attribute to no other source.

Mr Konig speaks of several kinds of shells—in this there are many broken oysters and one *serpula.* Mr Konig does not mention an oyster shell in his description.

A question naturally arises as to the date of that catastrophe which enclosed several hundred individuals in the tufa of the Rio Santas. The aborigines of that coast were always very poor, few and ignorant:—could they erect such a mound?

Monsieur Lavaysse was at Guadaloupe when General Ernouff wrote his account of the Galibies to M. Faujas St Fond, and says he collected many specimens, as heads, arms, legs, vertebræ, &c. for his own use. He also found *à coté des Sqélettes,* mortars, clubs, &c. &c. in a petrified state, and consisting of a basaltic or porphyritic stone. We might ask, how can you petrify a basalt or a porphyry. Mr L. regards the skeletons as indigénes burried in a cemetery.

It seems unlikely that these remains were formally buried by surviving friends. It is unlikely that so solid a stone should have been formed at so great a distance from the sea. The enormous trees that grow on the surface make it necessary to go back many years in search of the date.

I would not venture to differ from the opinion of Mr Cuvier on such a subject as this if I could learn his opinion. I will, however, take the liberty of referring to some appearances of our maritime borders for illustration of the few additional observations I have to make. This alluvion extends from Long Island to the province of Texas, widening in some places till it recedes 150 to 200 miles from the sea shore. From North Carolina to near the mouth of the Mississippi there is traceable, at intervals, a line of beds, consisting mostly of oyster shells in some particular spots of an enormous size. These beds are, at the point where the line crosses Eddistoe and Savannah rivers, very wide and deep. No doubt they are co-existent with the emerged land; they are not to be considered as the results of human industry. The shore of the Atlantic must have formerly swept nearly in a line with these remarkable deposits. But the Atlantic level has remained nearly what it is for more than 4000 years, and still these oyster shells are whole; they are not petrified; they are occasionally burned for lime. Within this bed, or nearer than it to the sea, are found fossil bones of elephants, &c. which can not be so old as the unfossilized oyster shells, since they could not have been fossilized anterior to the existence of the soil, out of which they are dug, unless you consider them as boulders, which is not admissible. Such fossils do not perhaps deserve the name of extraneous—that is all we can say of them, since they exist in an alluvion.

I am sorry I can not learn the geological character of the mountains of Cubiton. There is a long chain running near the coast from Rio Janeiro southwesterly.

The geologists are at liberty to determine the date and rank of the Santas tufa and thereby the probable age of these bones: our alluvial border, at least, bears no marks of volcanic agency. It emerged from a sinking sea; its organic remains are of an indefinite age. Did the Santas mound come above water by the same process?

No. VII.

Some Observations on the Moulting of Birds. By George Ord.—Read March 7th, 1828.

THAT Birds, in general, annually shed their feathers, will not be disputed. This change takes place, in some species, in summer; in others, in the autumn. When the old feathers drop, their place is supplied by new ones, which, in some species, are of quite a different complexion from those that they succeed. But when, in the spring, a retrocession of colour is found to have taken place, naturalists have concluded, that these birds undergo a double moulting; for in no other way could they account for a change of colour, which has been supposed to be dependent on a change of plumage. The species which are usually domesticated have been said to moult but once a year*; because, not perceiving

* With respect to the genus *Anas*, the author of the *Manuel d'Ornithologie* expresses himself thus: "La mue, chez le plus grand nombre des espèces connues, a lieu deux fois l'année, en Juin et en Novembre. Les femelles muent plus tard que les mâles, *et peut-être ne le font-elles qu'une fois*."—p. 814.

It here seems evident, that, in these remarks, Temminck would include the domestic geese. With us these valuable birds commence laying about the 1st of March; early in April they sit; and in May bring forth their young: the period of incubation being four weeks. Moulting then commences, and continues until August. In September they are pretty well fledged; and in November, the very season in which, agreeably to Temminck, the second moulting takes place, they are in full feather; and give frequent evidence of the fact by short flights, especially if dwelling near a lake or river. The same remarks are applicable to ducks.

any material change in their garb, it is inferred that no change is necessary; and yet if any notable mutation had obtained in any one of the domesticated species, it is probable it would be affirmed of that species, that there was some physical necessity for this exception, which did not hold of the rest.

Three great naturalists have given opinions on this part of the physiology of Birds, which do not altogether coincide with each other. From Buffon we learn that they moult but *once* a year*. Baron Cuvier says that their feathers fall *twice* a year†. And Temminck informs us, that, in some genera, the whole of the species are subject to a double change of plumage; in others, only some of the species experience it; whilst in the remainder, the moulting takes place but once a year‡.

The object of this inquiry is to ascertain, whether the opinion of Temminck, that some Birds§ change their plumage *twice* a year, is founded in fact.

The intention of Nature in renewing the covering of Birds, appears to be a revigoration of those powers which are necessary to the propagation and conservation of the animal. After the breeding season is passed, the period of moulting commences. The effects of this exhausting process, which, if not a disease‖, is closely allied to it, are well known. When the Bird recovers its strength, we find it in a new garb, which advances to perfection in proportion to its necessities: those which migrate to great distances standing in need of a speedy

It seems that Temminck is doubtful whether the females moult more than once: this doubt has arisen, we presume, from his inability to discover any variation in their plumage.

* Discours sur la Nature des Oiseaux.

† Règne Animal, tome 1, p. 296.

‡ Manuel d'Ornithologie.

§ It is necessary to state, that I have reference to Birds only in a state of nature.

‖ "La mue est pour tous les oiseaux un état de maladie, un tems de silence et de retraite: la plupart sont foibles et tristes pendant sa durée; quelques-uns sont très malades, et d'autres perissent; aucuns ne chantent tant qu'elle dure; ils se cachent, prennent peu d'ébats et se jouent plus rarement dans les airs, sur les arbres, ou dans les prairies."—*Mauduyt.*

maturation*; whilst others continue in the act of moulting between three and four months.

The most perfect state of plumage is observed in the spring. Now, if we admit the fact of a vernal moulting, then must this moulting be characterized by other circumstances than those which obtain in the autumnal; for, after the latter, the plumage requires several months to arrive at maturity; and the Bird, in ridding itself of its excretions, finds itself in too exhausted a state to perform the functions of propagation. The spring moulting, therefore, so far from exercising any debilitating influence upon the physical powers of the Bird, should seem to afford them additional energy; for this moulting is pretended to take place about the period of the sexual union, when all the powers of nature are in full vigour.

In those singing Birds which winter with us, we can perceive no diminution of vital energy during the vernal season, either as respects vigour of body, or capacity of voice. The *Fringilla tristis*, though migratory, frequently continues the whole year with us; and his song, in the month of March, while yet his autumnal dress continues, is tuneful and animated. The change in his garb begins to appear in April; and early in May, we behold him in his brilliant yellow plumage, which may be termed his bridal garniture, for shortly thereafter commences the period of nidification. During all this season of animation, his tuneful powers are unabated. In September, both sexes are nearly alike, for then they have moulted.

When the Reed-bird (*Emberiza oryzivora*) visits us in August, the male and female adults, as well as the young, so much resemble each other, that it is difficult to distinguish

* Many Birds change their feathers slowly, particularly their quills, so that they are not prevented from flying; but wild swans and geese cast their plumage so rapidly, even their wing-feathers, that they are unable to fly for several weeks: hence, in the northern parts of our continent, where they breed, many of them become the prey of foxes, and the Indians; and if they were not endued with extraordinary vigilance and sagacity, their race would stand a chance of becoming extinct.

them. But in May, in their return to their breeding places, the garb of the male is so totally dissimilar to that of the female, that many persons are doubtful whether or not they constitute the same species. This change begins to take place in March, the plumage at first assuming a mottled appearance; and in May, he exhibits the full party-coloured dress, which is the striking characteristic of his sex. But during the time that the male is undergoing this metamorphosis, there is no change of feathers: their colours being altogether the result of their organical secretions. This fact has been verified in many instances of these birds confined in cages or aviaries. Even if we had no means of experimenting upon this subject, analogical reasoning alone would not a little aid us in investigating the truth; for no person who has taken the trouble to keep Canaries, or Mocking-birds, will venture to affirm, that they shed their plumage, or moult, more than once a year.

So long ago as the year 1811, Wilson, in his history of the Carolina Parrot, in giving an account of the vernal change of the colours of the feathers of the young of the preceding year, asserted, that "*the colour changes without change of plumage.*" Had this excellent ornithologist been fully aware of the importance of this fact, it would, doubtless, have led him to an investigation, the result of which might have had a tendency to repress much of the absurdity which, since his time, has been promulgated on the subject of the moulting of Birds: for the authority of so experienced an observer, would have had greater weight than that of a mere compiler, or a closet naturalist.

In the year 1819, the Rev. William Whitear communicated to the Linnean Society of London, some "Remarks on the changes of the Plumage of Birds." These were published in the Transactions of that learned body. This gentleman, after detailing the result of observations which had been made, during the winter and spring, upon Mallards, Sandpipers, a Black-headed Gull, and some other birds, thus expresses himself:—"The above observations seem pretty strongly to confirm the fact which Mr Youell has pointed out, namely, that a change in the colour of the plumage of Birds does not always arise from a change of feathers, but sometimes proceeds from the feathers themselves assuming at one season of the year a different colour from that which they have at another*."

The Rev. Dr Fleming, in his Philosophy of Zoology, corroborates the above opinion of the Rev. Mr Whitear's; but maintains, that, "in those species whose plumage changes colour with the season, the different moultings take place at corresponding periods." "In the autumn," continues he, "we find that the black feathers on the head of the *Larus ridibundus* change to a white colour. But besides the altered feathers, others spring up, of a white colour, to increase the quantity of clothing. This Gull has, therefore, during the winter, some of the feathers of the head old, and others young. Again, in spring the white feathers of the winter become black, and a few new feathers make their appearance, likewise of a black colour, to supply the place of the older ones, which drop off in succession. Some of the feathers on the head of this Gull are half a year older than others; and consequently, we may infer, will fall off sooner than those of more recent growth. From these, and similar facts, furnished by several species of British birds, we are disposed to conclude, that the feathers which are produced in autumn, and the beginning of winter, and which correspond with the conditions of the season, change their colour in spring, and continue in this state until they are shed in autumn. The feathers which are produced in spring, continue of the same hue during the summer, change their colour in winter, and fall off again upon the approach of spring. In this manner, the quantity of the plumage fit for the different seasons of the year is easily regulated; and it is only necessary that the change of colour in each feather should take place but once in the course of its connection with the bird†."

* Transactions of the Linnean Society of London, vol. xii, p. 524.

† The Philosophy of Zoology, vol. ii, p. 28.

Now we cannot but consider this succession of moultings as at variance with the remarks of the Rev. Mr Whitear, on the *Larus ridibundus;* for the latter naturalist does not tell us, that there was a uniformity of hue in the same feather; but on the contrary, that "the same feather retained some of the brown of the imperfect bird, together with the light blue ash-colour of the adult state;" and that "the two colours prevailed in various degrees."

But why resort to all these conjectures to account for a supposed succession of plumage, when it is admitted that a change of colour may take place independent of moulting? In the greater part of those birds whose colours are uniform throughout the year, naturalists admit but of one moulting. Is there any physical necessity, then, for *two* moultings in the course of a year?—or even *three*, as some pretend? I know of none.

Montagu informs us, that he had kept a Herring Gull for several years, for the purpose of witnessing its change of plumage. This naturalist had previously asserted, that he had "*no conception of the feathers themselves changing colour**;" hence, when a change was perceptible, he tells us, that "the partial spring *moulting* of his Herring Gull commenced about the middle of February†;" a season in which all animals, in climates like ours, require an abundant supply of clothing, to obviate the effects of those vicissitudes of weather, to which they are constantly exposed. Montagu was a close observer; and had his mind not been under the influence of a theory, we are persuaded that he would have endeavoured to ascertain, whether the winter change of his Gull was the result of moulting or not. Nature administers liberally to the wants of her creatures, having a due regard to seasons and circumstances. Those animals which possess the means of migrating from cold to temperate climates, are not as abundantly provided with clothing as those which are compelled to re-

* Introduction to the Ornithological Dictionary.

† Supplement to the Ornithological Dictionary.

main. Quadrupeds and Birds, which hyemate in high northern latitudes, are well known to be supplied with a covering of extraordinary thickness and warmth; and this winter garb suffers no diminution, until the return of that temperature, which will enable the animal to dispense with it without inconvenience.

There is one more remark which we would make on this head. When in the act of moulting, birds are greatly sensible of cold: an unseasonable decrease of temperature drives them to shelter; and their actions give evidence that they are not yet prepared for such vicissitudes. In the case of those which meet with an accidental loss of plumage in the winter, until this loss is supplied, they are observed to be distressed: they seek sheltered retreats, and sunny exposures; they lose their wonted activity; and, like an animal which suffers a wound, they appear to have their attention completely absorbed by their situation.

But Montagu himself affords us one of the most apposite illustrations of the fact of a change of colour in mature plumage, that could well be desired. In the month of May, he was presented with a Black Stork, which had been taken in England. In June, he perceived some indication of a change of plumage. "The bird," says he, "continued very gradually to moult throughout the summer and winter, becoming much darker on the head and neck, and much greener on the back; and, by the beginning of February, the upper part of the head, and back of the neck, became dusky-black, glossed with green; the lower neck before dusky-black, and the whole upper part of the body, including wing-coverts and scapulars, dark shining green, similar in colour to that variety of the Glossy Ibis, known under the title of *Tantalus viridis*. The upper parts of the plumage continued as at first.

"Indisposition," continues he, "having prevented my seeing the bird since the last mentioned period, till the middle of March, I was much surprised to find the appearance of a few feathers, on the upper part of the back, that were dusky, resplendent with violet and purple, having a margin of dark glossy green. These elegant feathers continued to increase in number, till the whole upper part of the back had nearly assumed this beautiful plumage by the first of April. At this time no other part of the bird indicated any further change of plumage: the scapulars and coverts, many of which had recently changed, continued of the same colour as last described, without the purple reflections or marginal green. It is scarcely possible to account for such a succession of change in plumage in so short a time, except by supposing, that a change in the constitution of the bird, produced by captivity, and a want of natural food, had caused obstruction to the usual course of moulting; and that the autumnal change had been retarded, and was scarcely effected before the spring moulting commenced*."

With regard to the above, we would remark, that the supposition of a retardation of the autumnal moulting is totally inadmissible, inasmuch as the author distinctly states, from autoptical experience, that "the bird continued very gradually to moult throughout the summer and winter." And that there was no want of *natural food* in its state of captivity, we learn from the history of its habits, detailed by Montagu himself, in the preceding part of the paper above quoted. Let it also be observed, that all the species of the genus *Ciconia*, as well as of the genus *Ardea*, are acknowledged to cast their feathers but once a year, and that in the autumn.

It being now satisfactorily proved, that a change of colour obtains, in *some* birds, in the winter, and the spring, without a change of plumage; I am disposed to conclude, that the state of Moulting, properly so called, takes place, in all birds, but once a year.

* Some Remarks on the Natural History of the Black Stork, &c. Transactions of the Linnean Society of London, vol. xii, p. 19.

No. VIII.

Experiments made on the Poison of the Rattlesnake; in which the Powers of the Hieraceum Venosum, *as a Specific, were tested; together with some Anatomical Observations on this Animal. By Richard Harlan, M.D.—Read March 7th*, 1828.

IN offering the following observations, it is not my intention, or desire, to add another specific to the numerous antidotes to the poison of the Rattlesnake, already before the public. Most of these remedies have proved, on trial, to be either destitute of active properties, or altogether unworthy of serious consideration. I shall therefore briefly notice a few of the most celebrated.

The most ancient, at least, if not the most renowned, is the *volatile alkali*, a remedy prescribed by European practitioners more than a century ago, not only as an antidote for the poison of the viper, but against the effects of the bite of venomous animals in general*. The Abbé Fontana, about the middle of last century, published a work on the poison of the viper, to which we may refer for many curious experiments on the nature of this poison†.

* Vid. Dict. des Sciences Medicales, vol. xxxiv. p. 309; article Morsure.

† The following among other conclusions are offered by Fontana; the viper alluded to is the "Coluber berus" of Linn. "1. The bite of the viper is not pois-

There are few authorities of the present day inclined to place much faith in the volatile alkali as an antidote for the specific effects of the bite of the viper; but as the constitutional symptoms, produced by the bite of venomous reptiles, are generally adynamic in their nature, this remedy, together with other diffusible stimulants, is calculated to counteract this state of the system, and may prove very serviceable in supporting the vital powers, and thus suspend the fatal operation of the poison. To this conclusion I have been led by experiment.

The next remedy for accidents of this nature worthy of notice, is the "*Prenanthis serpentaria*" of Pursh. This plant is held in high esteem by the inhabitants of Virginia, as a remedy for the bite of the Rattlesnake, and is known to them by the familiar name of "*Lionsfoot.*" Pursh states that he had an opportunity of being a witness to the efficacy of this plant. A man living in Cove mountains, near the Sweet-springs, was bit in the foot by a Mockeson, [Cenchris Mockeson? Dandin,] a species of snake considered the most dangerous. An inflammation and swelling of the whole leg took place immediately; but by taking the milky juice of this plant, boiled in milk, inwardly, and applying to the wound the steeped leaves, which were frequently changed, he was cured in a few days. The plant is frequently confounded with another species of the same genus, from which it is important to distinguish it; this last the inhabitants name "*false Lionsfoot.*" Gronovius, in his Flora, page 113, mentions Dr Witt's *snake-root* under *P. autumnalis*, or Willdenow's "*rubicunda*," as a remedy for the bite of the Rattlesnake, which shews that he had information of the use made of this plant, though he did not know the genuine species.—Vid. Pursh's "Flora Americæ Septentrionalis," p. 499.

onous to its own body, or to that of its own species. 2. The venom is not equally destructive to all animals. 3. The poison is neither acid, alkaline, nor saltish. 4. It has no positive taste, and taken into the mouth does not cause the tongue to swell. 5. It is not inflammable. 6. Mixed with water it sinks to the bottom; when shaken it renders the water turbid and whitish."—Vide Fontana—" Ricerchè fisichè sopra il veleno della vipera."

The remedy which next claims our attention, has been considered as of sufficient importance to demand legislative enactment. It appears that some years ago, the State Assembly of South Carolina purchased from a Negro, for an annuity of one hundred pounds for life and his freedom, the secret of his cure for the bite of the Rattlesnake. This proved to be the "*Alisma plantago*," or water-plantain. Many of the members are said to have witnessed the efficacy of the remedy in the person of the Negro, who stripped himself naked and jumped into a tub, containing many of these venomous snakes, and received numerous wounds. He cured himself by swallowing one tablespoonful of the expressed juice of the Alisma plantago, and repeated the dose at intervals, until the effects of the poison were counteracted. An essay was published on this subject in the sixth volume of the Technical Repository of 1824, by C. Whitlaw, Esq.*, who states that the common plantain has been used by mistake, to which error he attributes all the reputed failures.

My friend Major N. A. Ware informs me that in Florida and Alabama, a species of *Pedicularia*, or "Louse-plant" is of considerable repute as an antidote to poisons of this nature. Sweet oil has also been famous as a specific in similar cases. A number of experiments were performed by a viper catcher before the Royal Society of London, in order to prove its efficacy, some account of which was published in the early numbers of the New York Medical Repository.

But passing over this remedy and many others of a similar nature, we come to the consideration of the plant which was

* The following extract from Mr Whitlaw's Essay is probably sufficient to destroy his authority altogether among medical men,—though the above statement concerning the experiments I believe to be historical fact.

"The specific action of the poison appears to be chiefly confined to the muscles: after the infliction of the bite, powerful muscular contractions take place over the whole body, the muscles are highly inflamed, a coldness and corrugation of the skin surround the part which was bitten, and violent spasms resembling tetanus supervene followed by mortification. A friend of mine at Savannah died in consequence of being bitten by a snake in the hand; when they took hold of his arm to place him in the coffin, *the arm came off at the shoulder joint.*"—Vid Technical Repos. vol. iv. p. 258.

the immediate object of my own experiments. It must be here repeated that the *Hieraceum venosum* is not offered as a specific cure for the bite of the Rattlesnake: much further observation is requisite to establish its claims to such high virtues. It is proposed to continue the experiments on the commencement of the approaching season, but in the mean while it was thought advisable to publish the present account as the first of a series, in as much as several facts have been elicited, which are considered very important by those who witnessed the experiments.

November 2d, 1827. In company with a number of professional gentlemen, I visited the collection of living Rattlesnakes* exhibiting by Messrs Elnsworth and Murray. The reptiles, to the number of 150, were all taken by the proprietors in their native county of Susquehanna, Pennsylvania, during the current months of August and September. The proprietors profess to be in possession of an infallible remedy for the cure of the symptoms resulting from the bite of the Rattlesnake; they display the utmost confidence, and are on terms of intimate familiarity with every individual of the collection; they take them in their hands and fold them around their necks,—open the mouth of the snake, and expose his fangs to the view of the visitors, &c. In order to satisfy ourselves that there existed no trick or deception in the case, and to prove that the bite of these animals, in their present state of subjection, is really mortal, two living animals were exposed to be bitten, both of whom died within the space of eight minutes. The first received a severe wound on the breast, the snake fastening his fangs in the flesh; immediately the eyes of the animal (a young cat) were observed to change their expression, lacking lustre, and appearing like the eyes of an intoxicated person. In three minutes after the infliction of the wound, involuntary discharges per anum occurred; in six minutes urine was also discharged. The pu-

* Crotalus durissus, Linn.

pils of the eyes were dilated, and in eight minutes convulsions and death supervened.

A narcotic or sedative effect of the poison was an early symptom, and this soon degenerated into insensibility.

In the second experiment, the kitten was introduced into the box among the snakes, and received wounds from several; one of the proprietors, Mr Elnsworth, having introduced his hand into the box among the reptiles with a view of irritating them, received two distinct wounds on the back of the hand, and which were observed to be inflicted by different individual snakes; the wounds bled slightly. Mr E. displayed no uneasiness, but loitered about the room and continued the exhibition for some time, and then took an opportunity to retire for a few minutes, and returned entirely out of danger; two small punctured wounds alone remained visible; the bleeding had ceased, and the slight tumefaction which had commenced around the wound had entirely disappeared. No marks of suction were discovered, nor were any precautions taken, in presence of the visitors, after the infliction of the wound, with the exception of the application of a ligature around the wrist.

In fine, that the proprietors are actually convinced that they possess some means to render the poison of the Rattle-snake innocuous, would seem to be proved by the experiments above stated, as well as by the perfect composure and unlimited confidence of the man, when fairly wounded by the poisonous animals, which at the same time were inflicting mortal wounds on the subjects of the experiments.

They stated to the company that the specific was of Indian renown, that a decoction of the plant was administered internally, and that, for a moderate compensation, the secret would be disclosed.

Accordingly, on the 15th of December, 1827, a number of gentlemen*, including several eminent individuals of the

* The following is a list of the names of those gentlemen who liberally contributed towards paying the amount demanded by the proprietors for the disclosure of

medical profession, convened at my office for the purpose of witnessing experiments made with the poison of the *Rattle-snake*, (*Crotalus durissus*, Linn.) Some days previous, a number of the most lively and vicious among them were separated, and permitted to drink; abstinence both from food and water having been strictly enjoined previously, during the period of their confinement, from an idea of the proprietors, that abstinence, particularly as respects water, is calcuated to render the poison less destructive.

Experiment 1.

It was decided that Mr Elnsworth, who had offered himself as the subject of the experiment, should be first bitten, and afterwards that the same snake should be made to demonstrate its poisonous powers upon a puppy.

A large active female snake was taken from the box and placed upon a table in a warm room. At 11 h. 20 m. A. M. the man received a bite from the irritated snake on the index finger of the left hand, about half an inch from the metacarpal bone; the wound resembled a minute incision, or briar scratch about one fifth of an inch in length; one fang only appears to have been projected, the animal striking with one or both fangs at pleasure; a little blood exuded. Pulse, just before the bite was received, 104 per minute; but it was observed to vary during the experiments to such a degree as to prevent any correct inference to be expected from that source.

11 h. 40 m. He says the wound smarts a little, but no signs of a poisonous wound are as yet exhibited.

their "Secret," most of whom, with several others, were present at the experiments:—

Drs Chapman, Harris, Meigs, Emerson, Mitchell, Wetherill, J. R. Barton, Pennock, Captain Bazil Hall, R. N., Messrs S. Wetherill, J. P. Wetherill, and W. Hembel. Notes were taken by several of the gentlemen, and the present statements result from a comparison of them all.

After the lapse of nearly an hour from the commencement of the experiment, no symptom denoting the action of the poison occurring, Elnsworth exposed the same hand to a large active male snake. As in the first instance, considerable irritation of the animal was requisite to force him to strike, and at

12 h. 15 m. He received a second wound from a single fang on the back of his hand, directly over a prominent venous branch. A large drop of transparent, yellowish, and glairy fluid was spread over and around the wound, which was doubtless ejected from the poison sack. A little very dark blood slowly exuded from the wound.

12 h. 31 m. Slight swelling is observable immediately around the second bite.

12 h. 48 m. Elnsworth again exposed his hand to the female snake, and received two additional punctures simultaneously, one from each fang, on the lower extremity of the metacarpal bone of the ring-finger. As in the first instance, neither of these wounds displayed symptoms of the specific effects of the poison; the *second bite* therefore, or that received from the male snake, will alone be the subject of further observations in this experiment.

1 o'clock, P. M. The swelling around the second bite has increased considerably, the tumefaction extending up and down along the course of the vein, about an inch and a half in length, and half that size in breadth, the greatest length of the tumefaction being below the wound. The man now complained of pain and numbness along the course of the lymphatic vessels on the inner part of the fore-arm.

1 h. 25 m. Pulse natural, symptoms last described somewhat increased; swelling unattended with symptoms of inflammation.

1 h. 30 m. Although the man is perfectly willing to permit the symptoms to proceed further, several of the witnesses expressed their unwillingness to bear the responsibility of the consequences; he was therefore permitted to have recourse to his remedy, and he immediately swallowed a few ounces

of the decoction of the root, and appeared indifferent about the external application of the same to the wound. He stated that the original stock of the vegetable being exhausted, and the season too far advanced to enable him to obtain more at present, he would be under the necessity of applying portions of the flesh of one of the reptiles (just decapitated for the purpose of another experiment) to the wound.

2 h. 30 m. He has held the bloody portion of the snake to his wound incessantly, from which all the swelling has subsided, together with all uneasy sensations, from his hand and arm.

4 o'clock, P. M. The man Elnsworth has remained constantly in the room under my inspection. His dinner was offered to him, but he had little disposition for food; says his stomach is a little sick, probably the effects of the medicine. No tumefaction or other symptoms remain; the wounds resemble slight scratches without any appearance of inflammation. The vein in which the bite took effect presents a peculiar appearance, being for the distance of an inch between the valves above and below the wound quite empty. Directly above the valve the vein is unusually prominent, and the pressure, from the application of the flesh, has been removed for more than an hour. It is scarcely necessary to remark that the application of portions of the snake to the wound, which the man appeared to think very important, could exert no other influence than might have been obtained from the application of the recent flesh of any other animal.

The root and leaf of the "specific" were produced and exposed to the inspection of an able botanist, Dr Charles Pickering, who identified it with the *Hieraceum venosum*, or Hawk-weed, Adder's-tongue, Poor Robin's plantain, Rattlesnake weed, &c.—a common weed in the dry open woodlands*. The same plant is noticed by Schoepf as a remedy for the bite of the Rattlesnake.

* Vid. Florula Cestrica, by W. Darlington. M.D., p. 84.

Experiment 2.

11 h. 31 m. A pup about three or four weeks old was bitten by the same female snake which had previously bitten Elnsworth in the first experiment: both fangs took effect, and the two wounds were about one inch and a quarter apart.

11 h. 34 m. Pup urinates.

11 h. 36 m. Cries and staggers.

11 h. 37 m. Belly tense in the vicinity of the wound, and apparently painful; the wound presents an ecchymosis, being tumid and of a dark colour.

11 h. 39 m. Pup lies on its side, and continues its plaintive cries, also emits some froth from the mouth. The ecchymosis increases rapidly, and a pale bloody humour exudes from the wounds.

11 h. 51 m. The animal is quiet and fanting.

12 o'clock, merid. Appears vertiginous, turning round and resting on its extended fore feet; staggering and resting on its side, and turning upon its back. These symptoms continued with little alteration until

4 o'clock, When the animal died, having previously exhibited some stertorous breathing, but without the occurrence of convulsions.

Dissection.

I examined the body fifteen minutes after death in presence of Drs Morton, Meigs, Emerson, &c. On raising the skin of the abdomen we observed an extensive extravasation of blood, not coagulated, in the cellular tissue over the whole front of the belly. The colour of the parts exposed to the specific action of the poison was a dark red, and the whole appearance in the vicinity of the wound might be aptly compared to that occasioned by an extensive and violent contusion.

The abdomen, being laid open, displayed the abdominal reflections of the peritoneum nearly in the same condition, being very red, and appearing as if soaked in blood. A similar appearance, to a considerable extent, prevailed in the peritoneal coat of the stomach and intestines, the veins of which were congested. The internal coats of the stomach and intestines were natural in appearance. Urinary bladder was empty. No coagulated blood was observed in any of the vessels throughout the system. Thorax presented no remarkable deviation from a natural state.

Cranium.—On raising the skull and dura mater, an extensive dark patch, formed apparently by extravasation or congestion, was observed under the arachnoid membrane lying over the cerebral lobes, and extending down in a slight degree between the convolutions. The substance of the brain and spinal marrow appeared natural. The muscular system was rather pale.

It will probably be remarked, that the specific action of the poison appears to have expended its deleterious influence on the *cellular* tissue in this animal: the usual phenomena which characterize death from poisons, such as non-coagulation of the blood, extravasations, &c. were remarkably well developed.

Experiment 3.

A full grown cock, having the feathers removed from over the pectoral muscles, was exposed to be bitten by a Rattlesnake, and at

12 o'clock, merid. Received two slight wounds from both fangs at the same time; each wound was covered with drops of a transparent fluid ejected from the poison bag.

12 h. 3 m. The bitten part assumed the appearance of a dark-purple ecchymosis, and the skin in the immediate vicinity of the punctures was puckered or corrugated.

12 h. 45 m. The parts over the wounds are slightly tumid, and present a black or gangrenous appearance, and are

moistened by a yellowish ichor which exudes from the wounds.

The animal finally recovered without having experienced any constitutional affection. It should be here remarked, however, that the punctures did not appear to have penetrated the skin thoroughly.

Experiment 4.

A black puppy, a few weeks old, received three bites between 12 h. 18 m. and 12 h. 23 m. The last and most severe bite was over the left eye.

12 h. 27 m. Apparently drowsy.

12 h. 40 m. Symptoms progressing slowly. And at

4 o'clock, P. M. the swelling over the eye, vertigo, and general uneasiness, appear to have attained their height. On the day following the animal had recovered without the interference of art.

Experiment 5.

4 o'clock, P. M. A stout pup was inoculated with the poison, expressed from the poison bag of a living snake, on the left side of the abdomen.

4 h. 15 m. Local symptoms are evident, and constitutional effects are beginning to be manifested.

5 o'clock, P. M. Symptoms much increased: the animal cries with pain and uneasiness; changes its posture frequently; moves with a tottering and irregular gait, sometimes lying on its breast with the fore-feet extended: these symptoms were occasionally interrupted with drowsiness, and finally the animal went into a deep sleep.

9 o'clock, P. M. The pup commenced licking his wound, the swelling of which, from the ecchymosis, had so increased as to hang down like a large hernia.

The succeeding day this animal also recovered, no symptom remaining except a slight tenderness in the part where the inoculation had been performed. Had the "*specific*" been administered in this case, the cure would doubtless have been attributed to its operation.

Experiment 6.

Poison was squeezed out of the sack of a living snake, and being placed on a piece of meat, was given to a pup to eat: it produced no effect, local or constitutional, upon the animal.

Anatomical Observations, &c.

In all venomous snakes there is an opening of considerable size situate between the eye and nostril, which penetrates in the direction of the poison apparatus, at the base of the fang; the use of this opening, in the economy of the animal, as far as I can learn, has never been discovered; it has no direct communication with the cavity containing the poison, but is connected with the lachrymal passages, so successfully investigated by Jules Cloquet*. On a careful examination of this portion of the anatomy of the Crotalus, I have invariably found at the bottom of this cavity an exceedingly delicate transparent membrane, extending over the osseous cavity in the bone at the base of the fang. This membrane, whilst it intercepts any direct communication between the sack and external canal, might at the same time permit the action of the atmosphere on the fluid contained in the sack, to take place through it, and thus to change its chemical properties. This sack communicates with the oculo-palpebral cavity, formed between the eyelid and conjunctiva. The poison of

* Vid. Memoire sur l'Existence et la Disposition des Voies Lachrymales dans les Serpens.

the living Crotalus, tested in numerous instances with litmus paper, &c. invariably displayed acid properties*.

General Remarks.

In conclusion it appears, that of the number of reptiles exhibited, some possessed the venomous faculty to a considerable degree, in others the poison was less active, and in some it had entirely disappeared, and in the latter the poison sack was found, on dissection, entirely empty.

These circumstances are readily explained when we are aware that the reptiles have remained in captivity without food for more than three months, during a cold season of the year, and, until within a few days of the experiments, deprived of water. It is more than probable that very little poison would be secreted during a state of perfect abstinence, and that of less activity than when produced under ordinary circumstances. Hence the same reptiles whose bite occasioned the death of an animal in eight minutes, when the experiments were performed in September, required five hours in order to produce fatal results at the present period. The operation of the poison on the animal system also varied. In September, when the animals died early after the infliction of the wound, death was preceded by convulsions, which was not the case in the present instance; but the animal appeared to suffer more pain, and finally fell into a state of stupidity, which continued for several hours, when death was produced by the slow operation of the poison on the system. On dissection the usual appearances produced by such poisons

* Similar observations relative to the acidity of this poison were long ago made by Dr Brickell of Savannah, who, speaking of the external application of the solution of caustic ley to the bite of the Rattlesnake, states "I was led to this by a chemical examination of the poison of the *Crotalus horridus*, which shewed an acid to be one of its constituents."—Vid. New York Medical Repository, vol. viii. p. 441.

on the organic structure, were manifest; congestions, exudation of blood throughout the system, together with the non-coagulation of this fluid, were among the more obvious results. The cavities of the heart were empty, and fluid blood was observed in the large veins.

Two of the Rattlesnakes were decapitated, and the heads being placed with the jaws expanded against the abdomen of a living rabbit, they were observed to bite repeatedly with the desperation of expiring nature, forcing their fangs into the flesh their whole length; but in these the poison bag appeared to have been emptied previously, by repeated efforts of the animal to bite, and on dissection were found nearly void. After decapitation it was curious to observe the motions of the body, which were continued from association; the cut extremity of the trunk, when an injury was inflicted near the tail, was thrown towards the offending body, as if with the intention of inflicting a wound; this experiment was repeated frequently. The heart torn from the body continued its contractions for ten or twelve hours.

Of all the animals bitten in these experiments, one only died, though all were more or less affected by the poison. Although the wound which was inflicted on Mr Elnsworth was attended with the usual *local* effects, there is no proof that the poison would have proved mortal without the use of the remedy, in as much as obvious local effects were observed in some of the animals that finally recovered without the interference of art. Though at the same time it will be remembered that the first animal experimented on died from the poison of the same snake which had previously inflicted a wound on the man.

As regards any moral influence being exerted over these animals by the proprietors, which enables them to handle the snakes without the fear of being wounded,—one of the proprietors, Mr Murray, subsequently confessed that no such influence existed; but that their knowledge of the habits of the Rattlesnake enabled them to handle them with impunity. Thus they are aware that the snake can strike only after certain preparation of the body; they assume an offensive attitude previously to striking a blow, and they seldom or never make an effort to strike when once secured by the hand.

The Abbé Fontana has remarked that the poison of the viper is not fatal to its own body, or to that of its own species when bitten; the contrary of this position is stated on respectable authority to be the case as regards the Crotalus—a result that might have been anticipated from the well known fact that Rattlesnakes, congregated together in any number, never inflict a wound on each other.

Among the most remarkable peculiarities observed in the economy of this animal is its power of abstinence. An individual lived more than two years in the Philadelphia Museum, totally deprived of food. Others in the same institution have been observed united for a considerable time in the act of coition, and subsequently to bring forth young in a living state. In one instance I have witnessed a female with fourteen young at one birth, which is far from being to the same degree prolific as some of the oviparous Colubers.

In the present stage of the investigation, had I occasion to treat a wound inflicted by a poisonous reptile, my faith in the *Hieraceum venosum*, as a cure, is not such as to induce me to resort to its employment, to the exclusion of the less equivocal means of suction, pressure, or ligature. Some very interesting experiments, which establish the superiority of the last mentioned methods, have recently been made by C. W. Pennock, M.D., and will be published in the American Journal of the Medical Sciences for May 1828.

No. IX.

On the Motion of Solids on Surfaces, in the two Hypotheses of perfect Sliding and perfect Rolling, with a particular Examination of their small Oscillatory Motions. By HENRY JAMES ANDERSON, M.D. Professor of Mathematics and Astronomy, in Columbia College, New York.—*Dated 10th Nov.* 1827. *Laid before the Society 4th Jan.* 1828.

I.

THERE are few branches of Mechanical Philosophy as interesting in every point of view as the theory of Oscillatory Motion. From the minutest vibrations of a harp-string to the magnificent oscillations of a planet's axis, there are an infinite number of analogous phenomena remarkable for their curious properties or important uses. The common pendulum, that little instrument which has rendered such essential service to science and the arts, and will soon, in the hands of the skilful observer, unfold to us the internal constitution of our globe, and give a clue to the process by which it has acquired its present state, is itself indebted for its accuracy to the incessant superintendence of a watchful mathematical analysis. The science of Acoustics in all its parts, the varied phenomena of the tides, the theory of Saturn's ring, that wonder of the solar system, and the philosophical explanation of the stability and harmony of the celestial motions, are in fact but different applications of this extensive branch of Demonstrative Mechanics. What adds to the interest and value of this subject is the circumstance that a large class of oscillatory motions, namely those of any rigid system whatever whose points depart but little from the position which they occupy when at rest, has been found susceptible of complete determination, by means of which the position of the bodies composing the system, may be expressed (to use the language of analysis) in finite functions of the time. The general problem is one, however, of the greatest difficulty, and even approximate solutions can rarely be obtained except when the conditions of the question restrict within near limits some of the variations of the system. Every contribution, therefore, however trifling, to this branch of analysis, is entitled to a favourable reception, and it is this reflection which encourages me to offer to the Society the fruits of an attentive consideration of some portions of this subject. The memoir which I have ventured to present to them is a general dissertation upon the Dynamics of solids on supporting surfaces, in the two hypotheses of perfect sliding and perfect rolling, with a special consideration of the laws of their oscillatory motions. The formulæ which I have given, besides their use in a variety of geometrical and mechanical speculations, conduct as it will be found to a complete solution of the problem of the oscillations of a supported body of any form and law of density whatever revolving on a plane or spherical surface with any initial velocity compatible with small deviations of the natural vertical of the body from its position when at rest; supposing either the absence of all friction or the action of a friction which prevents all sliding motion, but which allows the body, at the same time that it revolves round the normal, to roll in all directions from the variable point of contact. The same formulæ will conduct to the solution of a great variety of analogous problems, in which the excursions of some part of the system are confined to the immediate neighbourhood of its equilibrium position. They are susceptible moreover of easy adaptation to any hypothesis of friction, and may readily be extended to the cases in which there are several supporting surfaces, even when these surfaces are themselves in motion.

It was my original intention to prefix to the following dissertation a detailed history of the problem of the motion of a rigid body, with an account of the successive advances which have been made from the time of Galileo to the present day towards a complete determination of the phenomena of oscillating systems. The scantiness of the New York libraries with respect to scientific works, and the impossibility under which my engagements lay me of personally consulting the more copious collections of Boston and Philadelphia, to say nothing of the fact that some of the materials of such a task are not to be found in America, and only on rare occasions to be procured from Europe, have compelled me to defer until a better opportunity the execution of this part of my first plan. I shall therefore content myself at present with a very brief preliminary retrospect of what has been already done in connexion with the subject of the following communication.

Galileo appears to have been the first who considered in a mathematical point of view even the simplest cases of the problem before us, the descent of a material point along a straight line inclined to the horizon[1], and its oscillations in the arc of a vertical circumference[2]. In the first of these two cases he succeeded in defining the motion of the point; in the second, he was far from attaining the same result, and in both the resistances of friction and the air were carefully excluded. The well known law of oscillation round a horizontal axis of support, first conjectured rather than demonstrated by Descartes in the cases of plane surfaces vibrating *in latus*[3], and afterwards generalized by the celebrated Huyg-

[1] De motu naturaliter accelerato. Opere di Galileo Galilei. Milano, 1811. Vol. viii. p. 266—306. The first edition of the *Dialogues* of Galileo is that of Leyden, 1638.

[2] Opere di Galileo. Vol. viii. p. 153—160.

[3] Renati Descartes Epistolæ. Amstelodami, 1683. Epistola LXXVII. Ad Mersennum. March 2, 1646.

hens[4], was finally in 1703 deduced by James Bernoulli, from principles which have never been contested[5]. In the mean time, Newton, in his Principia, had begun to calculate in certain cases the effects of resistance in retarding the motion of points along cycloidal arcs, had reduced to the method of quadratures, the determination of their motion along curves whose planes pass through the centre of force, and had furnished general principles which served afterwards to facilitate the solution of the problem of the motion of a heavy point on surfaces of revolution[6]. In the same work too, Newton had investigated the duration of the pulses of air and the undulations of water, and had laid the foundations of the true theory of the tides[7]. Leibnitz and the elder Bernoullis had also discussed with success several interesting cases of the descent of a material point along given or required curves[8], but no mathematician appears to have had regard to the form and rotation of the supported mass, until John Bernoulli, late in life, proposed the problem of what he called the *oscillations of titubating bodies*[9]. In this problem none but the very small oscillations are considered, and the body is supposed to rock without sliding about an invariable axis, the surface of support being either a plane or the concave or convex side of a horizontal cylinder. After investigating the general formula, Bernoulli calculates the case in which the rocking body is the segment of a sphere or parabolic conoid. This rolling

[4] Hugenii Horologium Oscillatorium. Parisiis, 1673. Pars Tertia, Prop. V.

[5] Démonstration génerale du Centre de Balancement ou d'Oscillation tirée de la nature du Levier. 15 Mars, 1703.—Histoire de l'Académie Royale des Sciences. Année MDCCIII. Paris, 1720, p. 78.—Jacobi Bernoulli opera. Genevæ, 1744. Vol. ii. p. 930.

[6] Principia, Lib. II. Prop. XXV.—XXXI.—Lib. I. Prop. LIV.—Lib. I. Prop. LV.

[7] Principia, Lib. II. Prop. L.—Prop. XLVI.—Lib. III. Prop. XXIV.—Prop. XXXVI. XXXVII.

[8] Acta Erud. Lips. 1694, p. 276. 364. 394. Jac. Bern. Op. p. 601. 627.—Leibnitii et Bern. Com. Epis. Vol. i. 23. 34. 167. 286.—Joh. Bern. Op. Vol. i. 120. iii. 486.

[9] De Oscillationibus Corporum titubantium super superficie aliquâ immobili. Joh. Bern. Op. Lausannæ et Genevæ, 1742. Vol. iv. p. 296. This paper was written posterior to the year 1738. John Bernoulli was at that time 72 years of age.

without sliding (the *pura provolutio* of Leibnitz[10]) will result, it is true, for small motions from the usual hypotheses of friction, but without some condition of this kind the body would slip or slide as well as rock. Euler is the first who made this remark in the seventh volume of the Commentaries of St Petersburg (1740), where he gives an improved solution[11] of Bernoulli's problem, but does not appear to have been able, at that time, to determine what would take place if the body were left free to slide as well as to roll. Euler acknowledged his embarrassment to D'Alembert in a letter to him dated 1746, and it is to the latter mathematician that we owe the first successful investigation of the problem when the surfaces in contact are polished to a perfect smoothness. This solution is given by D'Alembert in the second edition of his *Traité de Dynamique*, published in 1758, and is offered by him as an instance of the utility of his now celebrated principle[12]. His method is then applied to the case in which the horizontal plane opposes, by its roughness, a given degree of resistance to the sliding motion, but the oscillations are still only of the kind in which the axis of rotation retains throughout the motion its original direction. This is a condition, however, which restricts the problem to a case comparatively simple, for it is manifest that in general the axis of rotation will change continually its position in space, and the body must be considered as subject, not only to roll from side to side, but also to pitch backward and forward, and at the same time to whirl around the perpendicular drawn to the surface at the point of contact. But before the triple rotation of a supported body could be determined, it was necessary to investigate the phenomena of the rotation of a free body, to which constrained

[10] G. G. L. De lineæ super lineâ incessu, ejusque tribus speciebus, motu radente, motu provolutionis, et composito ex ambobus. Jan. 1706. Act. Erud. Lips. 1706, p. 10.

[11] De minimis oscillationibus corporum tam rigidorum quam flexibilium, methoda nova ac facilis. Cõm. Acad. Petrop. 1740, p. 108.

[12] Des Corps qui vacillent sur des plans. Traité de Dynamique, 1796, p. 186.

rotation can always be reduced by regarding as accelerating forces the unknown reaction of the point or surface of support. Newton, whose name it is necessary to mention in the history of almost every interesting or important speculation in Mechanical Philosophy, is the first who attempted to deduce from mathematical principles the laws of these peculiar motions as they exhibit themselves in that most remarkable exemplification of them, the Precession of the Equinoxes[13]. The singular sagacity of this extraordinary man seems to have protected him from an erroneous result, amidst a number of precarious and sometimes inaccurate assumptions to which the tediousness and barrenness of the geometric method probably forced him to resort. An amended solution of this problem was given by D'Alembert in 1749, with all the developments and verifications which the possession of a powerful analysis had brought within his reach[14]. The treatise in which this subject is discussed contains at the same time every thing that is necessary for reducing in all other cases the general problem of the free motion of a rigid body to its six differential equations. This reduction was in fact accomplished by the same author in a memoir which he announced in 1758 as prepared for the press, but which was not actually published until 1761, in the first volume of his *Opuscules Mathématiques*[15]. The results here obtained, and to a certain extent the manner of obtaining them, differ from the methods and formulas of more recent authors in little else than the improved selection and arrangement of the symbols now employed. In this respect D'Alembert was in no degree superior to his cotemporaries, and indeed nothing is more striking than the contrast which exists between the profound and original views of this illustrious writer and the negligent and inelegant notation in which they are expressed. It is a little surprising that an author who has so often in his

13 Principia, Lib. III. Prop. XXXIX.

14 Recherches sur la Précession des Equinoxes et sur la Nutation de l'Axe de la Terre dans le Système Newtonien. Paris, 1749.

15 Du Mouvement d'un Corps de Figure quelconque, animé par des forces quelconques. Opusc. Math. Vol. i. 1761, p. 74.

philosophical writings pointed out the influence which words have upon our thoughts should have studied so little the advantages of symmetrical and well selected symbols. It seems reasonable to suppose too, that as the general speculations of mechanical science refer equally to the three dimensions of space, the formulas would naturally arrange themselves in three sets similar in their form and in the process of their derivation; an arrangement which would be favoured by the method taught long since by Daniel Bernoulli and Euler[16] of separating the motion of a body into the progression of its centre of gravity and the rotation round that centre, those two constituents of the motion being absolutely independent of each other. There were however good reasons for not adopting at that time this threefold division of algebraic symbols. The most interesting application of the calculus was the investigation of the celestial motions, and analysts therefore employed the astronomical elements of position, which have not the same reference to the three parts of space. Nevertheless the preparations for a more symmetrical analysis had been made by John Bernoulli in 1715, Euler in 1736, and Maclaurin in 1742. The first of these three authors had employed, in defining the position of the points of a curve surface, three rectangular coordinates[17], the second had adopted this method for the purpose of following the motion of a

[16] Commentar. Acad. Petropol. 1737.

[17] Leib. et Bern. Com. Epis. Tom. II. p. 345. The invention of this method is ascribed by some to Euler and by others to Maclaurin. The following extracts from John Bernoulli's letter and Leibnitz's reply, while they bar all claims in favour of the former two, make it somewhat doubtful to which of the latter the merit is to be ascribed. "Intelligo per superficiem curvam datam, cujus singula puncta determinantur (sic ut lineæ curvæ data puncta) per ordinatas tres x, y, z, quarum relatio datâ æquatione exprimeretur: sunt autem tres illæ coordinatæ, nihil aliud quam tres rectæ ex quolibet superficiei curvæ puncto perpendiculariter ductæ in tria plana positione data, et se mutuo ad angulos rectos secantia. Sit æquatio inter coordinatas, exempli gratià, hæc $xyz = a^3$. Feb. 6, 1715." To which Leibnitz replies, "Doctrinam de æquationibus localibus trium coordinatarum, seu de locis vere solidis, olim aggredi cœpi, eorumque intersectiones seu curvas etiam non planas; sed prosequi non vacavit. Operæ pretium faceret qui studium impenderet. Apr. 9, 1715."

point[18], and along with Maclaurin had resolved velocities and forces in the direction of these coordinates[19].

Euler had observed before Maclaurin that all forces whatever soliciting a point might be resolved in three directions parallel to three fixed rectangular coordinates. He merely employed these however for the purposes of immediately resolving the forces again into three others also rectangular but not fixed, the *tangentialis*, *normalis premens*, and the *normalis deflectens*. Maclaurin appears to have been the first who endeavoured to turn to account the advantages of having the forces fixed in their directions, but the geometrical methods to which he in common with all his countrymen were unfortunately attached, made it impossible for him to realize to any extent the benefits of this arrangement.

It became an easy matter then to reduce to a regular form the calculus of the motion of a point, but it was by no means so obvious what were the three elements which were equally concerned in defining the rotations about the centre of gravity. The formulas which were first invented for this purpose were given by Euler in 1750, and may safely be pronounced among the expressions in the science most remarkable for their simplicity and absolute generality[20]. In the perfect form in which they came at once from the hands of Euler, they have been extensively employed by later mathematicians, and particularly by Lagrange in his *Mécanique Analytique*. A year before the publication of this paper, Euler had given a solution of the problem of the compound rotation of the earth[21], which he acknowledges, in a memoir on the same subject inserted in the Transactions of the Berlin

[18] Mechanica analyticè exposita. Auct. Eulero. 1736. Tom. I. p. 339. 341.

[19] Mechanica, Tom. II. 477.—Treatise of Fluxions, by Colin Maclaurin. Edinburgh, 1742, p. 391, § 470.

[20] Découverte d'un nouveau principe de Mécanique. Mémoires de l'Académie Royale des Sciences de Berlin. Tome VI. 1750.

[21] Recherches de la Précession des équinoxes, et sur la nutation de l'axe de la terre. Mémoires de l'Acad. de Berl. Tome V. 1749.

Society[22] for 1750, had been composed after a perusal of D'Alembert's Treatise of 1749. The simplifications introduced by the discovery of the properties of the natural axes of rotation by Segner[23] in 1755 contributed materially to improve the form and manageableness of the equations of rotatory motion, and in 1758, Euler had made such advances in this theory, that the problem of the general motion of a free rigid body animated by no accelerating forces, or in other words agitated only by the inertia of its particles—a problem of some celebrity in the history of mathematics,—at last yielded to the power of the calculus and to the penetrating genius of its accomplished master[24]. Two years afterwards, Euler resumed the consideration of this subject, in an interesting paper in which he applied to a variety of curious problems the theory of the Segnerian axes[25]; and finally in 1761, John Albert Euler, in a prize dissertation on the stowage and ballasting of vessels, solved by a method evidently imitated from his father's, the problem of a rigid body not solicited by accelerating forces[26]. The analysis employed in these solutions though subtle and profound is certainly deficient in that directness and precision so difficult to attain in a new and complicated subject. To remedy this imperfection, D'Alembert, in a paper written in 1762, though not published until six years afterwards[27], derives the results of Euler from the principles laid down in the first volume of his *Opuscules*[28], by a process so remarkable for its simplicity and beauty, that Lagrange has adopted and inserted it with an improved nota-

[22] Avertissement au sujet des recherches sur la précession des équinoxes. Mém. de l'Acad. de Berl. Tome VI. 1750.

[23] Specimen Theoriæ Turbinum. 1755.

[24] Du Mouvement de Rotation des corps solides autour d'un axe variable. Mém. Acad. Berl. Tome XIV. 1758.

[25] Du mouvement de rotation d'un corps solide quelconque, lorsqu'il tourne autour d'un axe mobile. Mém. Acad. Berl. Tome XVI. 1760.

[26] Histoire de l'Académie des Sciences de Paris. Prix. 1761.

[27] Du mouvement d'un Corps de figure quelconque. Opuscules, Tome IV 1768. p. 32.

[28] Opuscules, Tome I. 1761. p. 74—103.

tion in the second volume of his *Mécanique*[29]. It is remarkable that in considering this variety of the problem, Landen, an English mathematician of excellent abilities, found himself unable to comprehend its principles, after fourteen years of earnest and almost unremitted efforts to overcome its difficulties, and that too with the solutions of Wildbore, Frisi, Euler and D'Alembert before him. In opposition to these writers he contended to the very day of his death that a correct analysis would give a constant angular rotation about the instantaneous axis.

The latter part of D'Alembert's memoir is occupied with the general equations when any accelerating forces are proposed, and contains some valuable extensions and simplifications of the formulas he had given before. It was now Euler's turn, however, to take the lead. In 1765, he had brought the general equations of rotatory motion into the form in which they are presented by Laplace in the first volume of the *Mécanique Céleste*[30], and there is an acknowledgment in the fifth volume of the same work[31], that the equations of Euler appear to him to be the very simplest which it is possible for the science to obtain. The work in which these formulas are given[32] contains two interesting applications, having some connexion with the subject of the present essay; the determination of the motion of a heterogeneous sphere on a horizontal plane, and a similar inquiry with respect to the motion of certain bodies, a given point in which remains in contact with the plane. Of these I shall speak more particularly hereafter.

The general results of Euler are obtained by the aid of the discovery of Segner. As the motions of a system, however, flow necessarily from its state at a given time and the forces by which it is solicited, it seems fair to demand a solution of the problem in which recourse shall not be had to the pro-

29 Mécanique Analytique, Tome II. 1815. p. 261—263.
30 Méc. Cél. Tome I. p. 74.
31 Méc. Cél. Tome V. p. 255.
32 Theoria motûs corporum solidorum seu rigidorum. Rostoch. 1765.

perties of the Segnerian axes. This was first effected by Lagrange[33] in the Memoirs of the Academy of Berlin for 1773. In the course of this solution, which is repeated with an improved notation in the *Mécanique Analytique*, the well known values of the resolved angular velocities in terms of the coordinates and resolved velocities of the body's poles, are given first as mere analytical abridgments, and made afterwards to exhibit their geometrical signification; a method which this author has followed on various other occasions. Nine years before this, however, Lagrange had considered another highly interesting case of planetary oscillation, the librations of the moon. His memoir on this subject was crowned by the Academy of Sciences in 1764 and will ever be memorable in the annals of Demonstrative Mechanics as containing the application of the beautiful principle of *virtual velocities* in all its simplicity and power to the most general speculations of Dynamical Philosophy[34]. Combined with the great theorem of D'Alembert, this principle dispenses altogether with the slow and enforced aids of Geometry, and leads the analyst at once from the definition of velocity and force safely and rapidly to the most recondite secrets and the most elevated regions of the Science. In the Berlin Memoirs for 1780, Lagrange resumed the whole subject, and in an admirable dissertation regarded by himself as the most finished of his productions, he terminates in formulas which delineate, in all their intricate variety, the motions of our satellite, for ages without number past and to come. These expressions are the results of a skilful transformation of the general equations in the case of rotation round a body-axis which forms with its mean direction a very small but variable angle, taking into account the figure which the moon

[33] Nouvelle solution du Problème du Mouvement de Rotation d'un Corps. Nouv. Mém. Berl. 1773.

[34] Recherches sur la libration de la Lune. Hist. Acad. Par. Prix. Tome IX. 1764.

must have acquired in the highly probable hypothesis of its original fluidity[35].

After the problem of free rotation had been solved, nearer approaches were made to the determination of the motion of a supported body. D'Alembert, who had briefly given in the first volume of his *Opuscules* the modifications of his general formulas applicable to this case, resumed the inquiry in the fifth volume of the same work[36]. For this purpose he undertakes a general solution of the question already considered by Euler. A body is supposed to be sustained by one of its points upon a plane, and the circumstances of the motion are required. The resulting differential equations are, however, so involved, that the author evidently abandons in despair all idea of obtaining the necessary integrations. A variety of simplifications and restrictions are then introduced with a view to obtain cases admitting of first integrals. The line which joins the centre of gravity and the point of support is supposed to be a principal axis, and the point is supposed to move without friction on a horizontal plane, the mode of considering the resistances of friction and the inclination of the plane being nevertheless laid down though found to lead to unmanageable results. On the whole, D'Alembert is far from having solved any but the simplest cases of this problem, though he appears to have proceeded somewhat farther than any of his cotemporaries.

Euler, who had in the earlier volumes of the Commentaries of the St Petersburg Academy considered, in conjunction with Daniel Bernoulli, the effects of friction in retarding the motion of polyhedral solids and homogeneous cylinders on inclined planes[37], turned his attention a few years before his death to some varieties of the general problem of greater difficulty than these. His first memoir on this subject is divi-

35 Théorie de la libration de la Lune. Nouv. Mém. Berl. 1780.

36 Sur le mouvement des Corps qui tournent. Opusc. Tome V. 1768. p. 489.

37 De descensu corporum super plano inclinato.—De motu corporum super plano horizontali aspero. Com. Acad. Petrop. Tom. XIII. 1751.—De frictione corporum rotantium. Novi Com. Acad. Petr. Tom. VI. 1761.

ded into two dissertations; treating of the oscillations of a heterogeneous vertical circle rolling first without and then with friction upon another vertical circle of support[38]. The entire paper is a favourable specimen of the characteristic perspicuity of Euler, and contains the solution of the problem of the small pendular motions of the body, comprised in two equations expressing in finite terms, the coexisting oscillations of the centre of gravity around the centre of the rolling circle, and of this centre around the centre of the circle of support. The integrations are effected by an application of rules which Euler had himself laid down forty years before[39] in discussing the coexisting oscillations of a jointed pendulum or string of weights, a problem of which John Bernoulli had previously proposed and resolved the simplest case, namely, that in which all the weights cross the vertical at the same instant of time[40]. Euler's solution of the general problem of the jointed pendulum stands precisely in the same relation to Bernoulli's that D'Alembert's essay on the vibrations of a tense string does to the original paper of Brook Taylor, and must be regarded as constituting an era not only in mechanical but equally so in analytical science. The singular laws of coexisting oscillations which Daniel Bernoulli had already

[38] De motu penduli circa axem cylindricum fulcro datæ figuræ incumbentem mobilis, remota frictione. Dissertatio prior. Acta Acad. Petrop. 1780, p. 133. De motu penduli, &c. habitâ frictionis ratione. Dissertatio altera, p. 164. This subject is continued in one of the numerous posthumous memoirs of Euler. Nova Acta, Tom. VI. 1778. The friction is here supposed to prevent all sliding. A general investigation requires the consideration of a friction proportioned to the pressure. This is the basis of a dissertation of Euler's (inserted in the Nova Acta for 1783, the year in which he died),—De motu globi heterogenii super plano horizontali, ejusque motu a frictione impedito. In this paper the axis of rotation is parallel to the horizon and invariable in direction. For a more recent investigation by Poisson of this motion in the case of a homogeneous sphere rolling forward and partly sliding on a horizontal plane, see Bulletin des Sciences Math. Tome VI. 1826, p. 161. This paper proceeds on the same principles as those which form the groundwork of Euler's Essay—De effectu frictionis in motu volutorio. Acta Petrop. 1781. p. 131—176.

[39] De oscillationibus fili flexilis quotcunque pondusculis onusti. Com. Acad. Petr. 1741.

[40] De pendulo luxato, et de ejus reductione ad pendulum simplex isochronum. Joh. Bernoulli Opera, Tom. IV. p. 302.

pointed out without being able to demonstrate, are rigorously deduced from the linear differential equations in which they are comprised; and the beautiful theory of these equations, including their complete integration in a finite series of the multiples of sines of arcs proportional to the time, is developed and explained with admirable skill. An easy application of the principles of this theory solves the problem of the oscillation of a heterogeneous circle within a circle, without friction, or what is essentially the same question, of any solid upon any suitable surface, the plane of motion being invariable; as for instance a spherical segment in a spherical cup, supposing no whirling to take place, or a pendulum with cylindrical pivots working in cylindrical collars, which is the form in which the problem is proposed by Euler himself. When the friction prevents all sliding, the oscillation is single, and is determined without reference to the theory just mentioned. The effect which this friction has in diminishing the time of a pendulum's vibrations, (along with a variety of other circumstances necessary to take into the account when the *appareil* of Borda is employed) has been also calculated by Laplace in a paper on the seconds' pendulum inserted in the *Connaissance des Tems* for 1820. His memoir is remarkable for the subtlety of the analysis, rendered necessary by the multitude of the considerations included in his calculus, but when he mentions the effect of friction without sliding as a singular and interesting result to which he had arrived, he is evidently not aware of the formulas of Euler and John Bernoulli, from either of which the same inference may readily be drawn.

In the *Acta Petropolitana* for 1782, one year before his death, Euler resumes the investigation of the problem he had considered in his *Theoria motûs corporum rigidorum.* This problem, which consisted, as I have already mentioned, in determining the motion of a heterogeneous sphere along a horizontal plane, is called by Euler himself, *quæstio maximè ardua*, and is regarded by him as inaccessible by the methods then in use, except in the case in which the centres of gravity and of figure are supposed to coincide. This simplification is accordingly introduced, and, under the hypothesis of a friction proportional to the constant pressure, he finally obtains. after a long and complicated process, a solution of the problem, as far as the progressive motion and the velocity about the instantaneous axis are concerned, but the determination of the position of this axis in terms of the time is abandoned as absolutely unattainable[41].

The whole theory of simultaneous linear equations, so important in a large class of mechanical inquiries, was left by Euler in a formed, but by no means in a finished state. D'Alembert, in whose capacious and prolific intellect almost every branch of mathematical and mechanical philosophy seems to have found place and to have borne abundant fruit. invented, for the solution of these equations, the method of indeterminate coefficients, a method remarkable for the facility of its application, and the fertile variety of its results[42]. This method is not confined as Euler's is, to the case of constant coefficients, but brings to their least difficulties many classes of equations which previously had been considered as intractable. It was however not applied by D'Alembert to the case of variable coefficients, until Lagrange and Laplace had considered the same subject in new and interesting lights. In the memoirs of the Academy of Paris for 1772, Laplace gives with numerous developments Lagrange's process for integrating any number of simultaneous linear equations of the first order with constant coefficients, and for determining the value of the arbitrary constants, which is by no means the least difficult part of the problem. Both the memoir of Lagrange which discusses the variations of the nodes of the

[41] De motu globi circa axem obliquum quemcunque gyrantis et super plano horizontali incedentis. Acta Petrop. 1782. P. ii. p. 107.

[42] Sur l'integration de quelques équations differentielles. Opuscules, Tome VII. 1780, p. 377. D'Alembert had employed the method of indeterminate multipliers in the case of constant coefficients, thirty-two years before in the Berlin Memoirs for 1748. "La belle methode de d'Alembert (these are the words of Laplace) est sûrement une des plus ingénieuses, et des plus fécondes de l'analyse." Miscellanea Taurinensia, Tom. IV. 1766, p. 273.

planets and of the inclinations of their orbits[43], and that of Laplace which is extended so as to include all their variations, whether periodical or secular[44], are alike remarkable for the analytical treasures they contain and the singular success with which this purely intellectual apparatus is made to declare the minutest and most prolonged of the celestial oscillations.

In 1788 Lagrange published his *Analytical Mechanics*. The first paragraph of the fifth section of the first edition of this work is a masterly investigation of the small oscillatory motions of any system of bodies round the places of their rest. The great generality of this solution, along with its useful applications and manageable formulas, render it altogether one of the most important contributions ever made by mathematics to mechanical philosophy[45]. The *equilibrium* positions of the elements are supposed, in Lagrange's dissertation, to be determinate and unique; that is, the system is supposed such that it cannot change its position without departing from a state of equilibrium. It is manifest however that in a large variety of cases, a system of material points may have a *range*, more or less extensive, in any part of which it will remain at rest. If the analysis of Lagrange had been made to comprehend, as far as that is practicable, the motions of a system in the immediate neighbourhood of its *range of equilibrium*, the subject would have been exhausted, and the limits of the science in no small degree enlarged.

After Huyghens and James Bernoulli had completed the

[43] Recherches sur les équations séculaires des mouvemens des nœuds et des inclinaisons des Orbites des Planètes. Mém. Acad. Paris, 1774, p. 117. This paper, though of posterior date, is quoted by Laplace in the memoir following :—

[44] Recherches sur le calcul intégral et sur le système du monde. Mém. Acad. Paris, 1772. P. ii. p. 293.

[45] It may be well to mention for the benefit of those who may find it useful to employ these formulas, that by some oversight on the part of Lagrange the values of all the bracketted coefficients in the final differential equations are deficient in all the quantities which arise from having regard to the terms of the second order in the developments of the coordinates of the elements. In the American Journal of Science and Arts for July—Sept. 1826, p. 398, I have given the terms necessary to complete the values of these coefficients, with some remarks as to the best form of the function which expresses the finite action of the impressed forces on any one of the corpuscles of the system.

theory of oscillations round a constant axis, Clairaut in 1735 generalized the doctrine of the simple pendulum, in an able investigation of its conical vibrations, in which the effects of an oblique impulse were for the first time subjected to mathematical determination[46]. The results for the cases in which the weight describes a circle either vertical or horizontal were deduced as corollaries from the general formulas, and shown to be coincident with the conclusions to which Huyghens had already arrived for these simpler cases of the question. A more difficult problem still remained. When a pendulous body hangs by a fixed point about which it may turn freely in all directions, its motion will be affected not only by the obliquity of the impulse by which it is set in motion, but also by the rotation of the pendulum around the line which joins the sustaining point and the centre of gravity, so that even when this axis is dropped vertically from a state of rest with the body revolving around it, this rotation will be sufficient, at every instant of the motion, to wrench (as it were) the axis from the direction in which it would move if it were left at the same instant to vibrate by itself. Up to the present time no solution of this problem has been given for finite oscillations, and even for oscillations infinitely small, none was given until Lagrange published, in the first edition of his *Mécanique Analytique*, an ample dissertation on the subject. After a general investigation of the free rotation of a rigid body, in which the author skilfully combines all the advantages of the various methods he had previously invented, he proceeds to the examination of the well known case in which the body *pirouettes* by virtue of the inertia of the elements alone. After a masterly detail of all the circumstances of this case, Lagrange enters upon the discussion of the general motions of a heavy body *pirouetting* about a fixed point not the centre of gravity, and advances as far towards

[46] Examen des differentes Oscillations qu'un corps suspendu par un fil, peut faire lorsqu'on lui donne une impulsion quelconque. Mém. Acad. Par. 1735, p. 281.

a solution as it is possible to proceed in the present state of the Calculus. The case however in which the natural vertical of the body makes infinitely small conical oscillations around its resting place, while the body itself revolves about this axis with any velocity compatible with such oscillations, is completely solved by means of an analysis remarkable for its brilliancy, generality and rigour. The problem, it is shown, naturally divides itself into two distinct portions, one in which the form and density of the body is absolutely arbitrary, but the rotation round the vertical small and consequently variable; the other in which the rotation round the vertical is arbitrary and consequently constant, but the form and density of the body such that the conditions requisite to constitute the natural vertical a natural axis of rotation shall be nearly, though it is not necessary that they should be exactly, fulfilled.

Poisson published his excellent *Traité de Mécanique* in 1811. In the second volume of this work, the author applies his calculus to a determination of the motions of a homogeneous ellipsoid upon an inclined plane, both surfaces being supposed perfectly smooth. The investigation does not bring the formulas within the reach of the method of quadratures, and therefore the problem cannot as yet be considered as solved[47]. The author then proceeds to give an improved solution of the question considered long before by Euler and D'Alembert, of the motion of a solid body when it is sustained upon a plane by a point fixed in the body, but moving freely along the plane. In the case in which the density and figure are symmetrical about the axis joining the centre of gravity and sustaining point, the problem is reduced to the method of quadratures, and a complete solution is given in the hypothesis of small departures of the axis from some intermediate inclination to the plane. In this solution Poisson has been followed by Prony in his *Leçons de Mécanique*

[47] This reduction, it ought to have been remarked, is easily effected when the ellipsoid becomes a spheroid of revolution.

Analytique[48], Whewell in his *Dynamics*[49], and various other authors and compilers.

It is, I think, a matter of surprize, that none of the European mathematicians should have thought of ascertaining whether the method of Lagrange might not be successfully employed in determining the variable *pirouettes* or oscillations which a heavy body bounded by a given surface will make on a given plane or in general on any given surface of support. The first solutions I have been able to find of any case whatever of this interesting question are contained in the eighth number of the New York Mathematical Diary for July 1827. The problem as proposed by Mr E. Nulty, of Philadelphia, requires a determination of all the small oscillations which can be made by the segment of a sphere in contact with a horizontal plane. Euler, as we have seen, had perfectly resolved this case, in the two hypotheses of perfect sliding and perfect rolling, as long as the motion of rotation is around an axis of invariable direction. But the motion round a variable axis he had carefully excluded, expressly on the ground of its being inaccessible to the analysis of the day. One of the solutions published in the work which I have just mentioned is by Dr Adrain, at that time Professor of Mathematics in Rutger's College, New Jersey. This solution, which regards the segment as symmetrical and moving without friction, begins with a very ingenious and direct transformation of Lagrange's general formula of Dynamics into another in which three of the variations are, as usual, variations of the coordinates of the centre of rotation, and the other three, variations of the finite angles employed by Euler and Laplace; a process which, though the most direct, has not, as far as I can ascertain, been pursued or even suggested by any other author. The facility with which this problem, as long as friction is not concerned, may be subjected to the methods and formulas of Lagrange, enabled me, in a solution

[48] Leçons de Mécanique Analytique, Tome II. 1815. p. 415.
[49] A Treatise on Dynamics. 1823. p. 336.

subjoined to Dr Adrain's in the same number of the Diary, to dispense with the conditions of a symmetrical density or a vertical natural axis of rotation. In the hypothesis of perfect rolling (the first instance I believe in which it has been considered in reference to an axis varying *ad libitum*) the formulas I have there given lead to a complete solution of the problem[50] considered in all the generality of which it is susceptible. It still remained to apply to oscillating bodies of any form whatever what is there remarked of bodies with a spherical areola of contact, and at the same time to have regard to the figure of the surface of support. This I have attempted in the following dissertation; with what success I leave to those who are better practised than myself in speculations of this nature, to examine and decide.

Before entering upon this subject, I beg leave simply to remark that the new words or new combinations of words occasionally employed in the following paper, have not been introduced from any idle love of innovation, but from the absolute necessity of the case. The tedious circumlocutions and the incessant repetitions to which I should have been forced without the proposed abridgments, would have extended this communication far beyond its proper limits, and would not I think have added either to its interest or perspicuity. In short, I have employed these terms precisely for the same reasons that I employ the symbols of analysis, and attach no sort of value to them after they have served my purpose, but leave them to be accepted or rejected, as those who choose to pursue this subject may happen to find it most convenient.

[50] In consequence of an error in developing the variation of the living forces due to the progression of the system, a correction (to be made by substituting $e - h$ in place of e) becomes necessary in some of the expressions at the close of the paper above referred to.

II.

Mathematical Investigation of the Motion of Solids upon Surfaces, in the Two Hypotheses of Perfect Sliding and Perfect Rolling, with a Particular Examination of their Small Oscillatory Motions.

Let us now refer, as usual, the oscillating body (M) to two systems of coordinate axes, one of them, which I shall call *space axes*, fixed in space, and originating at any fixed point (O), the other called *body axes*, invariably connected with the body and originating at any given point ($O_{,}$). Let x, x', x'', $x_{,}$, $y_{,}$, $z_{,}$, denote the coordinates of any element Dm of the body referred to these two sets of axes; ξ, ξ', ξ'', $\xi_{,}$, $\eta_{,}$, $\zeta_{,}$, the coordinates of $O_{,}$, reckoned from O, parallel respectively to the space and body axes; A, B, C, p, q, r, the moments of inertia and the velocities of rotation round the body axes; F, G, H, P, Q, R, the integrals $Sy_{,}z_{,}Dm$, $Sz_{,}x_{,}Dm$, $Sx_{,}y_{,}Dm$, $\int pdt$, $\int qdt$, $\int rdt$; X, X', X'', $X_{,}$, $Y_{,}$, $Z_{,}$, the accelerative forces in the direction of the space and body axes; and finally, the symbol d denoting the differential coefficient with respect to the time t*, let dx_{1}, dy_{1}, dz_{1}, $d\xi_{1}$, $d\eta_{1}$, $d\zeta_{1}$, d^2x_{2}, d^2y_{2}, d^2z_{2}, and $d^2\xi_{2}$, $d^2\eta_{2}$, $d^2\zeta_{2}$, denote the velocities and accelerations of Dm and $O_{,}$, in the direction of the axes of the body.

As the general formula of Dynamics is, by its nature, inde-

* I have ventured upon this modification of the usual notation, at the suggestion of a valued friend, principally with a view to save room. A single symbol of the form $\frac{\mathrm{d}x}{\mathrm{d}t}$, besides occasioning more or less of trouble and delay to the printer, evidently makes every line in which it is introduced take up more than double the space which it would occupy without it. The Roman d will be reserved (as usual in these Transactions) for simple differentials.

pendent of the direction of the axes in space, it may be presented in either of these forms, (1)

$$SDm[(d^2x + X)\delta x + (d^2x' + X')\delta x' + (d^2x'' + X'')\delta x''] = 0$$

$$SDm[(d^2x_2 + X_{,})\delta x_1 + (d^2y_2 + Y_{,})\delta y_1 + (d^2z_2 + Z_{,})\delta z_1] = 0$$

where it must be carefully recollected, that in consequence of the motion of the body axes, the variations and accelerations in the latter formula, as well as the velocities dx_1, dy_1, dz_1, $d\xi_1$, $d\eta_1$, $d\zeta_1$, belong to the class of incomplete differentials.

In these equations the variations are of different values for different elements of the body, or in other words are functions of the coordinates of Dm. It is evident, however, that before this formula can be employed, these variations will in general require to be reduced to other variations *common* to all the elements, so that, in the language of the calculus, they may be passed from under the sign S. The manner of effecting this, by a general method for all constitutions of matter and for all conditions of motion, must have been a problem of no ordinary difficulty. Mathematicians however have succeeded in this transformation by several processes equally remarkable, each of them terminating in an equation of the form

$$L\delta\alpha + M\delta\beta + N\delta\gamma + L'\delta\lambda + M'\delta\mu + N'\delta\nu = 0.$$

In all these transformations, $\delta\alpha$, $\delta\beta$, $\delta\gamma$ are the *progressive* variations common to all the particles in the direction either of the body-axes or the axes in space; but with respect to the variations $\delta\lambda$, $\delta\mu$, $\delta\nu$, there exists between these methods an essential difference which deserves to be noticed. To render this distinction the clearer, it is necessary to observe that the absolute position of a body in space involves two considerations: 1st, the position in space of some fixed point $O_{,}$ of the body, which may be denominated the *station* of the body; and 2dly, that part of the position which depends only upon the direction of the body-axes, and which, for the sake of brevity, may be called the *aspect* of the body. A body therefore may change its station while it keeps its aspect, or it may alter its aspect while it maintains its station, these two constituents of position being entirely independent of each other. It is evident, moreover, that the station of a body depends upon three arbitrary variables, the three coordinates of $O_{,}$; whereas its aspect is a function of the nine angles which the three body-axes make with the three axes in space. As the angles which a straight line makes with axes to which it is referred, are elements of very frequent use in geometrical and mechanical speculations, I shall take the liberty, for the purpose of avoiding tedious repetitions, to call them the *axe-angles* of the line, distinguishing also between the *space-axe angles* and the *body-axe angles*; thus $a, a', a'', b, b', b'', c, c', c''$ (which is the usual notation) will denote the cosines of the space-axe angles of the body-axes. Between these nine cosines there exist six equations of condition, so that, in ultimate analysis, the aspect of a body will, as well as its station, depend upon the values of three independent variables. The choice of these becomes therefore a matter of importance. Euler, who must be regarded as the inventor of this interesting branch of analysis, showed as early as the year 1771, in a paper published in the fifteenth volume of the *Novi Commentarii* of the Academy of St Petersburg, under the title of *Problema algebraicum ob affectiones prorsus singulares memorabile*, how these nine quantities might be expressed in terms of three independent angles, namely, the inclination of one of the moveable to one of the fixed planes, and the distances from their intersection to an axis in each plane. The author begins by considering the question analytically; and this view of it gives rise to a problem altogether similar, with respect to the determination of sixteen quantities connected by ten analogous conditions, from which he proceeds, with his characteristic habit of gradual generalization, to extend his analysis to twenty-five quantities with fifteen connecting relations, and so on. It is only the first case of the problem that can have any application to geometry, but the whole paper is deserving of attention as furnishing one of the earliest specimens of the improved methods of modern analysis. Of all the solutions of the first case of this problem which have since been given, there is perhaps none equal to Euler's in directness and perspicuity. The methods of obtaining the resulting formulas have however been, with great advantage, occasionally modified so as to suit particular views and purposes. It is in astronomy more especially that these three elements of aspect are most employed, for which reason they are preferred by Laplace to the three indefinite integrals, the angles P, Q, R, notwithstanding the greater symmetry which arises from the use of these three angles. It is to Euler also that we are indebted for formulas which lead to this last determination, by which the cosines of the nine angles are made to depend by the medium of differential equations on the values of the integrals P, Q, R. In the sixth volume of the Berlin Transactions for the year 1750, in a memoir entitled *Découverte d'un nouveau principe de mécanique*, Euler gave the formulas, now so well known, which express the motion of every point of a system in terms of the coordinates of the point and the motion of progression and rotation common to all the points. These expressions were employed by Lagrange in obtaining the relations by which the variations of the cosines of the axe-angles were reduced to the three variations δP, δQ, δR, or the three analogous variations of the angles of rotation round the axes fixed in space. Finally, in the Memoirs of the Academy of Turin for the years 1784 and 1785, there is a curious paper by Monge, in which, having occasion to introduce these nine cosines, he takes for the independent variables the three angles $xO_{,}x_{,}$, $x'O_{,}y_{,}$, $x''O_{,}z_{,}$, and gives without demonstration the values of the other six, expressed in terms of these three. Lacroix has inserted these results, with an accompanying demonstration, in his quarto treatise on the Differential and Integral Calculus; but I am not aware that this method of determination has been employed in Analytical Mechanics.

One of the methods by which the transformation from individual to common variations has been effected is founded on the formulæ which give the variations of the cosines a, a', a'', &c. in terms of the variations of the angles of rotation round the space-axes. This method has the advantage of leading readily to two integrations with respect to time, thus giving at once the principles of the centre of gravity, of areas and of living forces; but does not allow of integration with respect to the dimensions of the system, without which it is obvious that the phenomena of its motion cannot in general be ascertained. For this purpose either the equations of motion obtained by this transformation must be employed to produce six others which admit of this integration, as Laplace has done, or these six must be obtained directly from the general dynamical equation by the application of the formulas involving the variations of the angles of rotation round the axes of the body, a method which was first carried fully into effect by Lagrange. In his *Mécanique Analytique*, he effects this transformation, not by a direct method, but by means of his favourite subsidiary formulas, (*Vol. I. p.* 13, edit. 1811); and in doing so he is under the necessity of warning the reader that the usual interchange of the differential of the variation and the variation of the differential would not be legitimate with respect to the quantities δdP, δdQ, δdR. The difference arising from the order in which the signs are placed (a difference obviously to be ascribed to the incompleteness of both the differential and the variation of the indefinite integrals P, Q, R,) Lagrange then carefully investigates and takes into account. In a note found among his papers after his death, and inserted in an appendix at the end of the second volume of his *Mécanique*, he carries to its results, by a direct process, the last mentioned plan of transformation, and extends his analysis to all possible systems, whether solid or not, thereby having regard to the intestine or proper motions of the particles. As the method indicated in this note appears to me to conduct to the necessary results from the simplest principles, by the directest means, and with the smallest quantity of analysis compatible with a process entirely analytical, I shall devote a page or two of this paper to the purpose of obtaining, by means of this transformation, formulas preparatory to the solution of the problem I have proposed. On this subject I think it proper to premise, that as the whole notation I have adopted refers to the three dimensions of matter with absolute similarity, the equations will necessarily form themselves into triplets perfectly symmetrical, so that when the first of each triplet is investigated, the others will be had without calculation by changing simultaneously throughout the first triplet every letter of the triplets of notation into the letter which follows it circularly in that triplet. The same observation applies equally to the accents; to allow of which in all cases, it was necessary to alter in some respects the usual notation, which however will not be much disturbed if we make the triplets of successive accents refer to the fixed axes and the triplets of successive letters to the axes of the body.

Among the quantities which I have distinguished by symbols, there exist the following well known relations.

$$(2)\qquad \begin{aligned} x &= \xi + a\,x_, + b\,y_, + c\,z_, \\ x' &= \xi' + a'x_, + b'y_, + c'z_, \\ x'' &= \xi'' + a''x_, + b''y_, + c''z_, \end{aligned}$$

$$(3)\qquad \begin{aligned} x_, &= -\xi_, + ax + a'x' + a''x'' \\ y_, &= -\eta_, + bx + b'x' + b''x'' \\ z_, &= -\zeta_, + cx + c'x' + c''x'' \end{aligned}$$

$$(4)\qquad \begin{aligned} a^2 + a'^2 + a''^2 &= 1 & a\,b + a'b' + a''b'' &= 0 \\ b^2 + b'^2 + b''^2 &= 1 & b\,c + b'c' + b''c'' &= 0 \\ c^2 + c'^2 + c''^2 &= 1 & c\,a + c'a' + c''a'' &= 0 \\ a^2 + b^2 + c^2 &= 1 & a\,a' + b\,b' + c\,c' &= 0 \\ a'^2 + b'^2 + c'^2 &= 1 & a'a'' + b'b'' + c'c'' &= 0 \\ a''^2 + b''^2 + c''^2 &= 1 & a''a + b''b + c''c &= 0 \end{aligned}$$

$$(5)\qquad \begin{aligned} dP &= cdb + c'db' + c''db'' \\ dQ &= adc + a'dc' + a''dc'' \\ dR &= bda + b'da' + b''da'' \end{aligned}$$

(6)

$$\begin{aligned} da &= b\,dR - c\,dQ & db &= c\,dP - a\,dR & dc &= a\,dQ - b\,dP \\ da' &= b'dR - c'dQ & db' &= c'dP - a'dR & dc' &= a'dQ - b'dP \\ da'' &= b''dR - c''dQ & db'' &= c''dP - a''dR & dc'' &= a''dQ - b''dP \end{aligned}$$

The equations marked (5) occur for the first time in Lagrange's memoir of 1773 referred to in the historical sketch which precedes this essay, and arise not by any derivation from their mechanical meaning, but simply as analytical abridgments naturally presenting themselves in the course of his investigations, and then afterwards examined and defined. The values of these velocities dP, dQ, dR, may however be obtained from their definitions without calculation, by means of the following simple consideration,—that the velocity round *any one* of the axes is the same with the velocity of a point (distant unity from $O_{,}$ in a *second* axis) estimated in the direction of the *third* axis. Thus the components, in the direction of the fixed axes, of the velocity of the point (a, a', a'') in the axis of $x_{,}$, being da, da', da'', its velocity in the direction of the axis of $y_{,}$ will be $bda + b'da' + b''da''$, which is therefore equal to dR, the velocity of rotation round the axis of $z_{,}$. The velocities dP, dQ are then had by changing the letters.

The following corollaries from the above formulas will be useful on a variety of occasions: (7)

$$\begin{aligned}
da^2 + da'^2 + da''^2 &= dQ^2 + dR^2 \\
db^2 + db'^2 + db''^2 &= dR^2 + dP^2 \\
dc^2 + dc'^2 + dc''^2 &= dP^2 + dQ^2
\end{aligned}$$

$$\begin{aligned}
dadb + da'db' + da''db'' &= -dPdQ \\
dbdc + db'dc' + db''dc'' &= -dQdR \\
dcda + dc'da' + dc''da'' &= -dRdP
\end{aligned}$$

$$\begin{aligned}
ad^2a + a'd^2a' + a''d^2a'' &= -(dQ^2 + dR^2) \\
bd^2b + b'd^2b' + b''d^2b'' &= -(dR^2 + dP^2) \\
cd^2c + c'd^2c' + c''d^2c'' &= -(dP^2 + dQ^2)
\end{aligned}$$

$$\begin{aligned}
ad^2b + a'd^2b' + a''d^2b'' &= dPdQ - d^2R \\
bd^2c + b'd^2c' + b''d^2c'' &= dQdR - d^2P \\
cd^2a + c'd^2a' + c''d^2a'' &= dRdP - d^2Q
\end{aligned}$$

$$\begin{aligned}
ad^2c + a'd^2c' + a''d^2c'' &= dRdP + d^2Q \\
bd^2a + b'd^2a' + b''d^2a'' &= dPdQ + d^2R \\
cd^2b + c'd^2b' + c''d^2b'' &= dQdR + d^2P
\end{aligned}$$

Much use will also be made of the subjoined equations:

$$
\begin{aligned}
\xi &= a\,\xi_1 + b\,\eta_1 + c\,\zeta_1 \\
\xi' &= a'\xi_1 + b'\eta_1 + c'\zeta_1 \\
\xi'' &= a''\xi_1 + b''\eta_1 + c''\zeta_1
\end{aligned}
\qquad (8) \qquad
\begin{aligned}
\xi_1 &= a\xi + a'\xi' + a''\xi'' \\
\eta_1 &= b\xi + b'\xi' + b''\xi'' \\
\zeta_1 &= c\xi + c'\xi' + c''\xi''
\end{aligned}
$$

$$
\begin{aligned}
dx_1 &= a\,dx + a'dx' + a''dx'' \\
dy_1 &= b\,dx + b'dx' + b''dx'' \\
dz_1 &= c\,dx + c'dx' + c''dx''
\end{aligned}
\qquad (9) \qquad
\begin{aligned}
d^2x_2 &= a\,d^2x + a'd^2x' + a''d^2x'' \\
d^2y_2 &= b\,d^2x + b'd^2x' + b''d^2x'' \\
d^2z_2 &= c\,d^2x + c'd^2x' + c''d^2x''
\end{aligned}
$$

$$
\begin{aligned}
d\xi_1 &= a\,d\xi + a'd\xi' + a''d\xi'' \\
d\eta_1 &= b\,d\xi + b'd\xi' + b''d\xi'' \\
d\zeta_1 &= c\,d\xi + c'd\xi' + c''d\xi''
\end{aligned}
\qquad (10) \qquad
\begin{aligned}
d^2\xi_2 &= a\,d^2\xi + a'd^2\xi' + a''d^2\xi'' \\
d^2\eta_2 &= b\,d^2\xi + b'd^2\xi' + b''d^2\xi'' \\
d^2\zeta_2 &= c\,d^2\xi + c'd^2\xi' + c''d^2\xi''
\end{aligned}
$$

with similar expressions for the incomplete variations δx_1, δy_1, δz_1, $\delta\xi_1$, $\delta\eta_1$, $\delta\zeta_1$. Finally we have the following relations between the accelerative forces:

$$
\begin{aligned}
X &= a\,X_1 + b\,Y_1 + c\,Z_1 \\
X' &= a'X_1 + b'Y_1 + c'Z_1 \\
X'' &= a''X_1 + b''Y_1 + c''Z_1
\end{aligned}
\qquad (11) \qquad
\begin{aligned}
X_1 &= aX + a'X' + a''X'' \\
Y_1 &= bX + b'X' + b''X'' \\
Z_1 &= cX + c'X' + c''X''
\end{aligned}
$$

If we substitute now, in place of the variations and accelerations of x, x', x'' in the above formulas, their values derived from equations (2), and reduce by means of (6) and (10), we shall find

$$
(12) \qquad
\begin{aligned}
\delta x_1 &= \delta\xi_1 - y_1\delta R + z_1\delta Q \\
\delta y_1 &= \delta\eta_1 - z_1\delta P + x_1\delta R \\
\delta z_1 &= \delta\zeta_1 - x_1\delta Q + y_1\delta P
\end{aligned}
$$

$$
(13) \qquad
\begin{aligned}
d^2x_2 &= d^2\xi_2 - x_1(dQ^2 + dR^2) + y_1(dPdQ - d^2R) + z_1(dRdP + d^2Q) \\
d^2y_2 &= d^2\eta_2 - y_1(dR^2 + dP^2) + z_1(dQdR - d^2P) + x_1(dPdQ + d^2R) \\
d^2z_2 &= d^2\zeta_2 - z_1(dP^2 + dQ^2) + x_1(dRdP - d^2Q) + y_1(dQdR + d^2P)
\end{aligned}
$$

By the substitution of these expressions in the second general formula (1), it becomes integrable with respect to S; and if we suppose the point $O_{,}$ to be taken in the centre of gravity of the system, we shall have, after the obvious reductions,

(14)

$$\left.\begin{array}{l}(Md^2\xi_2+SX_{,}Dm)\delta\xi_1+[U+S(Z_{,}y_{,}-Y_{,}z_{,})Dm]\delta P\\(Md^2\eta_2+SY_{,}Dm)\delta\eta_1+[V+S(X_{,}z_{,}-Z_{,}x_{,})Dm]\delta Q\\(Md^2\zeta_2+SZ_{,}Dm)\delta\zeta_1+[W+S(Y_{,}x_{,}-X_{,}y_{,})Dm]\delta R\end{array}\right\}=0,$$

where

(15)

$$\begin{aligned}U&=Adp-Gdr-Hdq+(C-B)qr+F(r^2-q^2)-Gpq+Hrp.\\V&=Bdq-Hdp-Fdr+(A-C)rp+G(p^2-r^2)-Hqr+Fpq.\\W&=Cdr-Fdq-Gdp+(B-A)pq+H(q^2-p^2)-Frp+Gqr;\end{aligned}$$

which are the same expressions as those which are given by Lagrange in his first volume, although obtained by a process altogether different.

These values would be greatly simplified by referring the elements Dm to the principal axes of the body; but as the axis which is vertical when a heavy body is at rest is not in general a principal axis, it will be found necessary, in investigating the phenomena of oscillatory motion, to retain the terms multiplied by F, G, H, quantities which may I think, from their giving rise to a constant displacement of the instantaneous axis of rotation, be called with some propriety the *distorsive moments of inertia.*

If the system is free, then by equating to nought the coefficients of the six variations, we shall obtain six equations determining the progressive and rotatory motion of the body, namely, (16)

$$\begin{aligned} Md^2\xi_2 + SX_, Dm &= 0, \\ Md^2\eta_2 + SY_, Dm &= 0, \\ Md^2\zeta_2 + SZ_, Dm &= 0; \\ U + S(Z_, y_, - Y_, z_,) Dm &= 0, \\ V + S(X_, z_, - Z_, x_,) Dm &= 0, \\ W + S(Y_, x_, - X_, y_,) Dm &= 0. \end{aligned}$$

of which the first three may, by means of equations (10) and (11), be made to assume the following more usual form (17)

$$\begin{aligned} Md^2\xi + SX\, Dm &= 0, \\ Md^2\xi' + SX'\, Dm &= 0, \\ Md^2\xi'' + SX''\, Dm &= 0. \end{aligned}$$

But if the body, as in the problem I have proposed to examine, is forced to roll or slide on a given surface, the above variations are no longer independent, and we must ascertain the influence which the progressive and rotatory motions have upon each other; or to give this question the geometrical form which the nature of variations seems essentially to require, it is necessary to determine the geometrical relations which a given limitation of position will occasion among the elementary changes of those magnitudes on which the station and the aspect of the body depend. For this purpose, let $K = 0$ represent the equation of the given supporting surface referred to the axes fixed in space, and let $K_, = 0$ be the equation of the surface of the given oscillating body referred to its own axes. Let $L, L', L'', L_,, M_,, N_,$ represent the cosines of the space and body axe-angles made by the normal common to both surfaces at the point of variable contact P, for whose space and body coordinates we may employ the symbols x, x', x'', $x_,, y_,, z_,$, so as to make the formulas (3) applicable to these coordinates, recollecting only that $x_,, y_,, z_,$ are now variable quantities. Then because the normal is at right angles to the elements δs, $\delta s_{,}$ of the curves traced on the two surfaces by the point of contact P, and that δx, $\delta x'$, $\delta x''$, $\delta x_{,}$, $\delta y_{,}$, $\delta z_{,}$, are proportional to the cosines of the space and body axe-angles of this element, we have the two equations (18)

$$L\,\delta x + L'\,\delta x' + L''\delta x'' = 0;$$
$$L_{,}\delta x_{,} + M_{,}\delta y_{,} + N_{,}\delta z_{,} = 0.$$

But the variational equations of the given surfaces are

$$\frac{dK}{dx}\,\delta x + \frac{dK}{dx'}\,\delta x' + \frac{dK}{dx''}\,\delta x'' = 0;$$

$$\frac{dK_{,}}{dx_{,}}\,\delta x_{,} + \frac{dK_{,}}{dy_{,}}\,\delta y_{,} + \frac{dK_{,}}{dz_{,}}\,\delta z_{,} = 0.$$

which equations, to subsist simultaneously with the other two, require that we should have (19)

$$L = k.\frac{dK}{dx}, \qquad L_{,} = k_{,}.\frac{dK_{,}}{dx_{,}},$$

$$L' = k.\frac{dK}{dx'}, \qquad M_{,} = k_{,}.\frac{dK_{,}}{dy_{,}},$$

$$L'' = k.\frac{dK}{dx''}. \qquad N_{,} = k_{,}.\frac{dK_{,}}{dz_{,}}.$$

Whence $k\sqrt{\left(\frac{dK^2}{dx^2} + \frac{dK^2}{dx'^2} + \frac{dK^2}{dx''^2}\right)} = \sqrt{(L^2 + L'^2 + L''^2)} = 1,$

and $$k = \left(\frac{dK^2}{dx^2} + \frac{dK^2}{dx'^2} + \frac{dK^2}{dx''^2}\right)^{-1}.$$

Similarly $$k_{,} = \left(\frac{dK_{,}^2}{dx_{,}^2} + \frac{dK_{,}^2}{dy_{,}^2} + \frac{dK_{,}^2}{dz_{,}^2}\right)^{-1}.$$

These last formulas, which are well known to mathematicians, will enable us to find the values of L, L', L'', $L_{,}$, $M_{,}$, $N_{,}$, in all cases where the surfaces are known, and thereby to put their differential or variational equations in the forms above given (18); forms which will always be found remarkably well adapted to geometrical and mechanical inquiries, from the facility with which the analytical results can be translated into the language of geometry. Between these cosines there exist the following relations: (20)

$$\begin{aligned} L &= a\,L_{,} + b\,M_{,} + c\,N_{,}\,, \\ L' &= a'L_{,} + b'M_{,} + c'N_{,}\,, \\ L'' &= a''L_{,} + b''M_{,} + c''N_{,}\,; \end{aligned}$$

$$\begin{aligned} L_{,} &= a\,L + a'L' + a''L''\,, \\ M_{,} &= b\,L + b'L' + b''L''\,, \\ N_{,} &= c\,L + c'L' + c''L''\,. \end{aligned}$$

Taking now the variations of equations (2), and recollecting that $x_{,}$, $y_{,}$, $z_{,}$ are no longer constant, we obtain (21)

$$\begin{aligned} \delta x &= \delta\xi + a\,\delta x_{,} + b\,\delta y_{,} + c\,\delta z_{,} + x_{,}\delta a + y_{,}\delta b + z_{,}\delta c\,, \\ \delta x' &= \delta\xi' + a'\delta x_{,} + b'\delta y_{,} + c'\delta z_{,} + x_{,}\delta a' + y_{,}\delta b' + z_{,}\delta c'\,, \\ \delta x'' &= \delta\xi'' + a''\delta x_{,} + b''\delta y_{,} + c''\delta z_{,} + x_{,}\delta a'' + y_{,}\delta b'' + z_{,}\delta c''\,. \end{aligned}$$

Adding these equations together, after multiplying the first by L, the second by L', and the third by L'', and then reducing by means of the formulas (20), there results

$$\left.\begin{aligned} &-(L\,\delta x + L'\delta x' + L''\delta x'') + x_{,}(L\delta a + L'\delta a' + L''\delta a'') \\ &+(L\,\delta\xi + L'\delta\xi' + L''\delta\xi'') + y_{,}(L\delta b + L'\delta b' + L''\delta b'') \\ &+(L_{,}\delta x_{,} + M_{,}\delta y_{,} + N_{,}\delta z_{,}) + z_{,}(L\delta c + L'\delta c' + L''\delta c'') \end{aligned}\right\} = 0.$$

Substituting in place of the variations of the nine cosines their values (6), reducing by means of equations (20), and observing that the differential equations of the surfaces give us

$$L\delta x + L'\delta x' + L''\delta x'' = 0, \qquad L_{,}\delta x_{,} + M_{,}\delta y_{,} + N_{,}\delta z_{,} = 0,$$

we shall find

$$\begin{aligned} 0 = L\delta\xi + L'\delta\xi' + L''\delta\xi'' &+ (N_{,}y_{,} - M_{,}z_{,})\delta P, \\ &+ (L_{,}z_{,} - N_{,}x_{,})\delta Q, \\ &+ (M_{,}x_{,} - L_{,}y_{,})\delta R, \end{aligned}$$

which, by virtue of the relations (10) and (11), may be also presented in this form, (22)

$$\begin{aligned} 0 = L_{,}\delta\xi_{\prime} + M_{,}\delta\eta_{\prime} + N_{,}\delta\zeta_{\prime} &+ (N_{,}y_{,} - M_{,}z_{,})\delta P, \\ &+ (L_{,}z_{,} - N_{,}x_{,})\delta Q, \\ &+ (M_{,}x_{,} - L_{,}y_{,})\delta R; \end{aligned}$$

remarkable expressions, independent of the variations of the point of contact, and containing the required relation between the variations of the station and aspect of the body made necessary by the condition of its contact with the given surface of support. These equations are in other respects independent of the manner in which the body is forced to slide, roll, or whirl upon the surface, and are therefore true under every hypothesis of friction.

It may be well to observe that these equations, the last for example, may be obtained by another method which introduces formulas that may be frequently useful in geometrical as well as in physical inquiries. If we investigate the equations (12), and have regard in so doing to the present variability of $x_{,}, y_{,}, z_{,}$, we shall find (23)

$$\begin{aligned} \delta x_{\prime} - \delta x_{,} &= \delta\xi_{\prime} - y_{,}\delta R + z_{,}\delta Q, \\ \delta y_{\prime} - \delta y_{,} &= \delta\eta_{\prime} - z_{,}\delta P + x_{,}\delta R, \\ \delta z_{\prime} - \delta z_{,} &= \delta\zeta_{\prime} - x_{,}\delta Q + y_{,}\delta P. \end{aligned}$$

But if we add equations (9) together after multiplying them respectively by $L_{,}$, $M_{,}$ and $N_{,}$ and reduce by means of (20), we shall find

$$L_{,}\delta x_{\scriptscriptstyle 1} + M_{,}\delta y_{\scriptscriptstyle 1} + N_{,}\delta z_{\scriptscriptstyle 1} = L\delta x + L'\delta x' + L''\delta x'' ;$$

which the equations of the two surfaces enable us to write in this form,

$$L_{,}(\delta x_{\scriptscriptstyle 1} - \delta x_{,}) + M_{,}(\delta y_{\scriptscriptstyle 1} - \delta y_{,}) + N_{,}(\delta z_{\scriptscriptstyle 1} - \delta z_{,}) = 0 .$$

This last expression becomes, with the aid of the three equations given above,

$$\left.\begin{array}{l} L_{,}(\delta\xi_{\scriptscriptstyle 1} - y_{,}\delta R + z_{,}\delta Q) \\ M_{,}(\delta\eta_{\scriptscriptstyle 1} - z_{,}\delta P + x_{,}\delta R) \\ N_{,}(\delta\zeta_{\scriptscriptstyle 1} - x_{,}\delta Q + y_{,}\delta P) \end{array}\right\} = 0 ,$$

which is the same with the result before obtained, and is in fact expressing algebraically that the velocity of the point of contact is *nought* in the direction of the normal. Care must be taken to distinguish between $\delta x_{\scriptscriptstyle 1}$, $\delta y_{\scriptscriptstyle 1}$, $\delta z_{\scriptscriptstyle 1}$, and $\delta x_{,}$, $\delta y_{,}$, $\delta z_{,}$. They both denote the variations of the point of contact (P) estimated in the direction of the body-axes; but the former denote its variation along the surface of the moving body, the latter its variation along the surface of support. The former are of the kind called incomplete variations, the body axes being supposed to remain fixed *during* any one of these variations, and to vary instantaneously in passing to the next. The latter are the total variations of the actual body coordinates of the point of contact (P). These two kinds of variations never coincide in value except in the case of rolling motion unaccompanied by sliding.

If the body is supported upon two, three, four or five given surfaces, there will be as many equations of condition similar to equation (22) as there are surfaces of support: if the body is required to be in contact with six given surfaces, its station and aspect become determinate and motion is no longer possible; the formulas I have given will however be very useful in investigating the position of the body. If there be absolutely no friction, in that case the above equations of condition are the only ones which exist along with the general dynamical equation. But if there be proposed any hypothesis of friction or analogous restraint, the following considerations will assist us in determining the relations between the momentary changes in translation and rotation.

Let us, for the sake of greater generality, suppose that the two bodies M and M', which are in contact with each other, are both of them in motion. There will be now at least *six* different velocities at the point of contact, liable without attention to be confounded with each other:—I. The absolute velocity in space of the physical point of contact p of the body M. II. The absolute velocity in space of the physical point of contact p' belonging to the body M'. III. The absolute velocity of the geometrical point of contact P. IV. The velocity with which the point P changes its place on the surface of M. V. The velocity with which the same point P changes its place on the surface of the body M'. VI. The velocity of rasure.—The same distinctions are to be observed with respect to the directions which belong to these velocities. The effects of friction at the point of contact will depend entirely upon the velocity and direction of rasure, which are the same with which the physical points p and p' recede from each other in the instant after they meet at the geometrical point P. If one of the bodies as M' be fixed, then this velocity and direction will be the same with the absolute velocity and direction of the physical point p, and the velocities of rasure in the direction of the body coordinates will therefore be denoted generally by

$$\begin{aligned} &d\xi_{,} - y_{,}dR + z_{,}dQ, \\ &d\eta_{,} - z_{,}dP + x_{,}dR, \\ &d\zeta_{,} - x_{,}dQ + y_{,}dP, \end{aligned}$$

or, when necessary, by the values (23), which we have shewn to be equivalent to the above expressions. We may suppose the friction to be a function of these velocities or of the pressure or of both conjointly. The effect of this would be to add to the other accelerating forces three new ones applied to the point $(x_, y_, z_,)$ of the form of

$$\phi \frac{dx_{\prime} - dx_{\prime\prime}}{dv}, \qquad \phi \frac{dy_{\prime} - dy_{\prime}}{dv}, \qquad \phi \frac{dz_{\prime} - dz_{\prime}}{dv},$$

where ϕ is any given function of the pressure and velocity of rasure dv, dv itself being equal to

$$\sqrt{[(dx_{\prime} - dx_{\prime})^2 + (dy_{\prime} - dy_{\prime})^2 + (dz_{\prime} - dz_{\prime})^2]}.$$

The pressure is then to be eliminated from the equations of motion; after which there will remain a number of equations sufficient, in conjunction with the equations of the surfaces, to determine the position of the body in terms of the time.

If the friction, be the cause of it what it may, be exactly sufficient to prevent all sliding, while it offers no impediment to the body's revolution round the normal at the point of contact, the motions will be of a nature much more resembling actual oscillations and rotations on supporting surfaces, than in the hypothesis of surfaces absolutely smooth, particularly when the tangent plane at P remains throughout the motion nearly horizontal. The effects of this kind of motion, of which the pendulum with a cylindrical axis is the simplest possible species, have not, that I know of, been examined by any author, when the triple rotation of pitching, rocking and whirling are all considered at once. Nevertheless, the problem of the small oscillations of the kind above described upon a plane or spherical surface is susceptible of complete integration and solution in the case both of free sliding and perfect rolling, whatever be the figure and constitution of the oscillating body, and whatever be the velocity round one of the axes, provided that it be compatible with small rotations round the other two. I have given in the New York Mathematical Diary for July 1827 formulas which are applicable to the case of all bodies, of any shape and density whatever with a spherical areola of contact, whirling and oscillating with a perfect rolling motion on an horizontal plane. The method I now offer is intended to comprise every form of this areola, having regard at the same time to the nature of the surface of support.

When the friction prevents all sliding, the elements of the curves described on the two surfaces are equal, and moreover coincide at every instant of the arbitrary variations, so that we have necessarily (24)

$$\begin{aligned} \delta x &= a\,\delta x_, + b\,\delta y_, + c\,\delta z_,, \\ \delta x' &= a'\delta x_, + b'\delta y_, + c'\delta z_,, \\ \delta x'' &= a''\delta x_, + b''\delta y_, + c''\delta z_,. \end{aligned}$$

These values reduce equations (21) to

$$\begin{aligned} o &= \delta\xi + x_,\delta a + y_,\delta b + z_,\delta c\ , \\ o &= \delta\xi' + x_,\delta a' + y_,\delta b' + z_,\delta c', \\ o &= \delta\xi'' + x_,\delta a'' + y_,\delta b'' + z_,\delta c''; \end{aligned}$$

or, substituting for the variations of the cosines their values as given by equations (6),

$$\begin{aligned} o &= \delta\xi + (c\,y_, - b\,z_,)\delta P + (a\,z_, - c\,x_,)\delta Q + (b\,x_, - a\,y_,)\delta R, \\ o &= \delta\xi' + (c'y_, - b'z_,)\delta P + (a'z_, - c'x_,)\delta Q + (b'x_, - a'y_,)\delta R, \\ o &= \delta\xi'' + (c''y_, - b''z_,)\delta P + (a''z_, - c''x_,)\delta Q + (b''x_, - a''y_,)\delta R; \end{aligned}$$

expressions which, by means of equations (10) and the reductions arising from the relations (4), may be presented in this form (25)

$$\begin{aligned} o &= \delta\xi_, + z_,\delta Q - y_,\delta R, \\ o &= \delta\eta_, + x_,\delta R - z_,\delta P, \\ o &= \delta\zeta_, + y_,\delta P - x_,\delta Q. \end{aligned}$$

These are the relations which the condition of the peculiar motion now considered introduces among the variations of the six elements of position*.

The same results may be obtained immediately from the equation $\delta v = 0$ (which is the fundamental equation of this kind of motion) taken in connection with the value of δv given above. It is evident that we have also in this case

$$\delta x_{1} = \delta x_{,}, \qquad \delta y_{1} = \delta y_{,}, \qquad \delta z_{1} = \delta z_{,}.$$

If there be a second surface of support upon which also the body is to roll without sliding, we shall have three other equations exactly similar to the above. If we denote by $\delta\alpha_1$, $\delta\beta_1$, $\delta\gamma_1$ the variations in the direction of the body-axes of a fixed point in the body whose body-coordinates referred to $O_{,}$ are α, β, γ, we shall obtain from equations (12)

$$\begin{aligned} \delta\alpha_1 &= \delta\xi_1 + \gamma\delta Q - \beta\delta R, \\ \delta\beta_1 &= \delta\eta_1 + \alpha\delta Q - \gamma\delta P, \\ \delta\gamma_1 &= \delta\zeta_1 + \beta\delta Q - \alpha\delta Q. \end{aligned}$$

From which if we subtract (25) we have

$$\begin{aligned} \delta\alpha_1 &= (\gamma - z_{,})\delta Q - (\beta - y_{,})\delta R, \\ \delta\beta_1 &= (\alpha - x_{,})\delta R - (\gamma - z_{,})\delta P, \\ \delta\gamma_1 &= (\beta - y_{,})\delta P - (\alpha - x_{,})\delta Q. \end{aligned}$$

For the points of the body which are momentarily at rest, both sides of these equations become equal to nought, and we obtain

$$\frac{\alpha - x_{,}}{dP} = \frac{\beta - y_{,}}{dQ} = \frac{\gamma - z_{,}}{dR},$$

the equation of a straight line passing through the point of contact and parallel to the axis of instantaneous rotation.

* Since this communication was handed to the Librarian to be read before the Society, Mr E. Nulty has shown me the above three formulas, derived (in the solution of a problem that had recently occupied his attention) from the ingenious consideration that in perfect rolling the motion of the physical point of contact in the direction of the body-axes is equal and opposite to the motion of the point in which these axes are supposed to have their origin.

When the surfaces are considered as perfectly smooth, we have seen that there are as many equations of condition as there are surfaces of support to be taken in conjunction with the general dynamical equation. Multiplying each of these equations by an indeterminate coefficient and equating to nought the sums of the coefficients of the variations, there results (26)

$$\begin{aligned} d^2\xi_2 + SX_{,}Dm + \Sigma\theta L_{,} &= 0, \\ d^2\eta_2 + SY_{,}Dm + \Sigma\theta M_{,} &= 0, \\ d^2\zeta_2 + SZ_{,}Dm + \Sigma\theta N_{,} &= 0; \end{aligned}$$

$$\begin{aligned} U + S(Z_{,}y_{,} - Y_{,}z_{,})Dm + \Sigma\theta(N_{,}y_{,} - M_{,}z_{,}) &= 0, \\ V + S(X_{,}z_{,} - Z_{,}x_{,})Dm + \Sigma\theta(L_{,}z_{,} - N_{,}x_{,}) &= 0, \\ W + S(Y_{,}x_{,} - X_{,}y_{,})Dm + \Sigma\theta(M_{,}x_{,} - L_{,}y_{,}) &= 0: \end{aligned}$$

where Σ denotes the sum of similar quantities, θ one of the indeterminate coefficients, the mass at the same time being put equal to unity.

These equations are evidently the same as those which would have been obtained immediately by substituting in place of the surfaces unknown forces acting constantly in the direction of the normals at the variable points of contact, and then considering the system as free. The equations of condition however would still have been indispensable, in order to supply the number of equations lost in the elimination of the unknown forces of reaction. I should also on other accounts have preferred investigating these equations by the preceding method; because it furnishes a variety of formulas useful in the analytical geometry of touching surfaces, and extremely convenient in the determination of the motions of bodies subject to a friction producing some assignable relation between their sliding and their rolling motions.

If we restrict ourselves to the examination of the motion on a single surface, the body being acted on by common gravity g, the preceding formulas become, (reckoning the positive coordinates x'' downward from the horizontal plane of x and a and observing that we have

$$X_{,} = -ga'', \quad Y_{,} = -gb'', \quad Z_{,} = -gc'',$$
$$Sx_{,}Dm = 0, \quad Sy_{,}Dm = 0, \quad Sz_{,}Dm = 0.$$

the other quantities remaining as before,)

$$\begin{aligned} d^2\xi_2 + \theta L_{,} &= ga'', \\ d^2\eta_2 + \theta M_{,} &= gb'', \\ d^2\zeta_2 + \theta N_{,} &= gc''; \end{aligned}$$

$$\begin{aligned} U + \theta(N_{,}y_{,} - M_{,}z_{,}) &= 0, \\ V + \theta(L_{,}z_{,} - N_{,}x_{,}) &= 0, \\ W + \theta(M_{,}x_{,} - L_{,}y_{,}) &= 0: \end{aligned}$$

from which θ being eliminated, there will remain five equations, which along with the equation of condition comprehend and determine all the phenomena of the motion. The first three of the above equations may by means of formulas (8) and (11) be presented in this form (28)

$$\begin{aligned} d^2\xi + \theta L &= 0, \\ d^2\xi' + \theta L' &= 0, \\ d^2\xi'' + \theta L'' &= g; \end{aligned}$$

which are in appearance simpler than the others, more especially as the accelerations are now complete. It will however be found necessary to have recourse to the former, except when the supporting surface is a plane, or the supported body is a homogeneous sphere.

Let us now suppose that the surface of the moving body and the surface of support are both of the second degree. For the sake of greater simplicity, let us suppose also that the rectangular diameters of the surface of support coincide with the axes in space, and that the centre of the moving body when it has a centre, or the summit or a point in the axis when it is without a centre, is at the same time its centre of gravity. Let the equations of the two surfaces be respectively

$$\sqrt{\left(\frac{x^2}{\alpha^2}+\frac{x'^2}{\alpha'^2}+\frac{x''^2}{\alpha''^2}\right)}-1=0,$$

$$\sqrt{\left(\frac{x_,^2}{\alpha_,^2}+\frac{y_,^2}{\beta_,^2}+\frac{z_,^2}{\gamma_,^2}\right)}-1=0;$$

where the constants are the semi-axes of the figure. Or, what will be more commodious in the present instance, let these equations be presented in the forms

$$\sqrt{(Ax^2+A'x'^2+A''x''^2)}-1=0,$$
$$\sqrt{(A_,x_,^2+B_,y_,^2+C_,z_,^2)}-1=0,$$

where the constants are the reciprocals of the squares of the semi-axes, and A of course not to be confounded with the A used before. These equations, although apparently only intended for ellipsoids, spheroids of revolution, and spheres, will answer for all surfaces of the second degree whatever, provided the following changes be made in the results to which the above would lead.

1. For a single-napped hyperboloid, change the sign of the square of the semi-axis of the ellipsoid corresponding to the imaginary axis.

2. For a double-napped hyperboloid, change the signs of the squares of the two semi-axes of the ellipsoid which correspond to the two imaginary axes.

3. For an elliptical paraboloid, diminish, in the results, the coordinates parallel to the figure's axis by the corresponding semi-axis of the ellipsoid; then make all the semi-axes infinite, but so that the two third proportionals to the first mentioned semi-axis and each of the other two, shall remain finite and

be equal to the semi-parameters of the principal parabolic sections.

4. For a hyperbolic paraboloid, the same transformation, changing the sign of the parameter of the principal negative parabola. The origin of the coordinates of the paraboloids will then be at the summit of the axis.

5. For an elliptical or circular cone, change the sign of the square of the semi-axis corresponding to the axis of the cone; then make all the semi-axes infinite, but so that that the ratios of the semi-axis first mentioned to the other two may be equal to the ratios of any altitude of the cone to the semi-axes of the corresponding base.

6. For an elliptical or circular cylinder, make infinite the semi-axis of the ellipsoid corresponding to the infinite axis of the cylinder.

7. For a hyperbolic cylinder, make a similar alteration, and change the sign of the square of the semi-axis which corresponds to the imaginary axis of the principal hyperbolic section.

8. For a parabolic cylinder, the same alterations as for either of the paraboloids, making infinite at the same time the third proportional to the two semi-axes corresponding to the normal and the infinite axes of the cylinder.

The values of the cosines of the normal's axe-angles obtained by means of the differential formulas (19) lead to the following equations: (29)

$$L = kA\,x\,, \qquad L_{,} = k_{,}A_{,}x_{,}\,,$$
$$L' = kA'x'\,, \qquad M_{,} = k_{,}B_{,}y_{,}\,,$$
$$L'' = kA''x''\,, \qquad N_{,} = k_{,}C_{,}z_{,}\,;$$

where k and $k_{,}$ are respectively equal to

$$\frac{1}{\sqrt{(A^2x^2 + A'^2x'^2 + A''^2x''^2)}}\,, \qquad \frac{1}{\sqrt{(A_{,}^2x_{,}^2 + B_{,}^2y_{,}^2 + C_{,}^2z_{,}^2)}}\,.$$

The above equations may be so combined with the equations of the surface, as to furnish other forms for k and $k_{,}$ namely

$$\sqrt{(\alpha^2 L^2 + \alpha'^2 L'^2 + \alpha''^2 L''^2)}, \qquad \sqrt{(\alpha_{,}^2 L_{,}^2 + \beta_{,}^2 M_{,}^2 + \gamma_{,}^2 N_{,}^2)}.$$

Finally, it is easy to verify the following values of these same quantities:

$$k = Lx + L'x' + L''x'', \qquad k_{,} = L_{,}x_{,} + M_{,}y_{,} + N_{,}z_{,}.$$

These last expressions are susceptible of an obvious geometrical interpretation, and show that k and $k_{,}$ are the projections of the two radius vectors of the point of contact upon the common normal at that point.

The conditions (20) of a common normal moreover give (30)

$$\begin{aligned} kAx &= k_{,}(A_{,}a\,x_{,} + B_{,}b\,y_{,} + C_{,}c\,z_{,}), \\ kA'x' &= k_{,}(A_{,}a'x_{,} + B_{,}b'y_{,} + C_{,}c'z_{,}), \\ kA''x'' &= k_{,}(A_{,}a''x_{,} + B_{,}b''y_{,} + C_{,}c''z_{,}); \end{aligned}$$

$$\begin{aligned} k_{,}A_{,}x_{,} &= k(Aa\,x + A'a'x' + A''a''x''), \\ k_{,}B_{,}y_{,} &= k(Ab\,x + A'b'x' + A''b''x''), \\ k_{,}C_{,}z_{,} &= k(Ac\,x + A'c'x' + A''c''x''). \end{aligned}$$

From each of these triplets may be obtained expressions for the ratio of the two projections which may occasionally be useful. If we add the first three equations together after multiplying the first equation by x, the second by x', and the third by x'', reducing by means of equations (4) and the equation of the surface of support, and proceed by an analogous method with the second triplet, employing in the reduction the surface of the moving body, we shall obtain the two equations

$$\frac{k}{k_{,}} = (x_{,} + \xi_{,})\frac{x_{,}}{\alpha_{,}^2} + (y_{,} + \eta_{,})\frac{y_{,}}{\beta_{,}^2} + (z_{,} + \zeta_{,})\frac{z_{,}}{\gamma_{,}^2},$$

$$\frac{k_{,}}{k} = (x - \xi)\frac{x}{\alpha^2} + (x' - \xi')\frac{x'}{\alpha'^2} + (x'' - \xi'')\frac{x''}{\alpha''^2},$$

which, by means of the equations of the surfaces, will become

$$\frac{k}{k_{,}} = 1 + \left(\frac{x_{,}\xi_{,}}{\alpha_{,}^{2}} + \frac{y_{,}\eta_{,}}{\beta_{,}^{2}} + \frac{z_{,}\zeta_{,}}{\gamma_{,}^{2}}\right),$$

$$\frac{k_{,}}{k} = 1 - \left(\frac{x\xi}{\alpha^{2}} + \frac{x'\xi'}{\alpha'^{2}} + \frac{x''\xi''}{\alpha''^{2}}\right).$$

If now we substitute the first of these two values in the first triplet of equations (30) and then substitute the values of x, x', x'' thus transformed in the first triplet of equations (2), $x_{,}$, $y_{,}$, $z_{,}$ may be determined by quadratics in terms of $\xi_{,}$, $\eta_{,}$, $\zeta_{,}$ and the aspect of the body. By a process altogether similar, x, x', x'' may be obtained in terms of ξ, ξ', ξ''. At the same time it ought to be observed, that whatever be the nature of the surfaces, if from the seven equations $K = 0$, $K_{,} = 0$, either of the triplets (2), and any two of the three equations of contact (20) (the three being in fact equivalent to two in consequence of the condition $L^{2}+L'^{2}+L''^{2} = L_{,}^{2}+M_{,}^{2}+N_{,}^{2}$) we eliminate the space and body coordinates of the point of contact, there will remain an equation of condition between the elements of the station and the aspect of the body, of which equation (22) is in all cases the differential.

As the angular velocities p, q, r are functions of the nine cosines and their differentials, and as these are connected by six equations of condition and variously expressible in functions of the three elements of the aspect of the body, it follows that the six equations of motion will by the above mentioned substitutions involve, beside the time, the six elements of the position of the body.

If we substitute in place of $L_{,}$, $M_{,}$ $N_{,}$ in the equations of motion their values as given by equations (29) and employ at the same time the abridgments,

$$C_{,} - B_{,} = A_{2}, \qquad A_{,} - C_{,} = B_{2}, \qquad B_{,} - A_{,} = C_{2};$$

we shall find (31)

$$\begin{aligned} d^2\xi_2 + A_{,}\theta k_{,}x_{,} &= ga'', \\ d^2\eta_2 + B_{,}\theta k_{,}y_{,} &= gb'', \\ d^2\zeta_2 + C_{,}\theta k_{,}z_{,} &= gc''; \end{aligned}$$

$$\begin{aligned} U + A_2\theta k_{,}y_{,}z_{,} &= 0, \\ V + B_2\theta k_{,}z_{,}x_{,} &= 0, \\ W + C_2\theta k_{,}x_{,}y_{,} &= 0: \end{aligned}$$

equations to which we shall have occasion to refer hereafter.

To return now for a moment to the general problem. If we add the second triplet of equations (27) together, after multiplying the first equation by $L_{,}$, the second by $M_{,}$ and the third by $N_{,}$, there results

$$L_{,}U + M_{,}V + N_{,}W = 0.$$

Substituting in this equation, in place of the six quantities which it involves, their values (15) and (20), and reducing by means of the relations (4), we shall find

$$\left.\begin{aligned} L\,.\,d(a\,P' + b\,Q' + c\,R') \\ L'.\,d(a'P' + b'Q' + c'R') \\ L''.\,d(a''P' + b''Q' + c''R') \end{aligned}\right\} = 0,$$

where P', Q', R' are the partial differentials, with respect to p, q, r, of the function

$$T = \tfrac{1}{2}(Ap^2 + Bq^2 + Cr^2) - (Fqr + Grp + Hpq),$$

which is one half of the living forces of the body arising from its motion of rotation.

By means of equations (20), the relations (4) and the substitutions (6), it will be found that the foregoing equation is susceptible of being presented in the following form:

$$d(L_,P' + M_,Q' + N_,R') = \begin{cases} P'(dL_, + M_,dR - N_,dQ) \\ Q'(dM_, + N_,dP - L_,dR) \\ R'(dN_, + L_,dQ - M_,dP). \end{cases}$$

These equations are true of all supporting and supported surfaces whatever. It might easily be shown that this last equation is capable of being derived from the principle that the rate of increase of the sum of all the areas projected on the plane tangent to the point of variable contact is momentarily constant, the tangent plane being supposed to remain for a moment fixed while the body passes on to its consecutive position on the surface of support.

When the sustaining surface is an inclined plane, L, L', L'' become constant, and the right member of the last equation will vanish on the substitution of the values which $L_,$, $M_,$, N acquire in such a case, so that the equation becomes integrable with respect to time, and we obtain

$$L_,P' + M_,Q' + N_,R' = I.$$

I being an arbitrary constant.

Again, if we add together the second triplet (27), after multiplying the three equations respectively by dP, dQ, dR, and reduce by means of the equation of condition (22), we obtain

$$UdP + VdQ + WdR - \theta(Ld\xi + L'd\xi' + L''d\xi'') = 0.$$

Substituting for L, L', L'' their values (20), and performing the operation indicated in the first three terms of this equation, there will result

$$dT + d\xi d^2\xi + d\xi' d^2\xi' + d\xi'' d^2\xi'' - gd\xi'' = 0,$$

an equation whose integral gives us the principle of living forces applied to the problem of any solid body rolling on any given surface,

$$T + \tfrac{1}{2}(d\xi^2 + d\xi'^2 + d\xi''^2) - g\xi'' = J,$$

J being another arbitrary constant, and $M = 1$.

It is evident, moreover, that the same triplet furnishes the relation

$$Ux_{,} + Vy_{,} + Wz_{,} = 0.$$

When the body is in a state of permanent equilibrium upon the surface of support, the velocities and accelerations of the six elements of its position are nought, and the six equations of motion give us

$$\begin{aligned} L_{,} &= a'', & N_{,}y_{,} - M_{,}z_{,} &= 0, \\ M_{,} &= b'', & L_{,}z_{,} - N_{,}x_{,} &= 0, \\ N_{,} &= c''; & M_{,}x_{,} - L_{,}y_{,} &= 0. \end{aligned}$$

The first equations express that the direction of the normal is vertical, the others that it passes through the centre of gravity. In general we may observe, that the equations of the motion of rotation are in fact the equations of the normal at the point of contact, and that the distance of the normal from the centre of gravity is at all times equal to

$$\frac{\sqrt{(U^2+V^2+W^2)}}{\theta};$$

so that $\sqrt{(U^2 + V^2 + W^2)}$ represents the effect which the plane's reaction on the body has in producing the motion of rotation. The line which passes through the centre of gravity and any one of the points $B_{,}$ of the surface on which it may be balanced is not in general a principal axis; but as the preceding formulas are independent of the position of these axes, we are permitted to take any of the lines $O_{,}B_{,}$ for the axis of $z_{,}$. For the sake of greater brevity we may call the points $B_{,}$ the *ballancing points* and the lines $O_{,}B_{,}$ the *natural verticals* of the body.

The phenomena of the motions of the body immediately about its state of equilibrium will manifestly depend upon the configuration of the surfaces or *areolas* as we may term them in the immediate vicinities of the two points B and $B_{,}$, the former denoting any of the points of the sustaining surface with which $B_{,}$ may be in contact when the body is at rest. From the established theory of contacts, it follows that every point, not singular, of any surface whatever may be brought into a contact of the second order with some curve surface of the second degree. Dupin, in particular, has shewn, in his excellent supplement to the *Analytical Geometry* of Monge, that every plane section of any curve surface parallel to a tangent plane and infinitely near to it is a conic section, indicating all the characters of the curvature around the point touched by the tangent plane. It is easy to infer from this, that for all phenomena depending upon the curvature of the areolas at B and $B_{,}$ these points may in all cases be regarded as the *summits of paraboloids*, elliptical, hyperbolical or intermediate. This proposition, which is fundamental, might be also proved thus. Let x, y, z denote the coordinates of either areola reckoning from B or $B_{,}$ along the tangent plane and normal. The most general equation of the areola will then be

$$z = Ax^2 + Bxy + Cy^2,$$

the condition of a tangent plane requiring that z should be of two dimensions in x and y, and the condition that the point is not a singular one excluding fractional and negative exponents. As the direction of the axes x and y in the tangent plane is arbitrary, the term Bxy may be made to disappear, and the equation becomes simply

$$z = A'x^2 + C'y^2;$$

a paraboloid, elliptical, hyperbolical or intermediate, according as C' is positive, negative or nought, the constants A' and C representing the reciprocals of the greatest and least diameters of curvature. In a similar manner it might be shown that every areola whatever may be represented by the areola around the summit of some assignable hyperboloid with an arbitrary vertical axis,—elliptical when the areola is *concurvate*, that is with the curvatures of all its normal sections directed the same way,—hyperbolical when *discurvate*, or with the curvatures of its normal sections directed some one way and some the opposite,—cylindrical when the curvature of the areola is intermediate as in the case of developable surfaces.

It follows therefore, from what precedes, that in the problem of the small oscillations of supported bodies, the equations (31) obtained above for surfaces of the second degree, with the positions there proposed, will answer for all possible areolas of contact, the arbitrary values of the axes α'' and $\gamma_{,}$ enabling us to avail ourselves completely of this simplification by placing the centre of the osculating figure in the centre of gravity of the body, at the same time that we may take any point at pleasure in the vertical through B for the origin of the invariable axes.

The hypothesis that, during the motion of the body, its natural vertical declines but very little from the position which it would occupy if at rest, is equivalent to supposing that c and c' are at all times very small, and we shall regard them therefore in the following calculations as infinitesimals of the first order. The hypothesis that the two areolas of contact are indefinitely small is analytically expressed by considering x and x', $x_{,}$ and $y_{,}$ as quantities infinitely small. The preceding formulas will now enable us to ascertain what values the rest of the denoted quantities acquire in consequence of these two hypotheses, and the conditions of their legitimacy will appear in the equations of condition which arise in the course of the solution of the problem. The fundamental relations (4) give us in the first place, neglecting all infinitesimals of higher orders than the first, $c'' = 1$, $b = -a'$, $b' = a$. The values of

p, q and r are best obtained by means of formulas (6). They furnish immediately (32)

$$p = ra'' + db'', \qquad q = rb'' - da''.$$

The same equations give $da = bdR$, $db = -adR$, which, integrated in conjunction with $a^2 + b^2 = 1$, give us $a = \cos R$, $b = -\sin R$, the angle R being counted from the axis of x. The nine cosines then become

$$\begin{array}{lll} a = \cos R, & b = -\sin R, & c = b''\sin R - a''\cos R, \\ a' = \sin R, & b' = \cos R, & c' = -b''\cos R - a''\sin R, \\ a'' = a''; & b'' = b''; & c'' = 1. \end{array}$$

From equations (8) and the equations of the surfaces we obtain

$$\begin{array}{ll} x'' = \alpha'', & \xi'' = \alpha'' - \gamma_{\prime}, \\ z_{\prime} = \gamma; & \zeta' = \alpha'' - \gamma_{\prime}. \end{array}$$

The analysis gives these constants the double sign, which I omit, as in case of application it will always be immediately obvious which will be affected with + and which with —. Thus if both areolas are concave upward, and the centre of gravity of the oscillating body is above the point of contact and below the centre of the figure which osculates with the areola of support, then the signs remain as above, the ellipsoid or elliptical paraboloid being in such a case the proper osculating figure. If, as in the common pendulum, the point $O_{\prime}$ is below $B_{\prime}$, and the two areolas are still concave upward, the osculatrix of the areola at $B_{\prime}$ must be an hyperboloid or elliptical paraboloid with the point $O_{\prime}$ taken in the prolongation of the axis, and the constant α'' would change its sign. If the pendulum were hung upon a fixed *annulus* interlinking with another annulus at the upper extremity of the pendulum, both areolas would then become *discurvate* and the osculating figures would be either single-napped hyperboloids or hyperbolic paraboloids. In cases of this kind, it may be well to observe at once, the analysis does not necessarily regard the motion round the normal as arrested by the impenetrability of the rings, but implies in general a mutual penetrability so as to admit but a single point of contact.

The law of continuity, a law to which analysis, in all its processes, adheres with singular and sometimes indeed with inconvenient faithfulness, requires us to attribute to *both sides* of the supporting surface the power of feeling and sustaining in *both directions*, the presence of the moving body. Thus, if we suppose a sphere in motion on the *outside* of another sphere, it would evidently come, at some determinate epoch, into a position where its pressure on the supporting surface would be nought. It would there leave the surface, and its motion afterwards would be a separate problem. An analytical solution of the question however would regard the moving body as still connected with the surface of support, and exerting on it a pressure tending to draw it outward from its centre. This pressure would be such as would arise from a momentary but continually renewed connecting thread infinitely short passing from sphere to sphere at the point of variable contact, or such as would take place if we supposed the surfaces of one of the spheres to consist of two concentric spherical surfaces infinitely near each other, and the momentary point of contact of the other sphere to be always engaged and confined between them. Again, let us suppose that a circle rolls and slides inside down an ellipsis whose maximum curvature is greater and whose minimum is less than the curvature of the circle. If we suppose moreover the long axis vertical and the short axis longer than the diameter of the circle, the circle in descending will come first to a place where it will touch the ellipsis in two points and there physically it would stop, but the analysis (on the hypothesis of one original point of contact) will consider the circle as geometrical except at this point of contact, and of course will represent the circle as passing onward unimpeded by this second contact. It will then reach a point in the ellipse where the curvatures of the two curves are equal, and where on one side of the point of osculation the circle passes inside, and on the other outside of the ellipsis. Before the circle comes into this position the arc of contact is entirely within, after it leaves it entirely without, the ellipsis, and the connection must be maintained as in the preceding example. The same remarks will apply to the motion of an ellipsoid placed within a sphere of a curvature intermediate between the greatest and least curvature of the ellipsoid, to all contacts between discurvate surfaces, and in general to all cases in which the *maximum* curvature of one of the surfaces is not less than the *minimum* curvature of the other.

In order to determine the actual oscillatory motions of such bodies, we must institute as many equations of condition similar to (22) as the moving body can have points of contact with the supporting surface. We must then determine when the pressure at any one of these points becomes equal to nought, after which the problem is to be considered as a new one, and the subsequent motion of the body must be traced by applying to it the equations resulting from one contact less than before, until the body either again comes into a fresh point of contact, or loses another of the contacts which it was supposed to have at first. In the course of the various positions into which the moving body would come, it would frequently happen that two of the points would unite into one by an inosculation of the curves of contact, or one would become two, as when a sphere moves upon an oval annulus of smaller dimensions than the sphere from the concurvate to the discurvate portion of it. An inquiry into motions of this kind is however foreign to the purpose of this paper, and I return to the consideration of the problem when restricted to a single point of contact.

The selection of a paraboloid, in its three varieties of elliptical, hyperbolical and intermediate, to serve as the osculating figure of the areola at the balancing point of the body, is attended with the advantage that, beside suiting all possible cases of curvature, it is always applicable, whether the centre of gravity be *at* the balancing point, *above* it, or *below* it. This is evident from the equation of the curve,

$$\frac{x_{,}^{2}}{\alpha_{,}} + \frac{y_{,}^{2}}{\beta_{,}} + 2(z_{,} - \gamma_{,}) = 0,$$

where it is manifest that $\gamma_{,}$ may be taken arbitrarily, positive, negative or nought, without producing any other change than an elevation or depression of the origin, while the different values and signs which we may ascribe to $\alpha_{,}$ and $\beta_{,}$ will furnish us with areolas of every variety of curvature. This advantage is however unimportant in the present inquiry, which is rather to ascertain the results of the general problem than to enter into a detailed examination of each particular case. Resuming therefore the expressions (30) before obtained for ellipsoids on ellipsoidal surfaces, and observing that the quantities k and $k_{,}$ in the case of small oscillations become constant and equal to the fixed and moveable vertical semi-axes, retaining at the same time the symbols c'', x'', $z_{,}$, ξ'', $\zeta_{,}$, in order to permit without further substitutions the application of the usual formulas, the second triplet of equations (30) furnish, when the areola of support is spherical, whatever be the form of the areola around the balancing point of the oscillating body,

$$\begin{aligned} k_{,}A_{,}x_{,} &= kA(ax + a'x' + a''x''), \\ k_{,}B_{,}y_{,} &= kA(bx + b'x' + b''x''), \\ k_{,}C_{,}z_{,} &= kA(cx + c'x' + c''x''). \end{aligned}$$

By means of equations (3) these become

$$\begin{aligned} \alpha\gamma_{,}A_{,}x_{,} &= x_{,} + \xi_{,}, \\ \alpha\gamma_{,}B_{,}y_{,} &= y_{,} + \eta_{,}, \\ \alpha\gamma_{,}C_{,}z_{,} &= z_{,} + \zeta_{,}; \end{aligned} \qquad \text{or} \qquad \begin{aligned} x_{,} &= l\xi_{,}, \\ y_{,} &= m\eta_{,}, \\ z_{,} &= n\zeta_{,}. \end{aligned}$$

Substituting the values of $x_{,}$, $y_{,}$, $z_{,}$ in equations (31) and employing the following abridgments,

$$\frac{1}{A_{,}lk_{,}} = \alpha - \frac{\alpha_{,}^{2}}{\gamma_{,}} = \lambda, \qquad \frac{1}{B_{,}mk_{,}} = \alpha - \frac{\beta_{,}^{2}}{\gamma_{,}} = \mu;$$

$$B_{2}lk_{,}\eta\zeta_{,} = \frac{\gamma_{,}^{2} - \alpha_{,}^{2}}{\alpha\gamma_{,} - \alpha_{,}^{2}} = A_{,,}; \qquad A_{2}mk_{,}\eta\zeta_{,} = \frac{\gamma_{,}^{2} - \beta_{,}^{2}}{\alpha\gamma_{,} - \beta_{,}^{2}} = B_{,,},$$

omitting infinitesimals of the second order, and restoring dt and M, we obtain (34)

$$\frac{d^{2}\xi_{2}}{dt^{2}} + \frac{\theta}{\lambda}\xi_{,} = ga'',$$

$$\frac{d^{2}\eta_{2}}{dt^{2}} + \frac{\theta}{\mu}\eta_{,} = gb'',$$

$$\theta = g;$$

$$U - M\theta B_{,,}\eta_{,} = 0,$$
$$V + M\theta A_{,,}\xi_{,} = 0,$$
$$W = 0.$$

By an examination of the values of the first and second differentials of the indefinite integrals $\xi_{1}, \eta_{1}, \zeta_{1}, \xi_{2}, \eta_{2}, \zeta_{2}$ given by equations (10), it will readily be seen that, with the assistance of the relations (4), (6), (8), the following expressions will be verified (35)

$$d\xi_{1} = d\xi_{,} - \eta_{,}dR + \zeta_{,}dQ,$$
$$d\eta_{1} = d\eta_{,} - \zeta_{,}dP + \xi_{,}dR,$$
$$d\zeta_{1} = d\zeta_{,} - \xi_{,}dQ + \eta_{,}dP;$$

$$d^{2}\xi_{2} = d^{2}\xi_{1} - d\eta_{1}dR + d\zeta_{1}dQ,$$
$$d^{2}\eta_{2} = d^{2}\eta_{1} - d\zeta_{1}dP + d\xi_{1}dR,$$
$$d^{2}\zeta_{2} = d^{2}\zeta_{1} - d\xi_{1}dQ + d\eta_{1}dP:$$

equations analogous to those first obtained by Lagrange to denote the motions of rotation of a system of particles which have at the same time individual motions of their own. In the case of small oscillations the third and sixth of these equations vanish altogether, as all the terms are infinitesimals of the second order, and the other four become (36)

$$d\xi_1 = d\xi_{,} - \eta_{,} dR + \zeta_{,} dQ,$$
$$d\eta_1 = d\eta_{,} - \zeta_{,} dP + \xi_{,} dR;$$

$$d^2\xi_2 = d^2\xi_1 - d\eta_1 dR,$$
$$d^2\eta_2 = d^2\eta_1 + d\xi_1 dR:$$

where $\zeta_{,}$ becomes a constant, and equal to $\alpha - \gamma$.

These equations are to be taken in connection with the equations of motion, and, as will presently be seen, will, along with these equations, assume the form of eight linear equations in a'', b'', $\xi_{,}, \eta_{,}$, ξ_1, η_1, ξ_2, η_2, with constant coefficients, reducible to four, by means of which the motion of the body will be completely determined, and the elements of its position assigned in finite and explicit functions of the time.

It would be easy to show, as Lagrange has done in the case of a body revolving and oscillating about a fixed point, that the centrifugal force of a body revolving on a surface nearly horizontal will throw its vertical axis to a finite distance from the fixed vertical, unless when either the rotation round the body's vertical is very small, in which case the distorsive moments of inertia F and G may be any whatever, or else when F and G are very small, and then the rotation round the vertical may be what we please. In both cases the form of the body and the distribution of its density may be such that the third distorsive moment of inertia H (which is brought into action only by the velocities p and q, and enters into the values of U, V and W, multiplied by these velocities only, or by their rates of increase) may be indefinitely great without affecting the truth of the solution.

Supposing then in the first place that r is very small, the values of p and q already found become $p = db''$, $q = -da''$, and the four equations last given (omitting hereafter the inferior accents of $\zeta_{,}$ and $\gamma_{,}$, as no longer wanted) are reduced to (37)

$$d\xi_1 = d\xi_{,} + \zeta dQ,$$
$$d\eta_1 = d\eta_{,} - \zeta dP;$$

$$d^2\xi_2 = d^2\xi_1,$$
$$d^2\eta_2 = d^2\eta_1:$$

whence we obtain

$$d^2\xi_2 = d^2\xi_{,} - \zeta da'' dt, \qquad d^2\eta_2 = d^2\eta_{,} + \zeta db'' dt.$$

By means of these expressions and the equation $\theta = g$, the two first equations of motion (34) become

$$\frac{d^2\xi_{,}}{dt^2} - \zeta\frac{da''}{dt} + \frac{g}{\lambda}\xi_{,} - ga'' = 0,$$

$$\frac{d^2\eta_{,}}{dt^2} - \zeta\frac{db''}{dt} + \frac{g}{\mu}\eta_{,} - gb'' = 0.$$

At the same time the equation $W = 0$ (15) becomes

$$Cd^2R + Fd^2a'' - Gd^2b'' = 0.$$

Substituting, in the expressions for U and V (15), db'' for p, $-da''$ for q, and for dr its value derived from the preceding equation, we shall find

$$(AC - G^2)\frac{d^2b''}{dt^2} + (CH + GF)\frac{d^2a''}{dt^2} - CMgB_{,,}\eta_{,} = 0,$$

$$(BC - F^2)\frac{d^2a''}{dt^2} + (CH + GF)\frac{d^2b''}{dt^2} - CMgA_{,,}\xi_{,} = 0;$$

which, together with the two equations above involving the same four variables, constitute four linear equations of the second order, with constant coefficients. It is well known that such equations are in all possible cases integrable in finite terms by the method of D'Alembert or other analogous processes. (*Lacroix, Cal. Int.* Vol. II. p. 37.) In the course of this computation, into which the limits of the present communication will not allow me to enter, equations of limitation will arise showing the conditions of the oscillatory motions of the body. These equations will in general be expressed in the form of relations between the constants which determine the form and magnitude of the areolas of contact, the magnitude and density of the body and the position of its centre of gravity. Among the oscillatory motions possible, there is one of a peculiar nature which I do not recollect ever having seen remarked,—I mean when the motion is around a state of equilibrium, stable from the form of the moving body but unstable from the form of the supporting surface, or the contrary; as for example, when an ellipsoid is balanced on the outer surface of a sphere, the summit of the *shortest* axis of the ellipsoid being in contact with the highest point on the surface of the sphere. Into such a position we may conceive the ellipsoid to have descended from some assignable initial place of rest, or some combination of position and velocity. A motion would ensue which in a variety of cases would be oscillatory. The oscillations would however be liable to be broken by the application of the slightest force, and would be followed by the entire departure of the body from the place it occupied. These motions may be called *unstable oscillations.* They bear the same relation to *stable oscillations* that unstable does to stable equilibrium.

With respect to the four linear equations above obtained, I shall only add that in the present case they may be immediately reduced by eliminating $\xi_{\prime}$ and $\eta_{\prime}$ to two equations of the fourth order of the form

$$A\frac{d^4a''}{dt^4}+B\frac{d^4b''}{dt^4}+C\frac{d^2a''}{dt^2}+D\frac{d^2b''}{dt^2}+E\frac{da''}{dt}+Ga''=0,$$

$$A'\frac{d^4a''}{dt^4}+B'\frac{d^4b''}{dt^4}+C'\frac{d^2a''}{dt^2}+D'\frac{d^2b''}{dt^2}+F\frac{db''}{dt}+Hb''=0.$$

The eight arbitrary constants introduced by the integration of these equations are to be determined from the known values which the variables a'', b'', $\xi_{,}$, $\eta_{,}$ and their velocities are supposed to have at some given epoch of time. These eight arbitraries are not the only ones of which the body is susceptible. There will be ten in all, two being introduced by the equation $W = 0$, whose integral is

$$CR + Fa'' - Gb'' = \varepsilon t + \varepsilon',$$

the constants ε and ε' being functions of the values which a'', b'', R, and their velocities have at any given epoch.

Let us now suppose that the distorsive moments of inertia F and G are very small, in which case the rotation round the normal may be increased to any assignable rapidity without disturbing by that circumstance alone the smallness of the oscillatory excursions. The equation $W = 0$ will now be found reduced to $Cdr = 0$, whence $r =$ a constant quantity, and $R = rt + R'$, R' being the angular distance of the first body-axis from the first space-axis when $t = 0$. Equations (35) become at the same time

$$d\xi_1 = d\xi_{,} - r\eta_{,} + \zeta(rb'' - da'');$$
$$d\eta_1 = d\eta_{,} + r\xi_{,} - \zeta(ra'' + db'');$$

$$d^2\xi_2 = d^2\xi_1 - rd\eta_1,$$
$$d^2\eta_2 = d^2\eta_1 + rd\xi_1,$$

four linear equations which, in conjunction with the four equations of motion transformed by the substitution of the present values of p, q and r, will make up eight equations of the first degree (six being of the second and two of the first order) with constant coefficients. The equations may be completely integrated either by D'Alembert's method, by which we should be brought to twelve equations of the first order; or by eliminating the indefinite integrals ξ_1, η_1, ξ_2, η_2, and then proceeding by the method of exponential substitutions. D'Alembert's method of integrating simultaneous linear equations is regarded by some of the first mathematicians of Europe as the best, and I have therefore introduced the equations (35); but if the direct substitution of exponential functions of the time be preferred (a method which has often the advantage of greater expedition), it would not be necessary to form these equations, as the values of $d^2\xi_2$, $d^2\eta_2$, $d^2\zeta_2$ are derivable from their equations of definition (10) in terms of the rotatory velocities and the coordinates, parallel to the body-axes, of the centre of gravity. For if we multiply by a, a', a'', the values of the second differentials of ξ, ξ', ξ'', the sum of the three products will be equal to $d^2\xi_2$ by the definition of this quantity, which is in fact the velocity which the point $O_{,}$ gains in every interval dt estimated in the direction which the body's first axis has at the *beginning* of that interval. It is because this acceleration is measured not on the variable axis itself, but on the *direction* which that axis had at the beginning of dt, that the sum of the elements $d^2\xi_2$ will not make up the velocity $d\xi_1$; nor the sum of the elements $d\xi_1$ the finite rate of increase of $\xi_{,}$. In consequence of these distinctions, many difficulties might arise in considering geometrically problems of the nature of the one before us; but they are always either avoided or explained by the adoption of analytical methods of solution, and I feel assured that the experience of those who are conversant with these methods will bear me out in saying that the necessity of even adverting to the difficulties of geometrical mechanics disappears precisely in proportion to the purity and generality of the analysis. While on this subject however I ought to remark that in consequence of this incompleteness of the values of $d\xi_1$, $d\eta_1$, $d\zeta_1$, and in the case of perfect rolling of $d\xi$, $d\xi'$, $d\xi''$, the application of Lagrange's Subsidiary Formula (*Méc. Anal.* Vol. I. p. 313) is inadmissible in such cases, and would lead to false results even if the velocities $d\xi$, $d\xi'$, $d\xi''$ be expressed in functions of the finite angles ψ, ϕ, θ and their velocities. In short his method is applicable only when the differential equations connecting the variables fulfil the conditions of integrability.

The values of the resolved partial accelerations of the centre of gravity found as above directed are

$$d^2\xi_2 = \begin{cases} (aa)d^2\xi_, + 2(ada)d\xi_, + (ad^2a)\xi_, \\ (ab)d^2\eta_, + 2(adb)d\eta_, + (ad^2b)\eta_, \\ (ac)d^2\zeta_, + 2(adc)d\zeta_, + (ad^2c)\zeta_, , \end{cases}$$

$$d^2\eta_2 = \begin{cases} (ba)d^2\xi_, + 2(bda)d\xi_, + (bd^2a)\xi_, \\ (bb)d^2\eta_, + 2(bdb)d\eta_, + (bd^2b)\eta_, \\ (bc)d^2\zeta_, + 2(bdc)d\zeta_, + (bd^2c)\zeta_, , \end{cases}$$

$$d^2\zeta_2 = \begin{cases} (ca)d^2\xi_, + 2(cda)d\xi_, + (cd^2a)\xi_, \\ (cb)d^2\eta_, + 2(cdb)d\eta_, + (cd^2b)\eta_, \\ (cc)d^2\zeta_, + 2(cdc)d\zeta_, + (cd^2c)\zeta_, , \end{cases}$$

where the parentheses denote a sum of three quantities of which the first is included between the parentheses and the other two are similar and accented once and twice. These abridgments, combined with analogous ones for the sum of three quantities differing by a change of letters, might be used with great advantage in general inquiries into the phenomena of the progressive and rotatory motions of solid or fluid bodies; and I should have employed them throughout this paper, had I not been principally desirous of being clearly understood. In case several terms were to be included in the parentheses, an accent or inferior index might be annexed to the second parenthesis for the sake of obviating any ambiguity.

Substituting for the quantities in parentheses their values, all of which are given (6) and (7), we shall find

$$\begin{aligned} d^2\xi_2 &= d^2\xi_, - 2(rd\eta_, - qd\zeta_,) - \xi_,(q^2 + r^2) + \eta_,(pq - dr) + \zeta_,(rp + dq), \\ d^2\eta_2 &= d^2\eta_, - 2(pd\zeta_, - rd\xi_,) - \eta_,(r^2 + p^2) + \zeta_,(qr - dp) + \xi_,(pq + dr), \\ d^2\zeta_2 &= d^2\zeta_, - 2(qd\xi_, - pd\eta_,) - \zeta_,(p^2 + q^2) + \xi_,(rp - dq) + \eta_,(qr + dp). \end{aligned}$$

In the case of small oscillations, r at the same time being small, these become, as before

$$d^2\xi_2 = d^2\xi_, + \zeta\, dq, \qquad d^2\eta_2 = d^2\eta_, - \zeta\, dp.$$

If r is not small, it is constant, as we have seen, and we have

$$d^2\xi_2 = d^2\xi_, - 2rd\eta_, - r^2\xi_, + \zeta(rp + dq),$$
$$d^2\eta_2 = d^2\eta_, + 2rd\xi_, - r^2\eta_, + \zeta(rq - dp).$$

Substituting for p and q their values (32) and employing the abridgments $\xi_, - \zeta a'' = u$, $\eta_, - \zeta b'' = v$, we shall find

$$d^2\xi_2 = d^2u - 2rdv - r^2u,$$
$$d^2\eta_2 = d^2v + 2rdu - r^2v.$$

By means of these values, and the values of $\xi_,$ and $\eta_,$ obtained from the abridgments last employed, the two equations of progressive motion are converted into linear equations of the second order involving a'', b'', u, v and t. At the same time the two equations of rotatory motion are transformed, by the substitution of the values of p and q, into two other linear equations of the same order involving the same variables. In this way we shall obtain

$$\frac{d^2u}{dt^2} - 2r\frac{dv}{dt} + \lambda' u + \lambda'' g a'' = 0,$$

$$\frac{d^2v}{dt^2} + 2r\frac{du}{dt} + \mu' v + \mu'' g b'' = 0;$$

$$(A1)\frac{d^2a''}{dt^2} + (A2)\frac{d^2b''}{dt^2} + (A3)\frac{da''}{dt} + (A4)a'' + (A5)b'' + (A6)v + Fr^2 = 0.$$

$$(B1)\frac{d^2b''}{dt^2} + (B2)\frac{d^2a''}{dt^2} + (B3)\frac{db''}{dt} + (B4)b'' + (B5)a'' + (B6)u + Gr^2 = 0:$$

four linear equations with constant coefficients whose values are

$$\lambda' = r^2 - \frac{g}{\lambda}, \qquad \lambda'' = \frac{\zeta}{\lambda} - 1,$$

$$\mu' = r^2 - \frac{g}{\mu}; \qquad \mu'' = \frac{\zeta}{\mu} - 1;$$

$$\begin{array}{llll}
(A1) = & H, & (B1) = & H, \\
(A2) = & A, & (B2) = & B, \\
(A3) = & (A+B-C)r, & (B3) = & -(A+B-C)r, \\
(A4) = & Hr^2, & (B4) = & Hr^2, \\
(A5) = & (C-B)r^2 - m'\zeta, & (B5) = & (C-A)r^2 - l'\zeta, \\
(A6) = & -\ m' = -MgB_{\prime\prime}: & (B6) = & -\ l' = -MgA_{\prime\prime}.
\end{array}$$

These equations may, by the elimination of u and v, be reduced to two of the fourth order, of eleven terms each, no term being wanting. They may be then completely integrated, and after the determination of the value of the ten arbitrary constants, eight of which are introduced by these equations and two others by the equation $W = 0$, the position of the body and all the phenomena of the motion will be expressed in terms of the sines and cosines of arcs proportional to the time. The conditions of oscillatory motion will also be expressed by equations of limitation arising during the process of determining the integrals.

I shall conclude this paper with an application of the preceding formulas to the determination of the small oscillatory motions of bodies of any figure, law of density, and areola of contact, rolling with the three rotations on a surface which from some slight asperity or other cause prevents entirely and in all directions the sliding motion of the body, while in other respects it leaves it free to rock, pitch and spin, with any combination of these motions consistent with a small declination of the natural vertical of the body from the vertical of equilibrium. I ought to remark that this motion, although more resembling the actual oscillations of supported bodies, differs from them materially in the circumstance that the friction is supposed not to interfere with the motion round the normal, whereas this cause undoubtedly cooperates with the resisting medium to retard the horizontal rotation of the body until it ceases altogether. What I am about to offer therefore must be considered, like every advance which has hitherto been made, as merely a step towards the determination of the actual phenomena. It would not be difficult to include in the next place the moments of the forces which resist the rotation round the normal, but this must form the subject of another dissertation.

The fundamental equations of condition resulting from the definition of the species of motion we are now considering are, as we have seen (25)

$$\begin{aligned} 0 &= \delta\xi_1 - y_, \delta R + z_, \delta Q, \\ 0 &= \delta\eta_1 - z_, \delta P + x_, \delta R, \\ 0 &= \delta\zeta_1 - x_, \delta Q + y_, \delta P. \end{aligned}$$

Substituting these values of the variations of the position of O, the centre of gravity in the general dynamical equation, there will result an equation of the form

$$(P)\,\delta P + (Q)\,\delta Q + (R)\,\delta R = 0;$$

in which the variations are now arbitrary, giving us therefore three equations of motion to be taken in conjunction with the three above, namely,

$$(P) = 0, \qquad (Q) = 0, \qquad (R) = 0:$$

or, writing out these equations at full length, in the case of common gravity,

$$U + M\left(\frac{d^2\eta_2}{dt^2} - gb''\right)z_, - M\left(\frac{d^2\zeta_2}{dt^2} - gc''\right)y_, = 0,$$

$$V + M\left(\frac{d^2\zeta_2}{dt^2} - gc''\right)x_, - M\left(\frac{d^2\xi_2}{dt^2} - ga''\right)z_, = 0,$$

$$W + M\left(\frac{d^2\xi_2}{dt^2} - ga''\right)y_, - M\left(\frac{d^2\eta_2}{dt^2} - gb''\right)x_, = 0;$$

expressions which are true whether friction be considered or not, and independently of all hypotheses of friction.

If the body remains always nearly upright, these become

$$U + M\gamma\left(\frac{d^2\eta_2}{dt^2} - gb''\right) + gy_{,} = 0,$$

$$V - M\gamma\left(\frac{d^2\xi_2}{dt^2} - ga''\right) - gx_{,} = 0,$$

$$W \qquad\qquad = 0.$$

These equations furnish the same relations between F, G and r as those obtained before. Either the rotation round the natural vertical, or else those moments of inertia which would (when made effective by a swift rotation) displace that vertical, must be very small. If r is very small, the equations of condition of perfect rolling are reduced to

$$d\xi_1 = -\gamma q dt, \qquad d\eta_1 = \gamma p dt.$$

Substituting these values in equations (37), and recollecting that $\zeta + \gamma = \alpha''$, we shall find

$$d\xi_{,} = -\alpha'' q dt, \qquad d\eta_{,} = \alpha'' p dt.$$

But when r is small we have

$$d^2\xi_2 = d^2\xi_{,} + \zeta dq dt, \qquad d^2\eta_2 = d^2\eta_{,} - \zeta dp dt.$$

Therefore

$$d^2\xi_2 = -\gamma dq dt, \qquad d^2\eta_2 = \gamma dp dt;$$

equations which are verified by the equation formerly obtained (37) when r is small, $d^2\xi_2 = d^2\xi_1$, $d^2\eta_2 = d^2\eta_1$. Finally, these last equations become, in consequence of the values which p and q acquire when r is small,

$$d^2\xi_2 = \gamma d^2 a'', \qquad d^2\eta_2 = \gamma d^2 b'';$$

by which means the equations of motion are reduced to equations with constant coefficients, namely,

$$U + M\gamma^2 \frac{d^2 b''}{dt^2} - Mg\gamma b'' + Mgy_{,} = 0,$$

$$V - M\gamma^2 \frac{d^2 a''}{dt^2} + Mg\gamma b'' - Mgx_{,} = 0.$$

Where the oscillations take place upon a spherical areola of support, which will include oscillations on a horizontal plane, we have $x_{,} = l\xi_{,}$, $y_{,} = m\eta_{,}$, and therefore, by preceding formulas,

$$dx_{,} = l\alpha da'', \qquad dy_{,} = m\alpha db''.$$

Integrating, and denoting by χ and ψ the arbitrary constants, there results

$$x_{,} = l\alpha a'' + \chi, \qquad y_{,} = m\alpha b'' + \psi;$$

which being substituted in the above equations of motion give two equations of the second order in a'', b'' and t of the form

$$(A1)\frac{d^2a''}{dt^2} + (A2)\frac{d^2b''}{dt^2} + (A3)a'' + (A4) = 0,$$

$$(B1)\frac{d^2b''}{dt^2} + (B2)\frac{d^2a''}{dt^2} + (B3)b'' + (B4) = 0,$$

where the coefficients may be readily determined, as U and V have now the same value as before when there was no friction and when the rotation round the normal was at the same time small. These coefficients being constant, the equations may be completely integrated in finite terms, four arbitrary constants being introduced by the integration, which together with χ and ψ introduced by the last integrals obtained, and ε and ε' arising as we have already seen from the integration of $W = 0$, make up eight in all, being two less than when the body was not restricted to the peculiar motion to which we now suppose it to be subject.

Lastly, let F and G be very small. The equation $W = 0$ will now give us, as if there were no friction, $r =$ any arbitrary constant, and $R = rt + R'$. At the same time we have

$$p = ra'' + db'', \quad d\xi_1 = d\xi_, - r\eta_, + \zeta q, \quad d^2\xi_2 = d^2\xi_1 - rd\eta_1,$$
$$q = rb'' - da'', \quad d\eta_1 = d\eta_, + r\xi_, - \zeta p, \quad d^2\eta_2 = d^2\eta_1 + rd\xi_1,$$

and, by the equations of perfect rolling,

$$d\xi_1 = \quad ry_, - \gamma q,$$
$$d\eta_1 = -rx_, + \gamma p;$$

whence

$$d^2\xi_2 = r^2x_, + rdy_, + \gamma(d^2a'' + 2rdb'' - r^2a''),$$
$$d^2\eta_2 = r^2y_, - rdx_, + \gamma(d^2b'' - 2rda'' - r^2b'').$$

By comparing the two values above given for each of the quantities $d\xi_1$ and $d\eta_1$, we obtain, after replacing $\zeta + \gamma$ by α,

$$r(x_, + \xi_,) = \alpha p - d\eta_,,$$
$$r(y_, + \eta_,) = \alpha q + d\xi_,.$$

When the supporting areola is spherical, these become

$$r\lambda x_, = \alpha m(ra'' + db'') - dy_,,$$
$$r\mu y_, = \alpha l(rb'' - da'') + dx_,,$$

where λ and μ are abridgments for $l + \frac{l}{m}$ and $m + \frac{m}{l}$.

By means of the preceding values of $d^2\xi_2$ and $d^2\eta_2$ it will be seen that the first and second equations of motion are transformed into equations of the second order involving a'', b'', $x_,$, y and t with constant coefficients. These, in conjunction with the two last equations which are of the first order involving the same variables, will enable us to determine fully and by finite integrations all the circumstances of the oscillatory motion. The arbitrary constants will be eight in number, six of them being brought in by the four equations just referred to, and two of them, R' and r, arising from the third equation of motion $W = 0$. These four equations will be found to be

$$A_1 \frac{d^2 a''}{dt^2} + A_2 \frac{d^2 b''}{dt^2} + A_3 \frac{da''}{dt} + A_4 \frac{dx_{,}}{dt} + A_5 a'' + A_6 b'' + A_7 y_{,} + A_8 = 0,$$

$$B_1 \frac{d^2 b''}{dt^2} + B_2 \frac{d^2 a''}{dt^2} + B_3 \frac{db''}{dt} + B_4 \frac{dy_{,}}{dt} + B_5 b'' + B_6 a'' + B_7 x_{,} + B_8 = 0,$$

$$C_1 \frac{da''}{dt} + C_2 \frac{dx_{,}}{dt} + C_3 b'' + C_4 y_{,} = 0,$$

$$D_1 \frac{db''}{dt} + D_2 \frac{dy_{,}}{dt} + D_3 a'' + D_4 x_{,} = 0;$$

the value of their coefficients being as follows,

$$\begin{aligned}
A_1 &= (A1), & B_1 &= (B1),\\
A_2 &= (A2) + M\gamma^2, & B_2 &= (B2) + M\gamma^2,\\
A_3 &= (A3) - 2M\gamma^2 r, & B_3 &= (B3) + 2M\gamma^2 r,\\
A_4 &= -M\gamma r, & B_4 &= M\gamma r,\\
A_5 &= (A4), & B_5 &= (B4),\\
A_6 &= (A5) - M\gamma^2 r^2 - Mg\gamma, & B_6 &= (B5) - M\gamma^2 r^2 - Mg\gamma,\\
A_7 &= M\gamma r^2 + Mg, & B_7 &= M\gamma r^2 + Mg,\\
A_8 &= Fr^2; & B_8 &= Gr^2;
\end{aligned}$$

$$\begin{aligned}
C_1 &= al, & D_1 &= am,\\
C_2 &= -1, & D_2 &= -1,\\
C_3 &= -alr, & D_3 &= amr,\\
C_4 &= r\mu; & D_4 &= -r\lambda.
\end{aligned}$$

The principles and formulas detailed in this memoir will also enable us to determine completely all the circumstances of the motion of any solid of revolution rolling or spinning with or without friction upon a horizontal plane, its axis being supposed to form at all times a very small but variable angle with the plane. The length to which this paper has extended itself obliges me, however, to defer for the present the further consideration of this subject. I shall confine myself therefore to the remark, that in some of these cases, and in a variety of others, the equations given at the foot of page 377 may be presented with advantage in the following form:—

$$\frac{\mathrm{d}(a\,P'+b\,Q'+c\,R')}{M\mathrm{d}t} = (x'-\xi')\frac{\mathrm{d}^2\xi''}{\mathrm{d}t^2} - (x''-\xi'')\frac{\mathrm{d}^2\xi'}{\mathrm{d}t^2} - g(x'-\xi'),$$

$$\frac{\mathrm{d}(a'P'+b'Q'+c'R')}{M\mathrm{d}t} = (x''-\xi'')\frac{\mathrm{d}^2\xi}{\mathrm{d}t^2} - (x-\xi)\frac{\mathrm{d}^2\xi''}{\mathrm{d}t^2} + g(x-\xi),$$

$$\frac{\mathrm{d}(a''P'+b''Q'+c''R')}{M\mathrm{d}t} = (x-\xi)\frac{\mathrm{d}^2\xi'}{\mathrm{d}t^2} - (x'-\xi')\frac{\mathrm{d}^2\xi}{\mathrm{d}t^2}.$$

ERRATA.

Page 342, *line* 19, *for* "(6) and (10)" *read* "(6), (7) and (10)".

.. 352, .. 15, *for* "$\alpha\delta Q$" *read* "$\alpha\delta R$".

.. .. .. 16, *for* "$\beta\delta Q$" *read* "$\beta\delta P$".

.. 354, .. 6 *to* 11. *These formulas should be numbered* "(27)".

No. X.

General Observations on the Birds of the Genus TETRAO; *with a Synopsis of the Species hitherto known. By Charles Lucien Bonaparte, Prince of Musignano, &c. Read June 20th*, 1828.

THE genus TETRAO, in the extent given to it by Linné, was so comprehensive, that he might with almost equal propriety have included in it all typical gallinaceous birds. It comprised species, differing not merely in their external characters, but even in their peculiar habits claiming only a remote affinity. Latham very judiciously separated from it the genera *Tinamus* and *Perdix*, which latter he restored from Brisson. Illiger also contributed to our more accurate knowledge of these birds, by defining two other natural genera, *Syrrhaptes* and *Ortygis*. Temminck, in his *Histoire des Gallinacés*, carried the number of genera to seven, but afterwards reunited *Coturnix* to *Perdix*. The real *Tetraones* are divided by Vieillot into two genera, the *Lagopodes* forming one by themselves.

In our arrangement of these birds, we distinguish three subgenera.

I. *Lagopus*, which represents the genus in the Arctic polar regions, whose chilly climates they are admirably adapted to withstand, being thickly clad with close set feathers, abundantly intermixed with down, and covering them to the very nails. Their pure white winter plumage is an additional protection, by confounding them with the snowy covering of the earth, which prevents their being easily descried by rapacious birds or quadrupeds.

II. *Tetrao*, whose geographical range is limited to the more temperate climates, being still protected by feathers as far down as the toes.

III. *Bonasia*, a new division for which we propose *Tetrao Bonasia*, L. as the type. In these, the upper portion only of the tarsus is feathered. They occasionally descend to still more southern countries, frequenting wooded plains, as well as mountainous districts, to which latter the true Grouse give the preference. The entire genus is however, properly, boreal, and is found exclusively in North America, Europe, and Northern Asia. The long and sharp winged Grouse, which replace them in the arid wastes of Africa and Asia, one being met with also in the southern extremity of Europe, we consider, in common with all modern authors, as a totally distinct genus. This small group, composed of a limited number of species, inhabits wild regions, remote from man and cultivation, preferring burning deserts to the shelter of the woods. Wandering near the confines of these oceans of sand, so terrific to the eye and the imagination of the human traveller, they boldly undertake to cross them in numerous bands, in search of the fluid so indispensable to life, there found only in few and distant spots. Over the intervening space they pass at a great elevation, and with extreme rapidity, being the only birds of their order that are furnished with wings of the form required for such flights.

The Grouse, on the contrary, inhabit forests, especially such as are dense, and situated in mountainous districts; the *Bonasiæ* however, as well as the American Pinnated Grous and Cock of the Plains, frequenting level countries, where grow shrubby trees of various kinds. The Arctic *Lagopodes* are also found on the lofty mountains of Central Europe, where the great elevation affords a temperature corresponding to that of more northern latitudes. There they always keep among bushes, on the dwarf willows, which, with pines, form the principal vegetation of those summits.

The Grouse feed almost exclusively on leaves, buds, berries, and particularly the tender shoots of pines, birch, and other trees, resorting to grains only when compelled by scarcity of their favourite food during severe winters and deep snows: they will, however, pick up a few worms or insects, and, especially when young, are fond of ants' eggs. Like other gallinaceous birds, they are frequently employed in scratching the earth, are fond of covering themselves with dust, and swallow gravel and small pebbles to assist digestion. No birds are more decidedly and tyrannically polygamous. As soon as the females are fecundated, the males separate from them, to lead a solitary life, without showing any further concern for them or their offspring; though, like perfidious seducers, they are full of attentions, and display the greatest solicitude to secure the possession of those they are soon after so ready to abandon. The nuptial season commences with the first appearance of leaves in the spring. The desire of procreation manifests itself by extraordinary sounds and gestures. Their voice becomes sonorous, the males appear quite intoxicated with passion, and are seen, either on the ground, or on the fallen trunks of trees, with a proud deportment, an inflamed and fiery eye, the feathers of the head erected, the wings dropped stiffly, the tail widely spread, parading and strutting about in all sorts of extravagant attitudes, and uttering sounds so loud as to be heard at a great distance. This season of ardour and abandonment is protracted till June. The deserted female lays, far apart on the bare ground, in some thick and low coppice, from eight to sixteen eggs, breeding but once a year. They hatch and rear their young precisely as the common fowl, the chicks being carefully protected by the mother only, with whom they remain all the autumn and winter, separating in spring on the return of the breeding season. It is at this period only that the males go in search of the females, and show a fondness for their company.

The Grouse are shy and untameable, avoiding the settlements of man, and retiring to wild and barren tracts, where they associate in packs or families. The *Lagopodes* only live in very numerous flocks, composed of several broods, which do not disperse until they separate in pairs at the return of the breeding season. Except in spring, the Grouse keep always on the ground, perching on trees only to pass the night, or when disturbed; by day retiring to the deepest recesses of the forest. The flesh of all is exquisite food, though dark coloured in some and white in others. The black meat is compact, juicy, and highly flavoured; while the white has in its favour, delicacy and lightness.

The Grouse are distinguished by a short stout bill, feathered at base; they are of all gallinaceous birds those in which the upper mandible is the most vaulted; the feathers of the bill are very thick and close, and cover the nostrils entirely. The tongue is short, fleshy, acuminate, and acute; and the eye surmounted by a conspicuous red and warty naked skin. Their legs are without spurs in either sex, and partly or wholly covered with slender hair-like feathers, which in the *Lagopodes* are thicker and longer than in the others, extending not only beyond the toes, but even covering the sole of the foot, a peculiarity which, agreeably to the observation of Buffon, is of all animals again met with only in the hare; and as if nature wished to carry her liberality to them still further, this covering becomes longer and closer in winter. The toes of the other species are rough beneath, and furnished with a row of processes or pectinations each side. The roughness of the sole appears requisite to enable the bird to tread securely on slippery ground and frozen snow; as well as to enable them to grasp the branches of trees covered with ice or sleet. In the *Lagopodes*, the nails are peculiarly adapted for removing the snow from over the vegetables on which they feed, and are for this purpose not only useful but indispensable instruments. All the genus have short rounded wings; the first primary is shorter than the sixth, the second being but little shorter than the third and fourth, which are longest. The tail is usually composed of eighteen feathers, generally broad and rounded. The Red Grouse, however, *T. scoticus*, as well as the *T. bonasia*, and the *T. canadensis*, have but sixteen, while the two new North American species have twenty: one of the latter, moreover, has these feathers very narrow and pointed, a character which is also found in the sharp tailed Grouse. They have the head small; the neck short, and the body massive and very fleshy.

The females of the larger species differ greatly from the males in colour, the latter being glossy black, or blackish, whilst the former are mottled with gray, blackish, or rufous: such are all the typical *Tetraones* of Europe, and the cock of the plains, the dusky, and the spotted Grouse of America, the latter being of smaller size. The smaller, mottled species, such as *T. phasianellus* and *T. cupido*, exhibit little or no difference in the plumage of the two sexes, which is also the case in the *Bonasiæ* and *Lagopodes*. The young in their first feathers are like the female in all the species, and moult twice before they obtain their full plumage. All have a double moult, and most of the *Lagopodes* vary in a remarkable degree with the seasons.

The genus *Tetrao* comprises thirteen species, of which we consider eight as typical, two we arrange under *Bonasia*, and three under *Lagopus**. The species of *Lagopus*, as might be expected from their high northern habitation, are common to both continents, with the exception of the Red Grouse, which is peculiar to the British Isles; and which, from the circumstance of its not changing its colour with the season, forms the passage to the true *Tetraones*. Of these, five inhabit North America, and three Europe, none being common to both. Of the two *Bonasiæ*, one is peculiar to the Old, and the other to the New continent. Thus we find, that of the entire genus, eight are distributed to America, and seven to

* Even the modern *Tetrao rupestris* we do not consider well established: as for that of former authors, it is undoubtedly *T. lagopus*. We are equally sceptical with regard to *T. islandicus* and *T. montanus* of Brehm.

Europe. Leaving aside the two that are common to both, and the respective *Bonasiæ*, we may draw the following parallel between the remaining species of the two worlds. The cock of the woods, or capercailzie of Europe, (*T. urogallus*) corresponds to the American cock of the plains, (*T. urophasianus*). The black game, (*T. tetrix*) finds its equivalent in the dusky Grouse, (*T. obscurus*). The *T. hybridus* or *medius*, has no analogue in America; neither has *T. scoticus.* They are however more than replaced as to number by *T. phasianellus*, *T. cupido*, and *T. canadensis*, all American species, that have none corresponding to them in the Old world.

Being perhaps the only naturalist who has seen all the known species of Grouse of both continents, having enjoyed the advantage of examining many specimens even of the rarest, and possessing them all but one in my own collection, I I am peculiarly well situated for giving a monography of this interesting genus. Such a work it is my intention to publish at some future period, illustrated with plates, and accompanied by further details of their habits. They are all found in Europe and North America, some of the European occurring also in Asia, from whose elevated central and northern regions, as yet unexplored, may be expected new species that still remain to be discovered. The extensive wilds of North America may also furnish others; but we do not think it probable; for since we have become acquainted with both sexes of *T. obscurus*, and *T. urophasianus*, we are not aware of any indicated in the accounts of travellers that cannot be satisfactorily referred to known species.

TETRAO.

I. Bonasia.

Tetrao, Vieill. *Coqs de bruyères*, Cuv. *Bonasa*, Stephens.

Lower portion of the tarsus, and toes, naked. Not varying much with the seasons. Crested and ruffed; tail elongated and rounded; female similar to the male; flesh light coloured.

Dwell in dense forests composed of different kinds of trees.

1. *Tetrao bonasia*, L.

Mottled; tail composed of sixteen mottled feathers, the lateral gray, with a broad black subterminal band.

Male; sides of the neck with a ruff of small feathers; uniform with the rest; throat black.

Female and young; ruff smaller, throat white.

Hazel Grouse, Lath. *La Gelinotte*, Buff., pl. enl. 474, male; 475, female.

Inhabits wooded mountains in the central parts of the old continent: rather common in several districts of eastern Germany.

2. *Tetrao umbellus*, L.

Mottled; tail of eighteen mottled feathers, all ferruginous, and with a black subterminal band.

Male; a ruff of large black feathers on the sides of the neck; throat white.

Female and young; ruff smaller, dark brown.

Ruffed Grouse, Wils. Am. Orn. vi. pl. 49, male.

Inhabits North America; common, especially in mountainous pine districts.

II. Tetrao.

Tetrao, Vieill. *Coqs de bruyères*, Cuv. *Tetrao*, *Bonasa*, Stephens.

Tarsus wholly feathered, toes naked. Not varying much with the seasons. Found in temperate climates, even at a comparatively low latitude, and in level as well as mountainous countries. Flesh dark coloured.

3. *Tetrao urogallus*, L.

Bearded; tail much rounded, of eighteen broad rounded feathers; bill white.

Male; glossy black, breast with greenish reflections.

Female and young; mottled.

Wood Grouse, Lath. Penn. Brit. Zool. pl. M. male; pl. N. female.

Inhabits mountainous forests of Northern Asia and Eastern Europe; less abundantly in central and south-eastern Europe.

4. *Tetrao urophasianus*, Nob.

Tail cuneiform, of twenty narrow, tapering, acute feathers.

Male; black?

Female and young; mottled.

Cock of the Plains, *Tetrao urophasianus*, Nobis, Am. Orn. iii. pl. 21, fig. 2.

Inhabits the extensive plains between the Missouri and the Rocky Mountains. Size of the preceding, and the largest of North American Grouse.

5. *Tetrao hybridus*, Sparrm.

Slightly bearded; tail hardly forked, of eighteen feathers; bill black; tarsus two inches long.

Male; glossy black, breast with purple reflections.

Female; mottled.

Tetrao hybridus, Sparm. Mus. Carls. 1. pl. 15. ad. male. *Tetrao medius*, Meyer, Temm.

Inhabits the high north of the old continent: most common in Russia and Lapland, but nowhere abundant; rare and accidental in central Europe.

6. *Tetrao tetrix*, L.

No beardlike appendages; tail deeply forked, of eighteen feathers, the exterior turned outwards; under tail-coverts white; tarsus one inch and a half long.

Male; glossy black, with violaceous reflections.

Female; mottled.

Black Grouse, Lath. Buff. pl. enl. 172, male; 173, female.

Inhabits Northern Asia, and Northern as well as Central Europe.

7. *Tetrao obscurus*, Say.

Tail slightly rounded, of twenty broad, rounded, blackish feathers.

Male; black.

Female and young; dusky brown, somewhat mottled.

Dusky Grouse, Tetrao obscurus, Nob. Am. Orn. iii. pl. 18, female. *T. Richardsonii*, Sabine.

Inhabits near the Rocky Mountains. Size of *T. tetrix*.

8. *Tetrao canadensis*, L.

Tail rounded, of sixteen black, rounded feathers; breast, flanks, and tail-coverts spotted with white.

Male; black, waved with gray; throat and breast deep black.

Female; mottled; throat and breast banded with black and rufous.

Spotted Grouse, Tetrao canadensis, Nob. Am. Orn. iii. pl. 22, male; pl. 21, fig. 1, female.

Inhabits the north of America, extending from the Rocky Mountains to the state of Maine.

9. *Tetrao phasianellus*, L.

Mottled; tail short, cuneiform, of eighteen narrow square feathers, the two middle ones much elongated, the outer white at the point.

Male and female; similar.

Winter plumage much darker and more glossy.

Sharp tailed Grouse, Tetrao phasianellus, Nob. Am. Orn. iii. pl. 19.

Inhabits Arctic America, as well as the high ranges of the Rocky Mountains.

10. *Tetrao cupido*, L.

Mottled; tail rather short, much rounded, of eighteen plain dusky feathers; primaries spotted with white on their outer webs.

Male; furnished with wing-like appendages on the neck, covering two loose, orange-coloured skinny bags.

Female and young; destitute of the cervical appendages and skinny bags.

Pinnated Grouse, Wils. Am. Orn. iii. pl. 27, fig. 1, male.

Inhabits certain districts both of the eastern and western United States: common on the Missouri, and even on the Oregan.

III. Lagopus.

Lagopus, Vieill. Stephens. *Lagopèdes*, Cuv.

Tarsus and toes, and even the sole of the foot entirely covered with feathers. Head without a crest. Tail rounded. Most of the species varying greatly with the season, becoming white in winter. Female differing but little from the male.

Confined to Arctic countries, or the regions of perpetual snow. Dwell in forests chiefly composed of pines: never alight on trees; fond of rocks. Collect in large flocks. Monogamous, pairing in spring.

11. *Tetrao scoticus*, L.

Reddish chesnut; feathers of the feet gray; tail of sixteen feathers, the lateral blackish, tipped with reddish; primaries sooty black; eyebrows papillous, elevated, denticulated.

Female; duller, more mottled.

Winter and summer plumage alike.

Red Grouse, Lath. *Lagopus scoticus*, Vieill. Gal. Ois. pl. 221.

Inhabits the British Islands: common in Scotland.

12. *Tetrao lagopus*, L.

Feathers of the feet snow-white; tail of eighteen feathers, the lateral black; bill moderate, compressed at the point; nails black, subulate, arcuated.

Winter plumage, snow-white; summer, reddish-gray mottled with black.

Male; a black band through the eye, which the female is without.

Ptarmigan, or *Rock Grouse*, Lath. *Le Lagopède*, Buffon, pl. enl. 129, female in winter; pl. 494, female acquiring summer dress.

Inhabit the Arctic regions of both continents, as well as the lofty mountains of the old, whence in winter they descend to moderate elevations: common at Hudson's Bay, in Russia, Switzerland, &c.

13. *Tetrao albus*, L.

Feathers of the feet white; tail of eighteen feathers, the lateral black; bill short, stout, depressed at the point, blunt; nails white, long, hardly curved.

Winter plumage snowy white, no black band through the eye: summer, reddish chesnut, mottled with black; throat unspotted.

Female hardly differing from the male in summer, and perfectly similar in winter.

White, and *Rehusac Grouse*, Lath. *Tetrao saliceti*, Temm. Frisch. pl. 110 & 111. *White Partridge*, Edw. Glean. pl. 72, male moulting.

Inhabits the Arctic regions of both continents, to the very pole; scarcely ever seen even on the highest mountains of Central Europe; common in Lapland, Iceland, Greenland, and Kamschatka: found also at Hudson's Bay, and on the northern side of Lake Superior.

No. XI.

Conchological Observations on Lamarck's Family of Naïades. By Philip Houlbrooke Nicklin. Read 6 March, 1829.

THE genus *Unio*, and its congeners, have become objects of great interest to naturalists in all parts of the world. American conchologists seem to have had their attention particularly drawn to these objects by the immense number and almost infinite varieties of them that are nourished by the great rivers of the West and their tributaries. Many beautiful species of *Unio* and *Anadonta* have been added to Lamarck's family of *Naïades*, by the useful labours of Messrs Say, Barnes, Green, and Isaac Lea; and the former of these naturalists has thought it necessary to add a new genus, called *Alasmodonta**, to the same family.

Doubts have been expressed by several distinguished conchologists, whether the family of *Naïades* contains more than one genus, or at most two. The new genus *Alasmodonta* of Mr Say seems to form a link of close connection between *Anodonta* and *Unio;* and the three genera exhibit such various forms of hinge, that, in many instances, it is difficult to determine to which genus the individual should be referred. Mr Isaac Lea has upwards of forty varieties of *Unio cornutus;* which, if arranged in a particular order, exhibit so gradual a

* From α' priv., ἔλασμα *lamina*, and ὀδοὺς *dens;* meaning without the lamellar tooth.

change, as to convince the observer of their identity of species; but if any two, near the opposite extremes of arrangement, be compared, they would be considered as specifically different.

De Blainville, a celebrated conchological anatomist, in the second edition of his "Manuel de Malacologie et de Conchiliologie," p. 539, says, that the animal of the *Unio* is precisely like that of the *Anodonta:* his words are, "*Animal entièrement semblable à celui des anodontes.*" It has not been discovered that the animal of the *Alasmodonta* differs in any respect from those of the *Unio* and *Anodonta.*

Under the genus *Unio*, De Blainville cites *Hyria corrugata* of Lamarck, as the example of his variety A of *Unio:* his words are—A. Espèces obliques, dont le corselet est dilaté et relevé en crête saillante, ce qui les rend comme auriculées ou aviculaires. He also cites *Castalia ambigua** of Lamarck as the example of his variety C of *Unio.* It is therefore evident that De Blainville believes the animals of *Unio*, *Hyria*, and *Castalia*, to be identical.

In the same manner, under the genus *Anodonta*, he cites *Iridina exotica* of Lamarck as the example of variety A; and *Dipsas* of Leach as the example of variety E of *Anodonta.* Thus it appears that De Blainville considers *Unio*, *Hyria*, and *Castalia* to be varieties of one genus, namely *Unio;* and *Anodonta*, *Iridina*, and *Dipsas* to be varieties of one genus, namely *Anodonta:* and since he expressly declares the animals of *Unio* and *Anodonta* to be identical, may we not safely include the whole six under one genus?

We may also add Mr Say's genus *Alasmodonta*†, as nothing has been discovered in the animal to distinguish it from that of *Unio;* and as the structure of its hinge proves it to be the connecting link between *Unio* and *Anodonta.*

If the above mentioned seven genera are to be considered as permanent, there are strong reasons why another should be added to them, conformably to a suggestion contained in

* Possibly, *Unio triangularis* of Barnes.

† Is not *Alasmodonta arcuata* of Say identical with *Unio sinuata* of Lamarck?

an observation appended by Lamarck to the description of his *Unio alata* (the *Unio alatus* of Say): it is as follows; "Ici, comme ailleurs dans ce genre, le ligament est en dehors de la charnière; néanmoins, comme les valves sont connées au bord inferieur de l'aile du corselet, M. Le Sueur, qui a observè cette réunion, pense qu'on doit former un genre particulier avec cette coquille."

The following observations, appended by De Blainville to his genus *Unio*, are well worthy of attention:

"Les espèces de ce genre deviennent tous les jours plus nombreuses: en effet on en trouve dans tous les pays, mais surtout dans l'Amerique septentrionale. M. de Lamarck en characterise plus de cinquante, mais il convient qu'elles sont en general fort difficile à distinguer; à plus forte raison, les subdivisions génériques qu'on a voulu établir dans ce genre, d'après la forme générale de la coquille et celle des dents præapiciales, comme l'a fait M. Rafinesque. On passe en effet par des nuances presque insensibles des espèces dont les dents sont à peine apparentes, jusqu' à celles où elles deviennent presque régulières comme dans la mulette ambigue, que nous croyons avoir été les premiers à rapprocher de ce genre, contradictoirement avec M. de Lamarck qui alors en faisoit une trigonie*.

"Nous pensons même que par la suite on découvrira des espèces qui *etabliront le passage* entre les anodontes et les mulettes, en sorte que ces deux genres devront être réunis."

The sagacity, almost prophetic, displayed in the last paragraph of the foregoing extract, has been fully proved by Mr Say; for whom was reserved the honour of discovering a species, that precisely fills up the hiatus formerly existing between *Unio* and *Anodonta;* and upon which he formed his genus *Alasmodonta;* but which, it is probable, should only be considered as a new species of *Unio*. This idea derives additional force from the observations made by Mr Say himself, in page 131, vol. v. of the Journal of the Academy of Natu-

* Trigonée ?

ral Sciences; where, after describing *Alasmodonta ambigua*, he says, "It forms a link between the genera *Alasmodonta* and *Anodonta*. When *young* the primary teeth are obvious, but when the shell arrives at the *full growth*, the teeth are obsolete, and in some instances *not at all visible*."

From this it appears that some shells of the family of Naiades, at different ages, assume different appearances in those parts which naturalists have fixed upon for the distinctive characteristics of different genera. How cautious should we be not to suffer our ingenuity to run before the unerring indications of Nature!

Mr Barnes, to whose suggestions great deference is due, in speaking of the almost infinite and nearly indistinguishable varieties of the genus *Unio*, observes, "that the thought had frequently struck him, that, properly speaking, there is but *one species* of the whole *genus*, and perhaps of the *whole family*. See Silliman's Journal, vol. vi. p. 115; the whole paragraph is well worth attention.

This opinion goes rather too far, but is still strongly corroborative of the conclusion at which it is wished to arrive, namely, that the seven genera, now referred to the family of *Naïades*, are founded in artificial distinctions, and not in Nature; and that in fact the whole family contains but one genus, which was originally established by Bruguières, and should be called Unio. In that case, the present genera might be considered as so many species, and the present species as so many varieties: or, the genus *Unio* might be divided into subgenera and species.

It often happens with young naturalists that the thirst of fame is greater than the desire of knowledge, which has caused the books to be swelled with genera and species that exist only in imagination; even the illustrious Lamarck has erred in this respect; and in the genus *Unio* has probably described as different species five or six varieties of Say's *purpureus*.

Linnæus, whose comprehensive mind seemed to scan the universe at a glance, was governed by the severest simplicity in his arrangement of the genera of shells; but by generalizing too much, in some instances he forced the barriers of Nature, and united genera that are totally distinct. The beautiful simplicity of that great naturalist, however, was much more favourable to the acquisition of knowledge than the endless multiplicity of genera and species introduced by the moderns; and the more we consider and scrutinise his arrangement, the more does our wonder increase, that the same mind should possess so vast a power of generalization, and such minute accuracy in observing the details of specific difference.

Note.—Since the foregoing observations were written, a paper on the *Naïades* by G. B. Sowerby, F.L.S., recommending a reunion of the whole family under one genus, and proposing a new arrangement, has fallen under the observation of the writer. The paper is in the Zoological Journal, Vol. I. page 53, and is well worthy of perusal.

No. XII.

Some further Experiments on the Poison of the Rattlesnake.
By R. Harlan, M.D. Read 20 *March*, 1829.

AGREEABLY to a promise made in a paper published in the first part of this volume, to continue the experiments on the poison of the Rattlesnake, in which the root of the *Hieraceum venosum* as an antidote was tested, I now offer a few additional observations.

It will be observed that though the experiments detailed below afforded different results, in no instance was it found successful, as an antidote, when administered to quadrupeds. In a few instances the medicine did certainly appear to mitigate the effects of the poison on the system in a slight degree, yet in others not the least benefit was derived from it. The reptiles were fresh healthy animals recently received from the country.

Experiment 1.

June 5th, 1828. Two kittens were exposed to be bitten by a young male Rattlesnake; several wounds were inflicted on both without any poisonous symptoms following.

A large female snake was next produced; the bite of this animal was speedily followed by the usual symptoms of similar poisoned wounds in both animals.

A decoction of the root of the Hieraceum venosum was freely administered to the animal first bitten, with the apparent effect of rendering the poison less narcotic and probably of retarding the death of the subject of the experiment, and it survived the animal subsequently bitten more than an hour.

Experiment 2.

At 4 h. 21 m. a small black pup was bitten by an active male snake.

At 4 h. 34 m. a brown dog was bitten by the same snake severely in the foot; the wound bled freely.

At 4 h. 37 m. the black dog was again bitten in the foot, the wound being severe.

At 4 h. 40 m. black dog was drowsy, and unable to stand.

At 4 h. 45 m. brown dog evacuated per anum.

At 4 h. 46 m. black dog evacuated per anum.

At 4 h. 47 m. administered a quarter of a pint of the decoction to the black dog.

At 4 h. 55 m. gave the same dog more of the decoction, say half a pint in all; he is certainly not more drowsy, while the brown dog appears very sick and restless; the black dog swelled a great deal, but shows signs of more liveliness.

At 5 h. 25 m. gave the black dog half a wine glassful more; he trembles very much, and the leg is greatly swelled, but he swallows his medicine easily.

5 h. 45 m. Black dog drinks of the decoction voluntarily, and at 6 h. 30 m. went to sleep. The brown dog has become more lively, and limps about the room; the parts in the vicinity of the wounds of both are much tumefied. About this period both became considerably revived; bloody serum was squeezed out of the black pup's wound, and the swelling thus diminished. On the following morning the black dog was found dead, whilst the brown dog recovered completely.

Experiment 3.

4 h. 10 m. A pup was bitten over the inner canthus of the right eye.

At 4 h. 15 m. the effects of the poison were visible, and at 4 h. 20 m. involuntary discharges of fæces occurred.

At 4 h. 35 m. the subject was very sick, the parts much swelled and painful.

At 4 h. 30 m. six ounces of the decoction have been taken at intervals of six or eight minutes.

5 h. P.M. Two ounces more were swallowed; the swelling is excessive about the eye; in other respects the symptoms have mitigated.

4 h. 40 m. A kitten received a wound from the same snake; several wounds were received in all, and the animal died with the usual symptoms in a few hours.

The constitutional symptoms in the pup appeared to mitigate an hour after the wound, but the swelling extended over the whole face. The blood, percolating from the vessels in the vicinity of the wound, became diffused through the cellular tissue, and did not coagulate. Next morning the pup was found dead, having swallowed the last portion of the decoction at 10, P.M.

Note.—In enumerating the names of those gentlemen who contributed towards defraying the expenses of the first series of experiments, Dr James Mease was accidentally omitted.

No. XIII.

Description of a New Genus of the Family of Naïades, including Eight Species, Four of which are New; also the Description of Eleven New Species of the Genus Unio from the Rivers of the United States: with Observations on some of the Characters of the Naïades. By Isaac Lea, M.A.P.S. M.A.N.S.P., &c. *Read March 6th*, 1829.

I HAD the pleasure to present to this Society in November, 1827, a description of six new species of the genus Unio, which they did me the honour to publish. Since that period I have continued to collect and examine the genera of the family of *Naïades* with great interest, and more success than I could have anticipated. I propose in this paper to describe fifteen new species, a number which rarely falls to the lot of a naturalist at one period; and I shall previously indulge myself in some observations respecting their characters, habits, &c.

Strong objections have been made to the study of conchology by persons unacquainted with this branch of zoology, and it has been alleged that a collection of shells is merely a collection of the houses or habitations of an animal carefully removed by the naturalist or destroyed by other causes, and therefore unworthy the time and attention of the student of nature. This assertion betrays ignorance, and recoils on the observer; for it may with truth be said, that no part of the works of nature, however minute or unimportant to the passer by, can be examined without creating in the student of nature the utmost wonder and astonishment.

In this class of animals nature seems not to have worked with the hand of a stepmother; she put them out of her lap after having lavished her bounties upon them in the utmost profusion. All the tints and combinations of the colours of the rainbow are called to adorn their coverings; and in the form of the shells we have almost all the figures that the science of geometry can present. Who can watch the common snail of our woods, and see him commence at a mere point, from which he builds his covering by a secretion from his own body and turns it with the most mathematical exactness, without exclaiming, Thou art indeed a great geometrician! and when he comes to finish his arched entrance, graced with a curvation pure and as white as marble, who can refuse to acknowledge him an accomplished architect?

In viewing the covering of this class of animals, I consider it as in some measure analogous to the skeleton in the vertebral animals. The muscular attachments, of which there are many, to the two valves of the conchifera, may be viewed as the attachments of the muscles of the animal frame to the bones, by which we are enabled to enjoy locomotion. The ligament, which firmly connects, exteriorly, the two valves, may be assimilated to those ligaments whose almost exclusive service is to connect some of the important bones of the human skeleton.

Is it reasonable to consider the valves as merely a habitation for the animal? Are they not always acting a more distinguished part? The ligament, beautifully formed of a combined horny and fibrous substance, is ever in action while the animal lives, and this action is counterbalanced by the contraction of the muscles attached to the interior of the valves. The epidermis too has its duty to perform in protecting from decomposition the calcareous matter of the shell. It is composed of a thin horny substance—somewhat like that of the exterior part of the ligament. The prolongation of the epidermis beyond the margin of the shell seems well adapted, when the animal closes the valves, to exclude the entrance of water, &c., and doubtless is thus used.

When a conchologist examines a shell which to him is new, almost the first question he puts to himself is, "what must be the form of the animal which once inhabited this covering?" He judges by analogy; and after examining the form of the shell, he has generally a very good idea of its former inhabitant, and although he may not be able to decide with the same precision as the osteologist, he can place it in its proper family.

Each family has a form of shell adapted to the wants of its inhabitant, and peculiarly fitted for its locomotion or its fixed situation. Thus the Ostracea could not exist in the shells of the *Naïades*, although the forms of the animals are not very dissimilar to the unpractised eye. The naturalist, however, sees in the former the entire want of the muscular foot for locomotion and its attendant pairs of muscles. In the valve of this he sees but one muscular impression, which muscle is used for the sole purpose of closing the valves, while in the other he sees at least four, two of the muscles of which are used for protruding, the other two for retracting the foot by which it propels itself. The species of the family Mytilacea attach themselves by a strong byssus to stones, &c., and therefore require a very differently constructed shell. The Lithophaga bore into stone, wood, mud, &c., and have no power of locomotion. The Solenacea generally live in pits, and move only between the two extremities of them. To these families might be added many more, all of which are as different in form and habits, as can well be imagined. It may therefore be safely asserted that the student of conchology can always form some idea of the animal from the form of the shell.

My attention having been particularly drawn to the study of the family of the *Naïades*, and my cabinet possessing a great number of species and varieties, I feel induced in this preliminary matter to say something on the species of the

Uniones, described by naturalists who have written on our shells.

The genus Unio presents in the waters of the United States, particularly in the rivers west of the Alleghany mountains, a number of species almost extending beyond belief. Nature has scattered them here with the hand of profusion, after having formed them with the most harmonising beauties.

The number of the species adds greatly to the difficulty of distinguishing them, for they glide into each other so insensibly through their varieties, that the most experienced are often at fault and perplexed with the difficulty of placing them properly in the most approved systems*. But, although we may at every step meet with these difficulties, I cannot suppose that most of those described as species do not exist; the fault has been that mere varieties, in the eagerness of authors to make species, have too often been erected into species, and the great Lamarck has committed this error in as great a degree as almost any other writer.

It is the opinion of some eminent conchologists that the family of the *Naïades* possesses but one genus, and that the genera into which it is at present divided are only species, and the species varieties. Were we to adopt this division, we should be in a worse dilemma than before; for we can scarcely imagine bivalves more different from each other in form than are some of our trans-Alleghany species of Unio.

How totally different is the *rectus* of Lamarck from the *irroratus?* (nobis). The first is four times the width of its length, whilst the latter is longer than broad. The one is broad rayed, in fine specimens; the other possesses dotted lines universally. The *triangularis* of Barnes is entirely dissimilar to the *nasutus* of Say, as is also the *circulus*, herein described, from the *lanceolatus* (nobis); and the same may be said of *peruvianus* and *pictorum*. Two species could

* Swainson says, "Indeed so much uncertainty hangs on the shells of this genus, that the species can only be fixed by ample descriptions and very correct figures."—*Zool. Illus. Vol. I. t.* 57.

be scarcely more unlike than the smooth and radiated *siliquoideus* of Barnes and the beautiful tuberculated *lacrymosus* (nobis); and the same remark may be applied to the *cylindricus* and *alatus* of that excellent conchologist Mr Say. Many other species could be thus contrasted, but I deem the above sufficient, upon examination, to prove the justness of my remarks, and the necessity, in the present state of our knowledge, to retain the species, whatever may be the changes in the genera*.

In a preceding paper on the Uniones I said something on the habits of the animal. I wish now to mention the simple fact that I have kept several specimens about ten months in a basin changing the water every five or six days. During this period they passed through the winter without any change in their usual habits, and nothing in the shape of food was given during the whole period.

This truly interesting family presents us with very difficult specific characteristics, rendered so by the species constantly approaching in similitude to each other, and by the change made in them by age, locality, and exposure.

I propose to offer a few observations on the principal characters, in which it will be seen how little we can depend on any one of them, and shall begin first with the teeth.

Teeth. In the species of the Unio these have been used as

* In a letter addressed to me by William Cooper, Esq., an intelligent naturalist of New York, he says, "There are now, I think, not less than thirty North American species of Unio well established, and perhaps seven or eight more. That they are species, each perpetuating its peculiar form, subject to certain variations, but permanent within fixed limits, seems to me the most rational opinion, although some of our most judicious naturalists think otherwise. Your account of the animal of the *U. irroratus* affords a strong argument in favour of this belief, for it proves that to be beyond doubt as distinct a species as any in any class of animals. Yet this may always be known with certainty by the shell, which, though so well characterised, is not, however, more different from the rest of the genus, than they are from each other, and frequently still less so. If, therefore, this difference is found to be constantly indicative of a species in one instance, it must also be in others. I believe that our lakes and rivers contained the same form of shells at the creation and ever since that they do at this day. If they are hermaphrodite per se, as is said of them, it could not be otherwise; and if the contrary were admitted, natural history would not deserve the name of a science."

strongly characteristic, but we cannot place much reliance on this character, unless accompanied by and dependent on others. Thus, the angle of the cardinal tooth depends much on the location of the beaks, and we know that in the same species the location is quite different, and yet this difference is not worthy of creating even a variety. If the beaks be placed immediately over the anterior margin*, as in the *ellipsis* they generally are, then the cardinal tooth will be nearly or quite parallel to the lamellar one; but if the beaks be more posteriorly placed, then the cardinal tooth becomes more oblique. We must, therefore, when characters are so difficult, look at them in combination, and adopt them with due consideration.

In the same species the mass or substance of the valves varies much according to localities. Thus we find the *complanatus*† in some of our Atlantic rivers full grown, when only an inch broad, while in other of our Atlantic rivers we have them four inches broad. In some localities we have them possessing but little calcareous matter, while in others they are almost massive. This also occurs in perhaps a greater degree with some of the western shells. And if we examine a massive specimen, we are almost sure to find the cardinal teeth more or less thick, whilst those of the same species which are thin, and they frequently differ very much in this respect, will be found to possess cardinal teeth of quite a crested structure. The cardinal tooth, being single in one and double in the other valve, or double in both valves, cannot be depended on as an unfailing character. The same species will often present double teeth in both valves, although it may be usual to possess them in the right valve only. The lamellar tooth depends much on the substance of the specimen. If it be massive the teeth will be thick, if thin more bladed; the teeth, therefore, differ almost as much in varieties as in species. We must, consequently, while examining a specimen to determine its species, give due attention to these counteracting characters.

* I reverse Lamarck's anterior and adopt Cuvier's as heretofore.

† *Purpureus* of Say.

Colour. The colour of the Uniones is generally a deceptive character. This, however, is not always the case, and therefore it deserves the attention of the conchologist. In some species it is permanent in the nacre, in others it is permanent in the epidermis. In the following species I have always found the nacre to be white and pearly, viz. *cornutus*, *tuberculatus*, *siliquoideus*, *ventricosus*, *ovatus*, *triangularis*, *parvus*, *plicatus*, *metanever*, *æsopus*, *scalenius*, *cylindricus**, *lacrymosus*, *irroratus**, *ellipsis*†, *donaciformis*, *calceolus*, *heterodon*, *multiradiatus*, *occidens*, *securis*‡, *iris*, *zig-zag*, *patulus*, and *planulatus*: the last eight herein described. In the "*torsa*" of Rafinesque, and *sulcatus* (herein described), the purple is permanent and generally dark. In the *subtentus*, *lanceolatus*, and *rubiginosus* (herein described), it is a pale salmon colour, and in the *ater* (herein described) it is a pink bordering on purple. The *gibbosus* is generally a dark purple or chocolate, but varies from this through all the intermediate shades to perfect white. The *verrucosus* is either chocolate or white, and does not seem to enjoy the intermediate tints. The *circulus* (herein described) is generally of a pure pearly white, but sometimes, though rarely, possesses a blush of pink in the centre of the valve. The *mytiloides* presents all the shades from the deepest flesh colour to the purest white. The *cariosus* is generally white, but sometimes is found of a deep salmon and the intermediate shades. The *nasutus* is either pearly white or approaching salmon colour under the beaks. The *rectus* is generally of a beautiful porcelanic white, sometimes tinted about the cardinal teeth and in the cavity of the beaks with purple

* The *cylindricus* and *irroratus* sometimes, in very perfect specimens, present a slight golden appearance in the nacre at the anterior margin.

† Var. *a* being herein described as a new species.

‡ This is Rafinesque's "*U. depressa*," but the name being preoccupied by Lamarck, apparently without the knowledge of Mr R., I am compelled to give it a new name or leave it out of the catalogue. I prefer the former alternative, as it is a distinct and beautiful species, and well known to most of our conchologists under its duplicated name "*depressa*." In this I act in accordance with the rules of nomenclature in natural history. See description.

or salmon, more generally the former: specimens are rarely found with the nacre entirely coloured. The *complanatus*, of which so many false species have been created by European naturalists, presents us with more colours and shades than any other species except the *cuneatus* of Barnes, which by many conchologists is considered analogous to it. These two species present us with specimens of the darkest purple, the purest white, the richest salmon, and all their intermediate shades. The fine indistinct striæ of the nacre, which are sometimes observed to diverge from the interior of the beak to the margin, are caused by the successive removals of the marginal attachment of the mantle.

It should be borne constantly in mind that the colour of the nacre is an extremely doubtful character in the family of *Naïades;* in exemplification of which I have an Anodonta from the Ohio, *the nacre of one valve of which is salmon and the other white.* The valves are beyond all doubt of the same animal. The green irregular spots and marks sometimes described to exist in our Uniones deserve no attention, as they are altogether accidental, perhaps the effect of disease: they are more frequent in the *rectus* and *cylindricus.*

Elevations on the surface of the disks. These are sometimes tuberculated, sometimes undulated; and our western waters are the only ones we know of which produce many species thus marked. There they exist in great variety and exceedingly great beauty. The *U. tuberculatus* and *U. lacrymosus* possess more tubercles than any other species. The *U. verrucosus* possesses them irregularly scattered over the sides of the valves. The *U. metanever* and *U. cylindricus*, besides the irregular elevations over the disk, have remarkable undulations along the umbonial slope*, from the beak to the margin. The *U. cornutus* is furnished with three or four protuberances or "horns" in a row, passing from the beaks direct to the basal margin; the varieties of the *cornutus* have these

* I use this term for the elevated *ridge* which passes from the beaks to the posterior margin.

"horns" more depressed and more frequent, and thus pass into varieties with a mere furrow without any distinct elevations, and these gradations are almost innumerable. The *irroratus* has slightly elevated tubercles along both sides of the furrow; these are sometimes continued along the wrinkles, making them elevated. The *æsopus* has a "nodulous ridge" over the middle of the shell, and the *plicatus* has folds or waves over the posterior part of the disks, more or less numerous, and which are so large as to produce an irregular effect through the nacre in many instances.

The epidermal colours of this family are exceedingly circumscribed. The ground varies from deep fuscous or black to pale yellow, frequently passing through obscure green, rarely bright green. This ground is intersected frequently with rays or spots of a darker hue. In fine and perfect specimens these are generally perceptible, sometimes eminently beautiful. In imperfect or old specimens these marks are almost always obliterated. The following species, when the specimens are perfect and fresh, occur beautifully painted with rays more or less broad: viz. *complanatus*, *cuneatus*, *radiatus*, *siliquoideus*, *ventricosus*, *ovatus**, *cariosus*, *nasutus*, *lacrymosus* (very slightly), *calceolus*, *rectus*, *ochraceus*, *heterodon*, *sulcatus*, *multiradiatus*, *occidens*, *iris*, and *zig-zag*.

The *securis* is rayed in a manner peculiar to itself. (See description.) The *cornutus* has beautiful hairlike lines, sometimes minutely waved, which diverge to its entire margin. Some of the varieties have no rays, while others have comparatively broad and beautiful ones. The *sulcatus* is indistinctly rayed over the umbones†, but the furrow passing from the beaks to the posterior basal margin has many hair like lines,

* Mr Say says this shell is "not radiated." This is generally the case: but some specimens are beautifully rayed; and Lamarck says of his var. *b*, "testâ radiis longitudinalibus pictâ."

† I use this term as Linnæus did: it is the "*ventre*" of the French writers. Draparnaud says, "la portion la plus renflée des valves." It is improperly used by English writers denoting the beaks or summits.

which are minutely waved; these lines are continued over the umbonial slope. The *irroratus* is covered over the whole disk with dark green spotted lines, running in a sweep from the beak to the margin and lying close to each other.

The following species have broad interrupted rays, which in some instances make rows of square spots: viz. *planulatus*, *scalenius*, *verrucosus* (when young), and *patulus*.

The *donaciformis* and *zig-zag* have diverging rays formed more or less distinctly by zig-zag lines. The *cylindricus*, *metanever*, and *triangularis* are singularly and most beautifully marked with dark green spots in the form of an arrow head, the point directed to the margin. The first and last possess the most; in the others it can only be distinguished in very fine or young specimens. The marks sometimes exist in a confluent state, and rays are consequently produced. They are most prevalent in the *cylindricus*, and vary from the length of a quarter of an inch to a mere point; in the *triangularis* they are more generally confluent. Some specimens of *cylindricus* are so much charged with these arrow-headed marks as almost to obliterate the yellow ground of the epidermis, and cause the valves to appear at first sight of an uniform dark green.

The remainder of the American species described are without epidermal markings, and I shall divide them, as it is extremely difficult to designate their shades, into blackish, brownish, and yellowish. The *ater*, *tuberculatus*, *circulus*, and *gibbosus** are blackish. The *circulus* is peculiar in having the posterior slope yellowish. The *parvus*, *torsus*, *plicatus*, *mytiloides*, *æsopus*, *subtentus*, *verrucosus*, *ellipsis*, *rubiginosus*, are brownish. Some of these, however, vary much. The *torsus* is found sometimes yellowish, and when young almost black; the posterior slope is, however, universally yellowish. Large and old specimens of the *plicatus* are quite black; the young are light brown. In the *mytiloides*

* The young *gibbosus* is sometimes very obscurely rayed.

the young specimens are sometimes rayed over the umbones. The young *æsopus* is bright yellow and highly polished. The young *verrucosus* has sometimes one or two broad interrupted green lines over the middle of the umbones. In young or very perfect specimens of the *ellipsis* may be seen numerous small rays passing over the umbones towards the posterior margin. In the younger specimens of the *rubiginosus* indistinct rays are sometimes seen. The *lanceolatus* is yellowish passing into olive.

It should ever be borne in mind, notwithstanding what has been said above, that colour is exceedingly deceptive, and may often lead to error. It is impossible to find permanent characteristics in it, on which we can universally depend, as locality, exposure, youth, and age so materially affect its appearance. We must therefore consider it in most cases as only auxiliary, though in a few cases it is permanent.

Beaks. Lamarck, in his generic description of the Unio, says, "natibus decorticatis, suberosis." This character is not permanent by any means in our species, some of which are almost universally found free from decortication, while others are partially so; and others again rarely free from it. The objection to receiving it as a permanent character even in species is, that more or less exposure to the action of the stream, &c. will cause the beaks to be more or less eroded in the species where erosion takes place. Some species, however, seem to resist this erosion with great success, owing, as I apprehend, to the peculiar firmness of the texture of their epidermis, which certainly differs in different species. I have never seen either of the following species eroded, viz. *U. parvus*, *U. calceolus*, *U. lacrymosus*, *U. rubiginosus*, or the *Symphynota lævissima* (the two last herein described). It is rarely we see a ponderous shell free from this erosion, and the *U. cylindricus* seems to be peculiarly subject to it, for the form of the beaks can rarely be even traced, yet the largest specimen in my cabinet, nearly five inches broad, possesses the epidermis untouched on this part. The beaks of many of the species, when found in a perfect state, are crowned with concentric undulations or slight elevations, which should always be noticed, as they are highly characteristic. The situation of the beaks, when peculiar, should have the student's attention. They are sometimes almost medial, as in the *U. irroratus*, *U. circulus*, *U. lacrymosus*, *&c.*; while in the *U. ellipsis*, *U. scalenius*, *U. cylindricus*, *Symphynota tenuissima**, *&c.* they are almost terminal: this character, however, varies. (See observations on the teeth.)

The *margins* or circumference should have our attention in examining a specimen. The general form of the *Naïades* is ovate, modified into rhomboidal, triangular, circular, and elliptical; but these forms in the same species will frequently vary, and therefore must not be entirely relied on. The *U. siliquoideus* is generally subangular posteriorly, but it is sometimes truncate, and the *U. cariosus* is found in the same way. We find very few species that are constant in this character; this accounts for the many species created from the *U. pictorum* in Europe.

Muscular impressions. These are important, and should always have our attention in examining a specimen. But even this character is not infallible. It should be understood that the animals of this family always possess two pairs of muscles, used for locomotion, and placed near or in contact with the two adductor muscles, used solely for closing the valves†. In the anterior margin these are generally separate, in the posterior more generally confluent; but in the same species we sometimes find individuals presenting two, sometimes three, and sometimes four cicatrices, besides those of the cavity of the beaks; and this depends in a great measure on the thickness of the shell. If the specimen be ponderous, we often find the posterior muscle of the foot attached to the side of the lamellar tooth near to its termination; if it be thin, although of the same species, it will be found generally confluent or near to the great posterior muscle. The cicatrices, made by the attach-

* Herein described.

† See my description of new Uniones in this volume.

ment of the superior part of the mantle in ponderous shells, generally will be found on the under part of the cardinal tooth. Sometimes six or eight may be found; and their direction is towards the lamellar tooth. In thin shells these cicatrices will be found in the cavity of the beaks, generally traversing it in an oblique direction*.

Ligament. This part of the shell must be viewed with the same doubt as the above character. In the same species the ligament may be long and narrow if the specimen be elongated and thin; and it may be short and thick if it be ponderous and obtuse. Thus we may find in an elongated *siliquoideus* the ligament an inch and a quarter long, and only one-tenth of an inch broad, while in an obtuse and ponderous specimen it may be found to be only three quarters of an inch long and yet one-eighth of an inch broad, as is the case in some specimens of my cabinet.

It has been a desideratum with the American conchologists to fix the nomenclature of this interesting genus, particularly so far as relates to our own species. In the hope of contributing in some measure to so desirable an object, I have carefully examined all that has been published on the subject so far as I could procure the descriptions, and with diffidence give the results, hoping my views may not be found to be incorrect.

The first column contains the species, the nomenclature of which is now likely to be permanent and fixed. The second the species described by other writers, which are either the same or varieties, and consequently synonymes.

1. U. radiatus†,	Gmelin,	1. radiata,	Lam.
		2. virginiana,	Lam.
		3. radiatus,	Barnes.

* See my description of new Uniones in this volume.

† Lister (t. 152, f. 7.) gives a correct representation of the species known to American conchologists as *U. radiatus*, and which he says came from Virginia. Chemnitz (vol. vi. t. 2, f. 7.) gives a representation of a shell very similar to it, the locality of which is Malabar. The first name we find for it is in Gmelin. *Mya radiata*, and this author refers to both figures in his description. Dillwyn re-

2. U. complanatus†, Soland. MSS.	purpureus,	Say.
	rarisulcata,	Lam.
	coarctata,	Lam.
	purpurascens,	Lam.
	rhombula,	Lam. var. *b*.
	carinifera,	Lam.
	georgina*,	Lam.
	sulcidens,	Lam.
	caroliniana,	Bosc.
	fluviatilis,	Green.

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fers to each of the above authorities, but thinks Lister's figure is too doubtful to be retained, as Solander had referred to it for a variety of *Mytilus modiolus*, in which, however, he errs, for Lister's figure is a good representation of a small specimen of the *radiatus* of our waters. Lamarck, in his description of "*U. radiata*," refers to Lister and Gmelin, and also to the figure of Mr Say's *ochraceus*. The last is a distinct species. Several of these writers refer also to the figure in the Ency. Meth. t. 248, f. 5, which is evidently copied from Chemnitz. Mr Barnes, in his description, refers to Say's *U. ochraceus*, Dillwyn's *Mya radiata*, and Lamarck's *U. radiata*. Considerable difficulty presents itself in establishing the name of this species, so well known among us by that of *U. radiatus*, in consequence of the old writers using the same name for those from Virginia and Malabar, which, I believe, when examined together, will be found specifically to differ. Should this prove to be the fact, we must give to our shell the name which Lamarck has described it under a second time, viz. "*U. virginiana*," giving it a masculine termination.

* It should be mentioned here that I was not aware that Mr Barnes had pronounced the first six to be varieties of Say's *purpureus* until after I had selected the seven.

† The celebrated *Lister* published his great work on conchology in 1685, and at that early period he was in possession of several species of our fluviatile shells procured from Virginia. The first he thus describes, "musculus brevior, admodum crassus, ex interna parte subroseus, cardine incisuris minutis exasperato," t. 150, f. 5. Dillwyn describes this shell under the name of *Mya complanata*, and refers to this figure. Beside the locality above, Solander gives Maryland and New Jersey, and Humphreys Mississippi. The latter is most likely an error. Dr Green supposed this shell, so well known to all our conchologists under Mr Say's name *purpureus*, to be the *Mytilus fluviatilis* described by Dillwyn from Gmelin, and referred to Lister, t. 157, f. 12. I differ, however, in this opinion, 1. Because it is not described as being toothed. 2. Gmelin says, "habitat in Europæ aquis dulcibus." 3. The *complanata* answering, in description, better to our shell, and being the first figured and described. It appears somewhat singular to me, that the observant and able zoologist, Mr Say, had not been struck with the similitude of our shell to Lister's figure and description. There is no species more common in all our fresh waters, east of the Alleghany mountains, than this, and nothing could be more likely than that it should be among the first to be taken to Europe by the early voyagers to North America. In accordance,

3. U. ovatus,	Say*,	ovata,	Lam.
		ovata,	Valenciennes.
4. U. cariosus,	Say†,	luteola,	Lam.
		cariosa,	Lam.
		crassus (old)‡,	Say.
		carinatus (rayed),	Bar.
		ellipticus (young),	Bar.
5. U. nasutus,	Say,	rostrata,	Valen.
6. U. cylindricus,	Say,	naviformis,	Lam.
		naviformis,	Valen.
7. U. subtentus,	Say.		
8. U. plicatus,	Le Sueur§,	crassidens ?	Lam.
		peruvianus,	Lam.
		rariplicata,	Lam.
		undulatus,	Bar.
		crassus,	Bar.
		undulata,	Valen.
		dombeyana,	Valen.

therefore, with the rules of nomenclature, I have inserted the name of *complanatus* to the shell described by Mr Say under the name of *purpureus*.

* Dr Hildreth, in describing this species of Say, says, "I think it a near relation of the *gracilis*;" and, when describing the *gracilis*, he says, "The contour of the shell, independent of the wing, is much like that of the *alatus*." In the latter he is right, but in the former remark altogether wrong.

Donovan, Dillwyn, Maton and Racket, and some other British writers have made use of this name for a Unio resembling the *pictorum*. I have thought it better, however, to retain Mr Say's name for his species, which is totally different, being satisfied that the British shell is only a variety of *pictorum*.

† This is probably the only species yet known to be common both to the Western and Atlantic waters.

‡ *Crassus* is omitted in this catalogue, believing that several other species, and those only because they were ponderous, have been described under this name. Mr Say's *crassus* (See Am. Conch. plate 1, fig. 8,) is evidently an old and ponderous *cariosus*, and he considered the "*plicatus*" as a variety. Mr Barnes's *crassus* is an old and thick *peruvianus*, as is most likely Lamarck's *crassidens*. The *giganteus* of Dr Mitchill's collection is also a *peruvianus*, which occurs in some of our western waters of a larger size and more ponderous than any species we know of.

§ This species was first described by Say in the American Conchology as a va-

9.	U. rectus,	Lam.*	præelongus, nasuta, purpurata ? recta,	Bar. Lam. Lam. Valen.
10.	U. torsus†,	Rafinesque.		
11.	U. mytiloides,	Rafin.	undatus,	Bar.
12.	U. metanever,	Rafin.	nodosus, rugosus (flat),	Bar. Bar.
13.	U. scalenius,	Rafin.		
14.	U. cornutus,	Bar.‡		

riety of *crassus*. At the same time he mentioned that its discoverer, that excellent naturalist Mr Le Sueur, suspected it to be a new species, and proposed, should this prove to be the case, to call it "*plicata*." We are, therefore, bound to adopt his name on the claim of priority; and a more descriptive one could not be given to it.

* When Dr Hildreth described the "*prælongus*," it is evident he believed it to be *prælongus* of Barnes, for he uses Barnes's name without stating it to differ from his, although the descriptions are not exactly the same. Barnes says, "Naker, *purple* of different shades," and "deep and splendid purple." (See Barnes's Reclamation.) Hildreth says, "Naker, *white*, and tinged with spots of green."

The specimen of "*recta*," described by Lamarck, was "white," according to his description. I have seen very many specimens of this species, some of which are tinted with light purple or salmon about the cavity of the beaks and cardinal tooth; they are generally, however, of a pure white. The explanation of these contradictory characters is this: The specimen in the collection of the New York Lyceum, and the same is said of one in Dr Mitchill's collection, both brought from the upper lakes, is unusually full of colour, having almost the whole of the nacre of a rose or delicate purple. It has more colour than any specimen I have seen.

† M. Rafinesque is entitled to a preference in this beautiful and extraordinary species, possessing the most elevated recurved beaks of the whole genus. It was generally known among us by the name of *U. orbicularis*, but not described. The variety, not emarginate, can not be made a species, as the two pass into each other. Dr Hildreth has recently described a shell, which I believe to be the *torsus*, in Silliman's Journal under the name of *U. orbiculatus*. He says, "This shell is a variety of the *crassus*." Whose *crassus?* Mr Say's, as mentioned before, is a ponderous *cariosus;* Mr Barnes's, a *peruvianus;* and, if a *variety* of *crassus*, why call it *orbiculatus?*

‡ This species is among the most interesting of the genus. It presents a much greater variety than any other, and might be called a real *proteus*. The true

15. U. verrucosus,	Bar.	{ verrucosa, { tuberculosa,	Valen. Valen.
16. U. tuberculatus,	Bar.		
17. U. gibbosus,	Bar.	mucronatus,	Bar.
18. U. cuneatus*,	Bar.		
19. U. ventricosus†,	Bar.		
20. U. siliquoideus,	Bar.	inflatus,	Bar.
21. U. triangularis,	Bar.		

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cornutus has three or four distinct "horns," and the varieties gradually increase in the number, and vary in the forms of those elevations until they are lost in two ridges passing from the beaks to the posterior basal margin. It is exceedingly interesting to trace these gradual changes of form; and to illustrate the fact of the anomalous varieties being of the same species, I have arranged forty-three specimens in my cabinet, no two of which are alike. Dr Hildreth has made a species of one of these varieties, and calls it *foliatus*. It appears that Mr Barnes and himself had seen only this specimen. I have had three or four in my possession for three years, and at first my impression was in favour of their being new, but examining them with that excellent conchologist, Mr Stewart, we found the line of impression, made by the mantle, did not run parallel with the deep arcuation of the margin, and therefore concluded, at once, that the animal could not conform to the shape of the shell, and consequently that the elongations of the basal and posterior margins were unnatural. Dr H. says he is "unable to determine whether it is a new variety, or only a "lusus naturæ;" and yet he makes a new species of it!! Some of my varieties have the prolongation much more extended than the specimen described by Dr H. In one specimen the unnatural prolongation is more than equal in extent to the natural size of the shell, designated by the impression of the mantle.

* We have been much in the habit of confounding this with the *complanatus*, and considering it as the analogue inhabiting the western waters. It deserves, however, to be retained by Barnes's name, for it possesses characters which the other does not. It is posteriorly more angular, and the shell is subtriangular; the *complanatus* is sub-rhomboidal and more carinate. One inhabits the western; the other the Atlantic rivers. The *cuneatus* is always ponderous; the *complanatus*, I believe, never. Mr B. says his species is never rayed; in this he is mistaken, young and fine specimens have dark broad rays.

† This is undoubtedly the species which we have known under the name of *globosus* (undescribed). Mr B. says "it is more capacious than any of the genus hitherto described." It resembles the *ovatus*, but is always more globose.

22. U. parvus*, Bar.

23. U. æsopus, Green.

24. U. calceolus†, Lea.

25. U. lanceolatus, Lea.

26. U. donaciformis, Lea.

27. U. ellipsis, Lea.

28. U. irroratus, Lea.

29. U. lacrymosus, Lea.

30. U. ater, Lea.

31. U. rubiginosus, Lea.

32. U. heterodon, Lea.

33. U. sulcatus, Lea.

34. U. planulatus, Lea.

35. U. circulus, Lea.

36. U. multiradiatus, Lea.

37. U. occidens, Lea.

38. U. securis, Lea.

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* This is rather the smallest species with which I am acquainted. Barnes says it is "the smallest and most beautiful of all the genus yet discovered in America." In this he alludes to the nacre only, which is more pearly and more brilliant than any species I have seen. The exterior presents nothing peculiar but its concentric waves on the beaks, and a slightly elevated rib passing from the beaks to the posterior margin.

† Although I had three specimens of this shell in my possession when I described it, I felt apprehensive it was too closely allied to the Alasmodonta of Say to be considered as an Unio; but as a lamellar plate really existed with an incipient tooth, though small, on each valve, besides the large cardinal tooth, I determined it to be the safest plan to class it with the Uniones. I have recently received larger specimens in which this plate almost entirely disappears, while in younger specimens it is more evident.

39. U. iris, Lea.

40. U. zig-zag, Lea.

41. U. patulus, Lea.

Conchologists have with great reason complained of the extreme difficulty of identifying Lamarck's species of the genus Unio. Mr Barnes says, "In most cases wherever M. Lamarck can find a difference, though by his own account '*nothing remarkable*,' he makes a different species;" and Mr Swainson declares that "one half the species which he has enumerated" cannot be determined on account of the short descriptions and want of figures. The truth of these remarks I have felt severely whenever I have had occasion to consult this author for the genus; and, with the hope of clearing the path in a measure of those who may follow me, I propose to give here the results of examinations of his species made at different times with much care.

U. sinuata. This is the *Mya margaritifera* of Linnæus and other authors, and to which Barnes's *Alasmodonta arcuata* is the analogue. Mr B. was not aware, when he described it, that it was similar. He has recently, in the reclamation of his Uniones, resigned this species of Alasmodonta. If Mr Say's genus be admitted, we must of course call this type of Lamarck's Unio, *Alasmodonta margaritifera.*

U. elongata. There can scarcely be a doubt but that this is a young shell of the above species.

U. crassidens. It is evident on examination of our author's description of this species and its varieties, and the *crassus* of Say and of Barnes, that all the *ponderous* varieties of our Uniones were brought into these species, neither of which can possibly stand. (See note, page 417.)

U. peruviana. This species embraces the *plicata* of Le Sueur, the *crassus* and *undulatus* of Barnes, the *giganteus* of Dr Mitchill's collection, the *rariplicata* and *crassidens* of Lamarck, and the *undulata* and *dombeyana* of Valenciennes.

As it was described previously by Le Sueur's name "*plicata*," this must take precedence. Its habitat, Peru, I think very doubtful; it most probably came from the United States.

U. rariplicata. This is, no doubt, a variety of the above.

U. purpurata. The *recta* answers to this description in every respect but the habitat. The author "believes" it came from Africa. The shell most probably came from the United States, in which case there could not be a doubt.

U. ligamentina, *U. obliqua*, *U. retusa*. The description of these is so imperfect that I cannot identify either of them, although they are all from this country, and the same species most probably in our cabinets. I doubt if either of them should be retained.

U. rarisulcata, *U. coarctata*, *U. purpurascens*. These are mere varieties of the *complanatus.*

U. radiata. Our author gives the *Mya radiata* of Gmelin and *U. ochraceus* of Say as synonymes to this species. It cannot be both; for the *ochraceus* is a perfectly distinct species from the *M. radiata*, which, Chemnitz says, comes from the rivers of Malabar. The *radiatus* described by Barnes after Lamarck, and Say's *ochraceus* are distinct species, and I have no doubt the *Mya radiata* of Gmelin is distinct from both. Mr Say's figure, referred to by Mr Barnes (pl. 2, fig. 8, Am. Conch.) as *U. radiata*, is undoubtedly an *ochraceus*. (See note on *U. radiatus.*)

U. brevialis. This shell is pictured by Crouch; it is thick, and resembles the *circulus* of the Ohio, but is larger, less round and radiated. It comes from the Isle of France, and is, no doubt, a distinct species.

U. rhombula, *U. carinifera*, *U. georgina*, Are all mere varieties of the *complanatus.*

U. clava. I cannot identify this species. The description is too short. Its habitat is Lake Erie and Nova Scotia, from which circumstance it is most probably in our cabinets under another name.

U. recta. This is the same with Barnes's *prælongus.* The *recta* being described first should be retained.

U. naviformis. This name cannot be retained, as Say had previously described the shell under the name of *cylindricus.*

U. glabrata. The habitat of this species is the Ohio river. The description is too imperfect to identify it, and as the author acknowledges it has "nothing remarkable," we may fairly conclude it to be a variety of some one of the numerous species described, a *cariosus* most probably.

U. nasuta. The author thinks this may be the *nasutus* of Say, but the description answers much better to his own *recta* or Barnes's *gibbosus,* and is no doubt one of those. I do not believe the *nasutus* has ever been found in our western waters*.

U. ovata is the *ovatus* of Say, and inhabits the western waters, not the Susquehanna and Mohawk, as mentioned by Lamarck. Maton and Rackett described a British shell under this name, which I believe to be only a variety of *pictorum.* Those sent me from England by this name were certainly mere varieties of the *pictorum.*

U. rotundata. In most of our cabinets may be found a beautiful shell, which we have thought to be of this species, and have adopted the name. It does not, however, answer to the description in some essential characters, and I have therefore thought proper to describe the American shell, and give it a new name. (See description of *circulus.*) Lamarck gives no habitat. Ours is from the Ohio.

U. littoralis is from the Seine, and is described by Draparnaud, who says it resembles the "*U. margaritifera,*" but is much smaller.

U. semirugata. Description too short to identify it. Has no habitat.

* Swainson says, "The *Unio nasuta*, however, of Lamarck, I apprehend, will be found different" from *Unio nasutus* of Say.—*Zool. Illus. Vol. I. pl.* 57.

U. nana. This species is said to inhabit Franche Comté. I do not know if there be a specimen in this country.

U. alata is the well known *alatus* of Say, and is herein made the type of a new genus, *Symphynota.*

U. delodonta. Description too short to identify it. Has no habitat.

U. sulcidens. A variety of *complanatus;* and is from the Schuylkill, Pennsylvania.

U. rostrata. The specimens which I received from Europe with this name are only elongated varieties of *pictorum.*

U. pictorum. This is a well known species, and described by Linnæus and others as *Mya pictorum.*

U. batava. The specimens sent me of this species from Europe appear to be only a variety of the *pictorum.* It is more obtuse*.

U. corrugata. This species can not be identified with any of ours. It comes from the coast of Coromandel, and is, doubtless, a distinct and well characterised species.

U. nodulosa. The habitat of this species is Lake Champlain, and although pictured in the Ency. Meth. I cannot identify it, the drawing being evidently incorrect. Although represented with a lamellar tooth, I should not be surprized if it proved to be a young *Alasmodonta undulata* of Say, as it has the strong character on the beaks.

U. varicosa. I can only assimilate this with the *Alasmodonta undulata* of Say. Its habitat is the Schuylkill and Lake Champlain.

U. granosa. This is a beautiful and distinct species. Habitat Guyana.

U. depressa. Habitat New Holland. The description is very imperfect, but the species nevertheless distinct. It is a very different shell from that called *depressa* by Rafinesque, who does not seem to have known that the name was preoccupied by Lamarck.

* The *U. anas* I believe to be a variety of *pictorum* very similar to this. My specimen is certainly such. The *U. tumida,* from the north of Europe, appears to me to be only a large and thick *pictorum.*

U. virginiana. This, doubtless, is the *radiatus* described by Barnes. Habitat Virginia.

U. luteola is a variety of Say's *cariosus.* Habitat Susquehanna and Mohawk.

U. marginalis. I have specimens of this species from Bengal. It is well characterised, although it does not always possess the marginal character as described by Lamarck and represented in the Ency. Meth. pl. 247.

U. angusta. This I believe to be a variety of *pictorum.* The figure referred to in Lister is certainly a *pictorum*, and is generally quoted as such. Habitat unknown.

U. manca. This may be a distinct species, but I strongly suspect it to be only a variety of *pictorum.* Habitat Bourgogne.

U. cariosa is the *cariosus* of Say.

U. spuria. I cannot identify this species with any of ours. Habitat . . . . .

U. australis. This, like the above, is not identified. Habitat New Holland.

U. anodontina. Habitat Virginia. We have no Unio of this description in our waters. It is probably *Anodonta undulata* of Say, which has sometimes small elevations somewhat similar to teeth*.

U. suborbiculata. I cannot identify this species.

In passing criticisms upon the species of the genus Unio of this great naturalist, I do not in the least wish to detract from his great and merited fame. My object is expressly to endeavour to facilitate the study of this interesting genus, and to remove, as far as I have it in my power, the confusion which has crept into it. My observations I wish to pass only for what they may prove to be worth.

* Since writing the above, I observe that Sowerby on the Lamarckian *Naïades* (Zoolog. Journ. Vol. I. p. 54.) gives the "*Anodon rugosus*" of Swainson as the synonyme of *U. anodontina.* It is well known to our conchologists that Swainson's *rugosus* is the old shell of Say's *Anodonta undulata*, which was described from a young specimen, and has priority to the *rugosus*.

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1. Unio Ater. Plate VII. fig. 9.

Testâ ovatâ, inæquilaterali, transversâ, ventricosissimâ; umbonibus elevatis; natibus prominulis; epidermide rugosâ nigrâque; umbonibus elevatis; dentibus cardinalibus erectis, cristatis, lateralibus granulatis, rectisque; margaritâ roseâ.

Shell inequilateral, ovate, transverse, much inflated; umbones elevated; beaks slightly prominent; epidermis black and wrinkled; cardinal teeth erect and crestlike, lateral granulated and straight; nacre rose colour.

Hab. Mississippi below Natchez. T. W. Robeson.
My Cabinet.
Cabinet of Prof. Vanuxem.

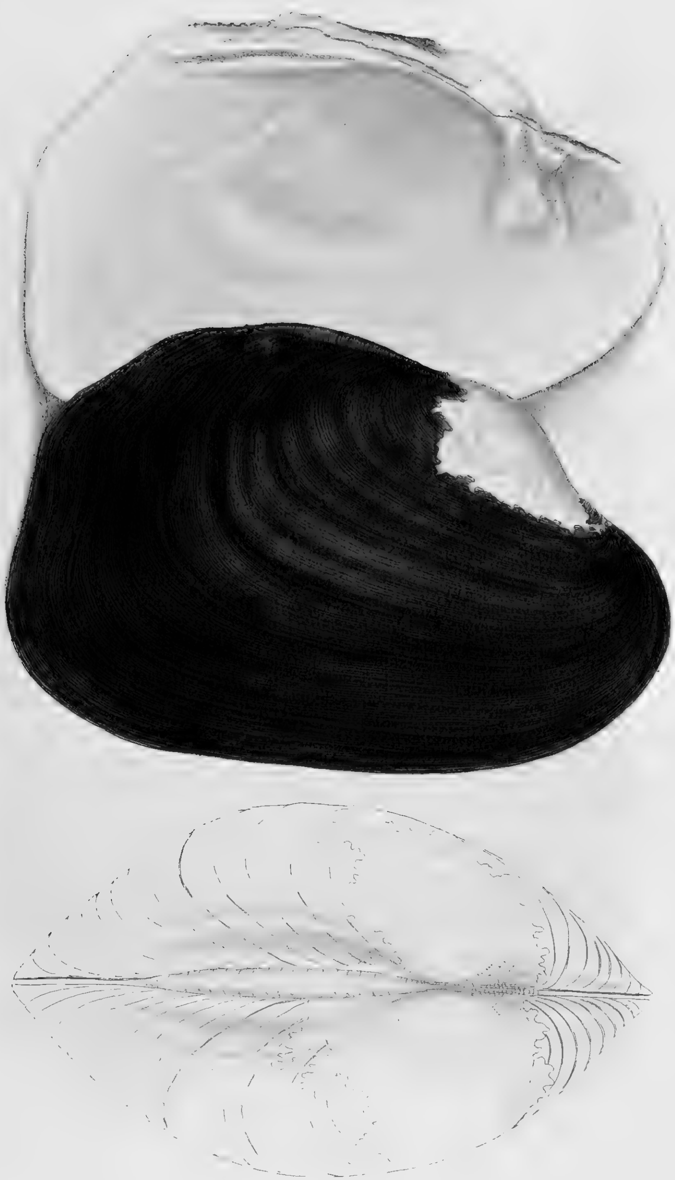
Diam. 2·6, Length 3, Breadth 4·5 inches.

Shell very ventricose; margin ovate, wider behind, slightly emarginate at base, and sometimes slightly truncate at posterior margin; substance of the shell thick; beaks slightly projecting and decorticated; ligament large; epidermis black or blackish, and wrinkled transversely; cardinal teeth erect, crestlike, and double in both valves; lateral tooth curved, long, deeply divided and slightly serrate, the interior division emerging from the cavity of the beak; posterior cicatrices confluent, anterior cicatrices very distinct; dorsal cicatrices pass across the cavity of the beaks in a row*; cavity of the shell great; nacre pink and iridescent in the posterior margin.

Remarks.—This shell is remarkable for the colour of its epidermis and nacre. The perpendicular distance from the cardinal tooth to the basal margin is very small, while that from the posterior end of the lamellar tooth to the same margin is unusually great. It slightly approaches in form to some varieties of the *cariosus*.

* In a former paper of this volume, (page 262) I described the attaching muscles of the back of the animal, the impressions of which in the shell I propose to call *dorsal cicatrices*.

Pl. VII.



Unio ater

2. Unio Rubiginosus. Plate VIII. fig. 10.

Testâ inæquilaterali, transversâ, postice sub-biangulari, antice rotundatâ; valvulis sub-crassis; natibus prominentibus, recurvis, postice sub-angulatis; dente cardinali magno, laterali crasso; margaritâ salmonis colore.

Shell inequilateral, transverse, sub-biangular behind and rounded before; valves somewhat thick; beaks prominent, recurved, sub-angulated behind; cardinal tooth large; lateral tooth thick; nacre salmon coloured.

Hab. Ohio.

My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.
Cabinet of the Academy of Natural Sciences.

Diam. 1·2, Length 2·1, Breadth 2·6 inches.

Shell somewhat ventricose; substance of the shell somewhat thick; umbones slightly elevated; beaks recurved, seldom decorticated, almost touching, whitish, possessing several concentric undulations, which are lost along the umbonial slope, which is carinate; a small curved elevated line passes from the point of the beaks to the margin above the posterior margin; ligament rather large passing from the points of the beaks; dorsal margin oblique; posterior dorsal margin carinate and slightly emarginate; posterior margin angular; posterior basal margin very slightly curved; basal, anterior and anterior dorsal and basal margins rounded; epidermis colour of rust, sometimes salmon yellow, slightly wrinkled and showing the marks of growth; rays in young specimens perceptible; cardinal tooth sulcate, broad and not elevated, often single in both valves; the tooth in the left valve closing in a cavity which sinks almost into the cavity of the beaks of the right valve; lateral teeth rather thick, elevated, straight, generally double in both valves; in the left valve the upper division is less elevated and shorter; anterior and posterior cicatrices both distinct; the smaller posterior cicatrix is situated against the side of the lamellar tooth, near its termination; the anterior adductor muscle makes a cicatrix also against the end of the cardinal tooth; dorsal cicatrices under the cardinal tooth perceptible; cavity of the beaks deep and rounded; nacre always more or less salmon colour; slightly iridescent at posterior margin; whitish on the margin near the adductor muscles.

Remarks.—This is a very distinct species. In its general form it approaches nearest to the *securis*, which, however, is always white in the nacre, and peculiarly rayed. It is peculiar in its reddish brown epidermis, which colour is caused by the salmon nacre showing through it. The character of the cardinal tooth is very peculiar, having a tendency to be single in both valves, while the lamellar tooth is quite equally disposed to be double. All the specimens which I have seen are salmon colour in the nacre. If this should prove universally so, it is the only species which we know to be constantly of that colour.

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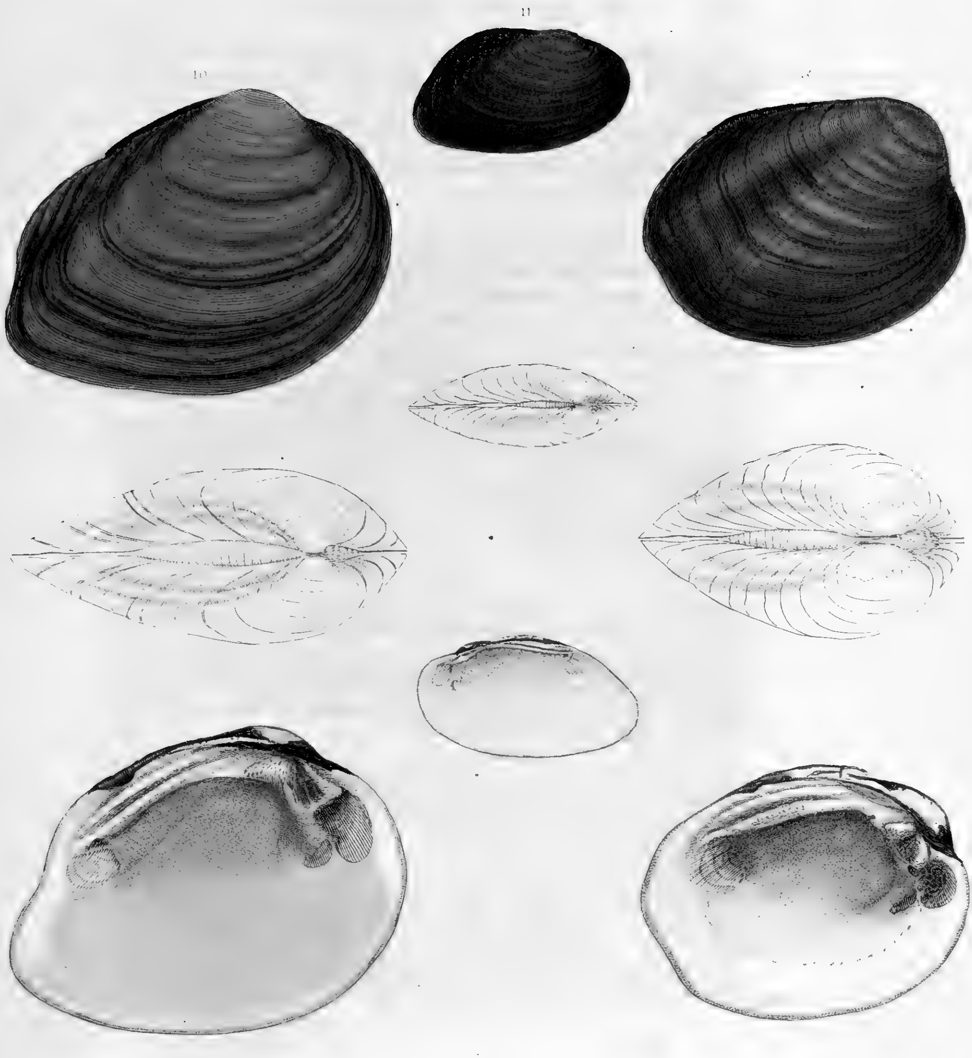
3. Unio Heterodon. Plate VIII. fig. 11.

Testâ rhomboido-ovatâ, inæquilaterali, ventricosâ; valvulis tenuibus; dentibus cardinalibus compressis, latis; dentibus lateralibus sub-curvatis, dente laterali valvulæ dextræ, duplici; natibus prominentibus; ligamento sub-brevi; margaritâ albâ.

Shell rhomboidal-ovate, inequilateral, ventricose; valves thin; cardinal teeth compressed, wide; lateral teeth slightly curved, the *double tooth in the right valve*; beaks prominent; ligament rather short; nacre white.

Hab. Schuylkill and Derby Creek, Pa.

My Cabinet.
Cabinet of Mr Mason.
Cabinet of Prof. Vanuxem.
Cabinet of Dr Griffith.



Unio rubiginosus. *Unio heterodon.* 10, *Unio sulcatus*

Cabinet of the Academy of Natural Sciences.
Cabinet of Mr Hyde.
Cabinet of Mr Phillips.
Cabinet of Mr Conrad.

Diam. ·5, Length ·9, Breadth 1·5 inches.

Shell rhomboidal-ovate, inequilateral, ventricose; substance of the shell thin; beaks prominent, subcarinate posteriorly, eroded, undulated; ligament rather short; epidermis greenish brown, with oblique obscure rays, wrinkled; dorsal margin rectilinear; posterior dorsal margin obtusely angular; posterior margin acutely angular; basal margin slightly curved; anterior, anterior basal and dorsal margins rounded; cardinal tooth in left valve compressed, wide, reaching beyond the cavity of the beaks, double cleft; in right valve one elevated recurved tooth, which clasps the side of the opposing one; lateral tooth curved, short in left valve, and long in the right, *in which it is double;* anterior cicatrices confluent, as are also the posterior; dorsal cicatrices situated on the under part of the cardinal tooth, scarcely perceptible; cavity of the beaks large; nacre white.

Remarks.—This remarkable species was first observed by Mr Mason and Mr Hyde. To the kindness of the former I am indebted for the use of the fine large specimen figured. It is very curious in the whole apparatus of the hinge, the teeth of which resemble in some measure the *Symphynota compressa*, herein described. From the anterior end of the cardinal tooth to the posterior end of the lateral, the distance is the same in both valves, but in the left valve the cardinal tooth is longest, while in the right valve the lateral tooth is longest. The peculiar character of this shell is in the *double* lateral tooth being in the right valve, in which it differs from all the species yet described. It most resembles in general form the *Alasmodonta** *marginata* of

* Mr Say published his description of the genus *Alasmodonta* in the Journal of the Academy of Natural Sciences of Philadelphia, 1818, without knowing, it is to

Say; and some of the younger and more ventricose specimens assume the appearance of the *U. triangularis.*

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4. Unio Sulcatus. Plate VIII. fig. 12.

Testâ sub-ellipticâ, inæquilaterali, ventricosâ, sub-emarginatâ; valvulis crassis; natibus fere terminalibus; dentibus cardinalibus lateralibusque magnis, et duplicibus in valvulis ambabus; margaritâ purpureâ.

Shell sub-elliptical, inequilateral, ventricose, slightly emarginate; valves thick; beaks nearly terminal; cardinal and lateral teeth large, and double in both valves; nacre purple.

Hab. Ohio. T. G. Lea.

My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.
Cabinet of P. H. Nicklin.
Cabinet of the Academy of Natural Sciences.

Diam. 1·3, Length 1·7. Breadth 2·3 inches.

Shell very thick, ventricose, inequilateral, obliquely longitudinal; margin sub-elliptical, with an emargination of posterior basal margin, caused by a broad furrow running from the beaks to this part of the margin; substance of the shell thick and ponderous; beaks thick and projecting beyond the margin, nearly terminal, decorticated; ligament partly concealed by the beaks; epidermis olive-brown, wrinkled, with numerous fine hair like lines, which are slightly undulated, passing from the beaks to the margin; these lines are obsolete in the anterior part of the shell, and crowded in the furrow, over the umbonial slope they are proximate; cardinal tooth elevated, conico-triangular, that in left valve deeply divided; lateral tooth long, thick, and slightly curved, direction nearly

be presumed, that the *Mya margaritifera* of Linnæus was in 1817 erected into a new genus by Schumacher, under the name of *Margaritana.* If the absence of the lateral tooth be sufficient to establish the genus, we must necessarily call it by the Danish naturalist's name.

same as cardinal tooth; posterior cicatrices distinct, the smaller one being placed immediately over the large one, and against the lateral tooth; anterior cicatrices distinct; dorsal cicatrices situated on the under part of the cardinal tooth, very perceptible; cavity of the beaks small; nacre flesh-red, varying from this to nearly white; iridescent in the posterior margin.

Remarks.—This is variety *a* of *U. ellipsis*, described in a former paper, and approaches it closely. Having seen several specimens since that description was made, my doubts have been satisfied, and I now consider it a new species. It differs from the *ellipsis* in having the furrow, in being generally covered with fine hair-like rays, and in being always more or less flesh-red inside. I have two specimens of this species which present a singular formation of the posterior basal margin, which is dentate, the points interlocking and almost hooked. The elevation anterior to the furrow commences to swell one-third of the distance from the margin to the beaks, increases as it approaches the margin, and assumes this dentation, which being successive as the shell increases displays laminæ of these dentations in the epidermis. In the interior this part of the shell has the appearance of having been gouged out. It is exceedingly curious, being the only specimen of fluviatile shells I have seen with a margin approaching to a dentate appearance.

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5. Unio Planulatus. Plate IX. fig. 13.

Testâ inæquilaterali, ovato-ellipticâ, transversâ; complanatâ per umbones à natibus usque ad marginem inferiorem, maculis quadratis radiatim pictâ; natibus prominulis; dente cardinali parvo, laterali magno, crasso, curvato; margaritâ sub-cæruleo-albâ.

Shell inequilateral, ovate-elliptical, transverse, flattened across the umbones from the beaks to the basal margin, marked with square spots in form of rays; valves thick; beaks slightly prominent; cardinal tooth small; lateral tooth large, thick and curved; nacre bluish white.

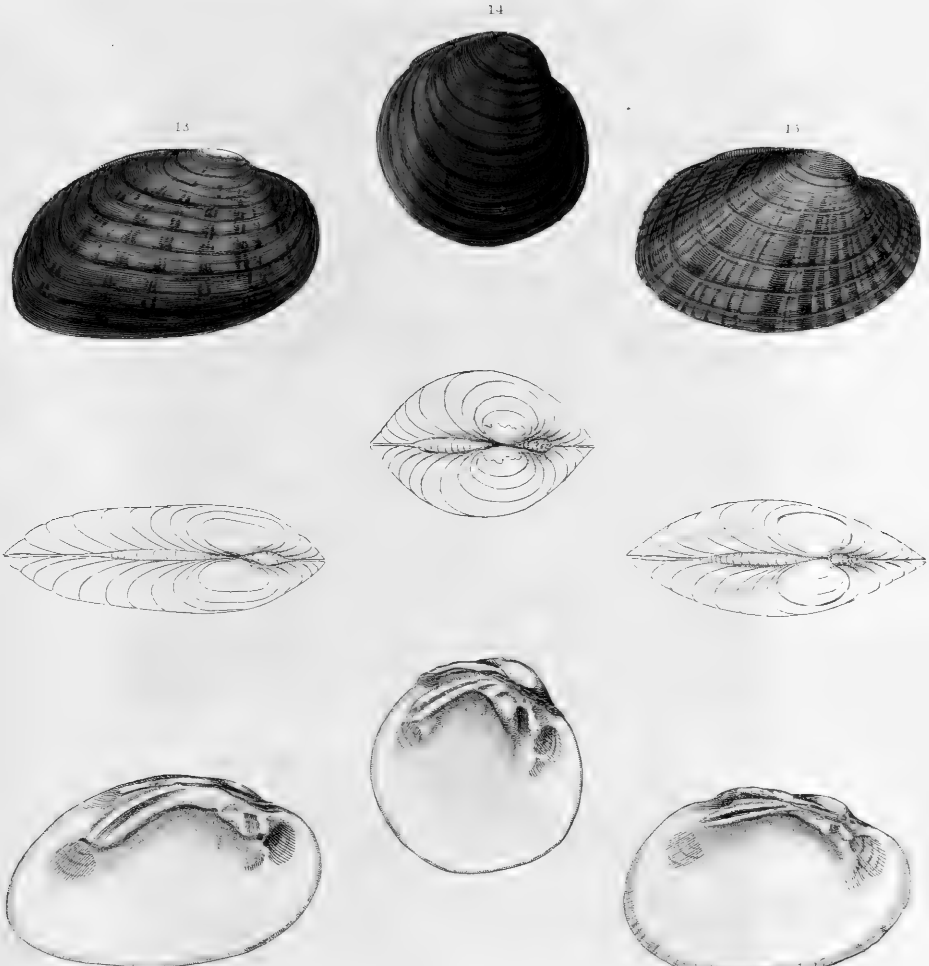
Hab. Ohio. T. G. Lea.

My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.
Cabinet of P. H. Nicklin.
Cabinet of the Academy of Natural Sciences.

Diam. ·8, Length 1·3, Breadth 2·2 inches.

Shell ovate-elliptical, remarkably flattened over the umbones from the beak to the basal margin, which frequently causes the greatest diameter to be near to the anterior margin; substance of the shell thick; beaks slightly prominent and decorticated; ligament deeply seated, scarcely appearing above the margin of the shell; epidermis wrinkled, yellowish brown, with transversely interrupted rays passing from the beaks in a slight curve to the margin along the umbonial slope; these rays are hair like, undulated, and interrupted; cardinal teeth very small and lobed; lateral tooth remarkably thick and situated on a large massive plate; curve very slight and directed much over the cardinal tooth, somewhat rough, upper division smaller than the lower; anterior and posterior cicatrices both distinct; the smaller posterior cicatrix is situated against the end of the plate at the point of the division of the tooth; dorsal cicatrices situated on the under part of the cardinal tooth, perceptible; cavity of the shell very small and irregularly waved; an indistinct depressed line may always be seen to pass from the great posterior cicatrix along the base of the lateral tooth into the cavity of the beaks; nacre white.

Remarks.—This shell is peculiar in the massive plate on which is situated its short and thick lateral tooth, as well as in the very small size of its cardinal tooth. It has scarcely any cavity under the beaks, the shell being very thick. Its epidermal rays, in perfect specimens, are very unusual to this genus; in old specimens they are almost or quite obsolete. It is remarkable also in its flat umbones. It resembles most in form the *gibbosus* of Barnes, but is less rostrated and more



planulatus. | Unio circulus. | Unio multiradiatus

thick. The *gibbosus* is seldom if ever perfectly white; all the specimens I have seen of this are perfectly so.

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6. Unio Circulus. Plate IX. fig. 14.

Testâ circulari, ventricosâ, sub-æquilaterali; valvulis crassis; natibus prominulis; dentibus cardinalibus lateralibusque magnis; ligamento brevi crassoque; margaritâ albâ et iridescente.

Shell circular, ventricose, nearly equilateral; valves thick; beaks slightly elevated; cardinal and lateral teeth large; ligament, short and thick; nacre pearly white and iridescent.

Hab. { Ohio at Cincinnati. T. G. Lea.
Monongahela at Pittsburg. T. Bakewell.
Tennessee at Nashville. Prof. Vanuxem. }

My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.
Cabinet of P. H. Nicklin.
Cabinet of Dr Griffith.
Cabinet of W. Hyde.
Cabinet of W. Mason.
Cabinet of J. Phillips.
Cabinet of the Academy of Natural Sciences.
Cabinet of Peale's Museum.
&c.

Unio rotundata? Lamarck.

Diam. 1, Length 1·5, Breadth 1·5 inches.

Shell round; posterior basal margin sometimes very slightly emarginate, very ventricose, transversely wrinkled, nearly equilateral; substance of the shell thick; beaks elevated, medial, and somewhat recurved; epidermis finely wrinkled, shining, satin-like, anterior to the umbonial slope dark brown, posterior light yellow brown; cardinal teeth oblique, thick, and disposed to be treble in both valves; lateral teeth short and thick, disposed to be double in right valve as well as left;

Anterior cicatrices distinct; posterior cicatrices also distinct; the smaller one being placed against the termination of the lateral tooth; dorsal cicatrices situated on the under part of the cardinal tooth, very perceptible; cavity of the beaks deep and sub-angular; nacre white, pearly, and iridescent, rarely tinted with rose in the centre.

Remarks.—This beautiful little shell is generally an inch long, rarely two. It is common in our cabinets, and has been considered the "*rotundata*" of Lamarck. I am induced, however, to think it different from our shell, as the *circulus* never possesses the fold mentioned in that eminent conchologist's very short description. The two colours disposed in so peculiar a manner in the epidermis are not mentioned by him. It differs also greatly in size. I have seen some hundreds, the largest of which was two inches in breadth. The "*rotundata*" is 78 millimetres; and its habitat is unknown.

The margin of the *circulus* is more perfectly round than any other species; it is sometimes disposed to be subangular posteriorly. The division of the colour on the umbonial slope is very peculiar. When the posterior slope is looked on, this view of the shell is heart shaped, and the dark brown colour is seen entirely to surround the light yellow brown. The epidermis is more satin-like than any other species, and the teeth are peculiarly disposed to be double. In form it approaches the "*torsa*" more closely than any other species.

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7. Unio Multi-radiatus. Plate IX. fig. 15.

Testâ ellipticâ, inæquilaterali, ventricosâ, multi-radiatâ; valvulis tenuibus; natibus prominulis; dentibus cardinalibus erectis, et in valvulis ambabus duplicibus; lateralibus lamelliformibus et abruptis; margaritâ cæruleo-albâ.

Shell elliptical, inequilateral, ventricose, much rayed; valves thin; beaks rather prominent; cardinal teeth erect and double in both valves; lateral teeth lamelliform and abrupt; nacre bluish white.

Hab. Ohio. T. G. Lea.
My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.

Diam. ·8, Length 1.3, Breadth 2 inches.

Shell elliptical, inequilateral, ventricose; substance of the shell thin, the rays being very visible through the nacre; beaks prominent and slightly undulated; epidermis bright olive yellow, with numerous green rays passing from the beaks to every part of the margin; slightly wrinkled, smooth and glossy; cardinal tooth double in both valves and deeply cleft; lateral tooth lamelliform, nearly straight, higher near the termination, termination abrupt; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices situated on the under part of the cardinal tooth, and within the margin of the cavity of the beaks; cavity of the beaks large and rounded; nacre pearly white and iridescent, thin, showing the rays very distinctly through it, and presenting a wide margin.

Remarks.—This beautiful shell resembles most the young *cariosus* of the Ohio and other western waters. It differs, however, in being much less ponderous, possessing more minute rays, being rather more ventricose, having more elevated teeth and more prominent beaks.

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8. Unio Occidens. Plate X. fig. 16.

Testâ sub-ellipticâ, inæquilaterali, transversâ, ventricosâ; valvulis crassis; natibus sub-undulatis, raro decorticatis; ligamento sub-brevi crassoque; dentibus elevatis; margaritâ albâ.

Shell inequilateral, sub-elliptical, transverse, ventricose; valves thick; beaks slightly undulated, rarely decorticated; ligament rather short and thick; teeth elevated; nacre white.

Hab. Ohio. T. G. Lea.
My Cabinet.

Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.
Cabinet of P. H. Nicklin.
Cabinet of the Academy of Natural Sciences.
Cabinet of Peale's Museum.

Diam. 1·6, Length 2·3, Breadth 3·4 inches.

Shell ovate, inequilateral, sub-elliptical, transverse, very ventricose; substance of the shell somewhat thick; beaks large, prominent, rounded, approaching, slightly undulated, rarely decorticated; ligament short and thick; epidermis slightly wrinkled, shining, olive yellow, with green rays passing obliquely from the beaks to the margin, most numerous on the posterior slope; cardinal teeth double and very prominent in both valves; in the left valve the cleft is deep and both prongs rake much, the outer most elevated; in the right valve the cleft is also deep, and the inner prong is broad, flat, curved, and most elevated; lateral teeth short and very lamelliform, the termination declining rather suddenly; anterior cicatrices generally distinct; posterior cicatrices confluent; dorsal cicatrices very perceptible, the line commencing with quite a large one on the under side of the callus between the lateral and cardinal teeth, and terminating at the outer part of the base of the cardinal tooth; marginal cicatrix very perceptible; cavity of the beaks deep, large and rounded; nacre milk white, rarely iridescent.

Remarks.—The specimen figured is the finest I have ever seen of this species, and, taking it altogether, perhaps of any other of the genus. The rays are very remarkably fine, and the nacre is purer and whiter than the finest porcelain. It is very frequently, however, found with few or no rays, and the nacre, though milk-white and pure generally, is not always so. The double, deeply cleft, cardinal tooth of both valves, and the raking position of that of the left valve are peculiar to the species possessing this general form, which includes the *ovatus* and *ventricosus*. It seems to form the link between these two. It differs from the *ovatus* in not possessing the flat

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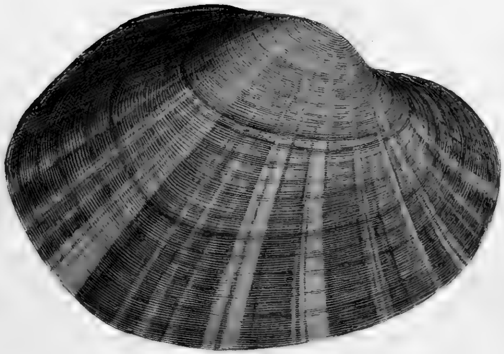

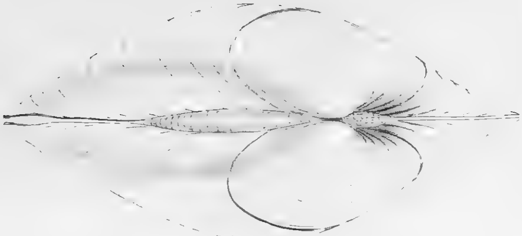

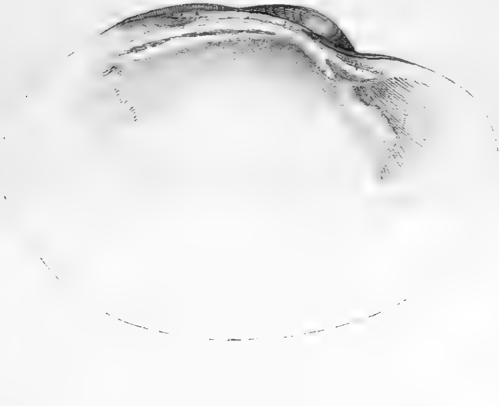

Unio occidens.

Drawn & Eng.d by J. Drayton

posterior slope, and from the *ventricosus* in not being globose over the umbones; and of course is much less in diameter. The quite large impression of the mantle under the callus, between the lateral and cardinal teeth, is very remarkable in these three species.

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9. Unio Securis. Plate XI. fig. 17.

Testâ subtriangulari, inæquilaterali, per umbones valde complanatâ; valvulis crassis; natibus elevatis, recurvatis, compressissimisque; dente cardinali magno, laterali crasso; ligamento breviusculo, crassoque; margaritâ albâ et iridescente.

Shell sub-triangular, inequilateral, flattened over the umbones; valves thick; beaks elevated, recurved, much compressed; cardinal tooth large; lateral tooth thick; ligament rather short and thick; nacre pearly white and iridescent.

Hab. Ohio. T. G. Lea.

My Cabinet.

Cabinet of T. G. Lea.

Cabinet of Prof. Vanuxem.

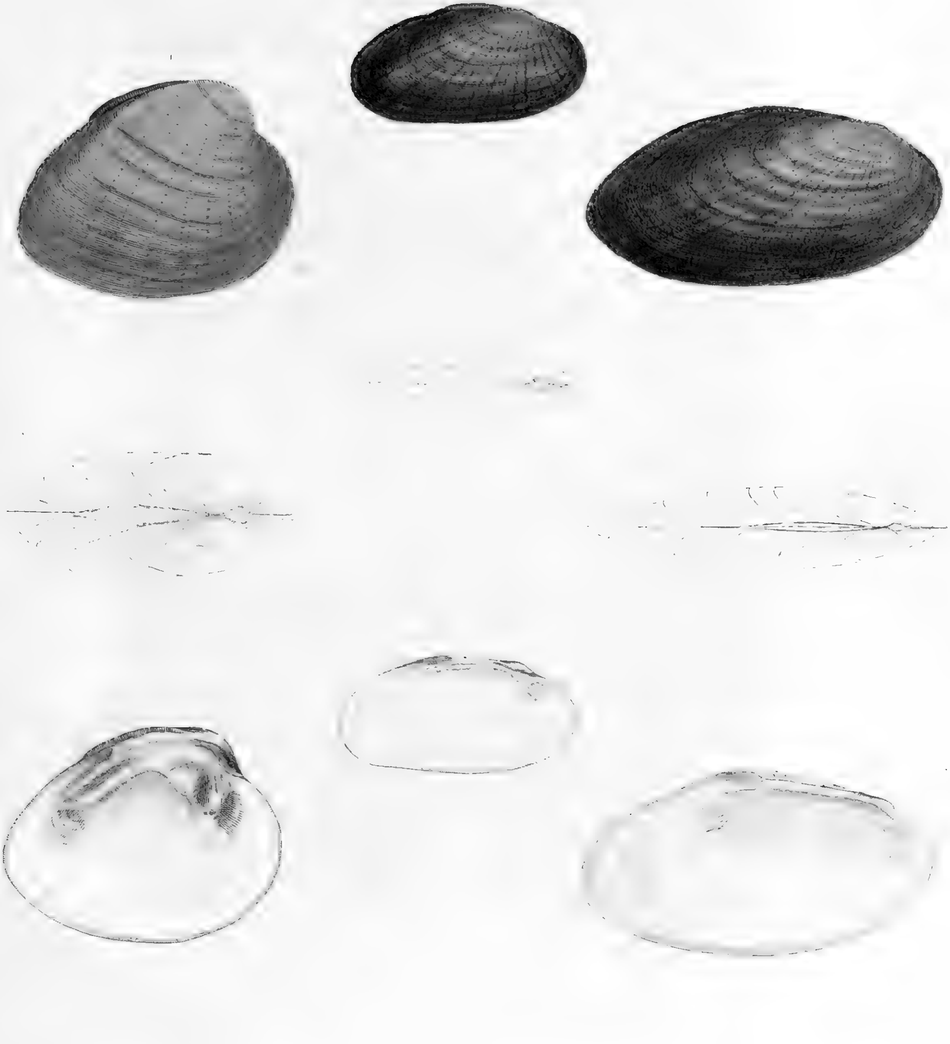
Cabinet of the Academy of Natural Sciences.

Unio depressa of Rafinesque.

Diam. ·9, Length 1·5, Breadth 1·9 inches.

Shell sub-triangular, transversely wrinkled, inequilateral, much flattened over the umbones; substance of the shell thick, often ponderous; beaks elevated, much compressed, recurved; dorsal margin angular; posterior dorsal margin oblique; posterior margin angular; basal and posterior basal margin curved; anterior and anterior basal and dorsal margins round; posterior slope flattened, this view presents the shell as a long ellipsis; epidermis olive-yellow passing into olive-brown, shining and transversely wrinkled; rays formed by small spots, alternately darker and lighter than the general colour of the epidermis, which cause the rays to look like a minute chain, these rays are from one to two eighths of an inch apart, and extend over the whole disk, the spaces between are supplied with numerous hair-like lines, the whole passing in a curve from the beak to the margin; cardinal tooth large, irregularly cleft and sulcated; lateral tooth rather short and thick, in the right valve disposed to be double; anterior cicatrices distinct; posterior cicatrices also distinct, the small one being placed against the termination of the lateral tooth; dorsal cicatrices situated on the under side of the cardinal tooth; cavity of the beaks shallow and rounded; cavity of the disk small; nacre pearly white and iridescent.

Remarks.—Mr Rafinesque first observed this singular and interesting species. He found a single specimen near Evamville, Indiana, and described it under the name of *U. depressa*, which name being preoccupied by Lamarck, I have considered it incumbent on me to give it a new name. Many specimens have come under my inspection, and the shell being a very remarkable one, I am induced, in consequence of Mr Rafinesque's short description and imperfect figure, to give a more full description and a correct figure. It is altogether peculiar in its rays and its very compressed beaks; no species is so flat over the umbones, and no other species presents, when the posterior slope is held towards the observer, a long ellipsis, the widest part of which is about the centre. In consequence of the beaks being so very much compressed, the junior, when not more than an inch long, is *exceedingly* flat, and the cavity proportionally small. When the shell increases beyond this it seems to become suddenly thick, and its form becomes more rounded towards the margins, consequently the adult is very different in form from the junior, which might easily be mistaken for another species. It is more generally gaping at the anterior margin than the other species. It assimilates closely to the *planulatus* (described in this paper), but differs in the rays, the much compressed beaks, and being more hatchet shape. In the last character it resembles somewhat the *rubiginosus* described in this paper. It sometimes occurs twice the size of the one represented here.



Symphynota tenu...

10. Unio Iris. Plate XI. fig. 18.

Testâ angusto-ellipticâ, inæquilaterali, sub-ventricosâ; valvulis tenuibus; natibus prominulis; dente cardinali in valvulâ sinistrâ, duplici, in dextrâ sub-bifido, parvo, erecto; dentibus lateralibus longis tenuibusque; margaritâ sub-cœruleo-albâ.

Shell narrow-elliptical, inequilateral, slightly ventricose; valves thin, beaks slightly prominent; cardinal teeth double in the left valve, subbifid in the right, small, erect; lateral teeth long and thin; nacre bluish white.

Hab. Ohio. T. G. Lea.

My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.

Diam. ·5, Length ·8, Breadth 1·6 inches.

Shell long-elliptical, inequilateral, slightly ventricose; substance of the shell thin, showing the rays through it, rather more dense before than behind; beaks slightly prominent, approaching, crowned with double concentric undulations when they are not decorticated; ligament rather long and thin; epidermis yellowish green, transversely wrinkled, marked with many oblique diverging rays passing from the beaks to the margin; cardinal teeth double in both valves, small, erect, and sharp; lateral teeth long, bladed, slightly curved and situated on the edge of the margin in contact with the ligament; anterior cicatrices distinct; posterior cicatrices confluent and scarcely perceptible; dorsal cicatrices within the cavity of the beaks, the largest on the under part of the callus; nacre very thin, milk white anteriorly, bluish white and iridescent posteriorly.

Remarks.—This species most resembles the *calceolus*. It differs, however, entirely in the teeth, which are distinct and well defined. The *calceolus* approaches closely to the genus *Alasmodonta* of Say. This is less ventricose and possesses more rays.

11. Unio Zig-zag. Plate XII. fig. 19.

Testâ ovatâ, inæquilaterali, ventricosâ; valvulis sub-crassis; dentibus cardinalibus magnis, erectis; lateralibus curvatis; natibus prominulis; radiis ex lineis angulatis compositis; ligamento brevi crassoque; margaritâ albâ.

Shell ovate, inequilateral, ventricose; valves rather thick; cardinal teeth large, erect; lateral teeth curved; beaks rather prominent; rays composed of zig-zag lines; ligament short and thick; nacre pearly white.

Hab. Ohio. T. G. Lea.

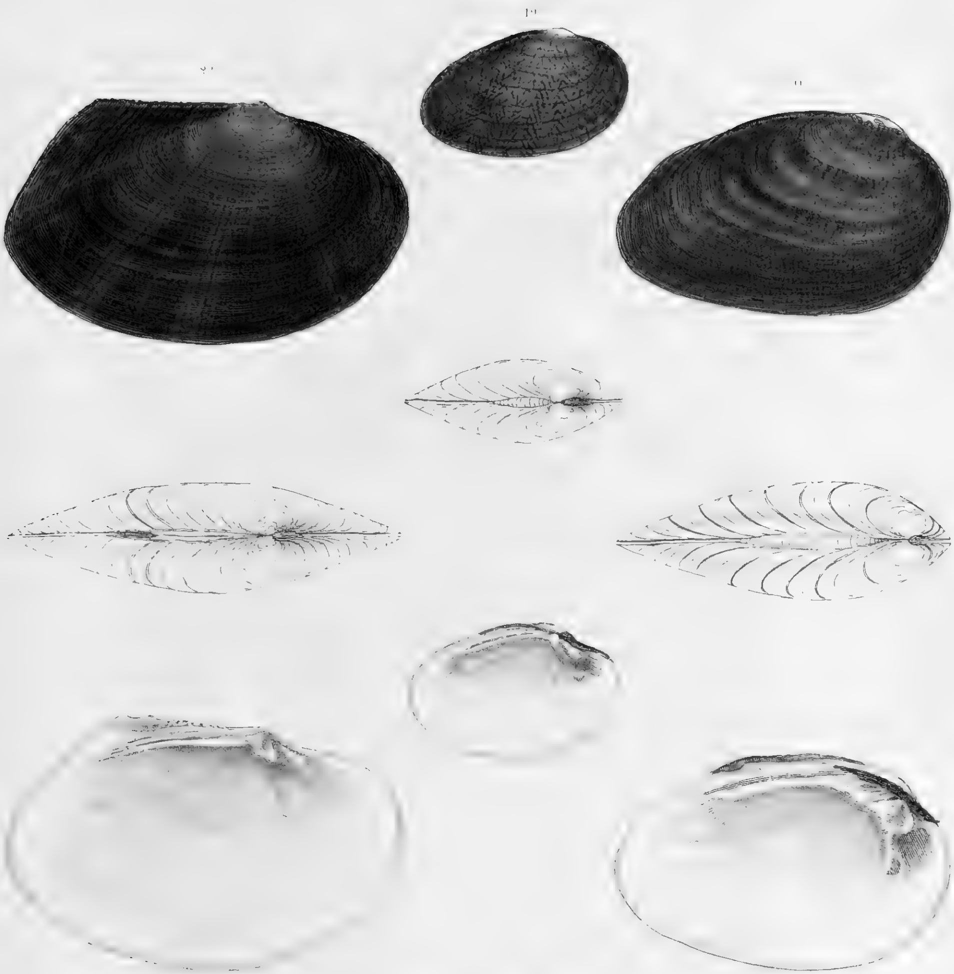
My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.
Cabinet of P. H. Nicklin.
Cabinet of the Academy of Natural Sciences.
Cabinet of Peale's Museum.

Diam. ·6, Length ·9, Breadth 1·5 inches.

Shell ovate, inequilateral, ventricose; substance of the shell thick; beaks rather prominent, subcarinate posteriorly, generally eroded; ligament short and thick; epidermis yellow in ground, but traversed by oblique green rays, which give it sometimes a dark hue; these rays pass from the beaks to the margin over the whole disk, and are formed by zig-zag lines, which in some specimens are joined so closely as to become confluent; on the posterior slope are irregular lines converging below the ligament; cardinal teeth large, deeply divided in the left valve; lateral teeth slightly curved; anterior cicatrices distinct, as are also the posterior, the smaller of which is placed against the side of the lateral tooth at its termination; dorsal cicatrices situated along the base of the cardinal tooth within the cavity of the beaks; cavity of the beaks shallow; nacre pearly white and iridescent.

Remarks.—This beautiful little shell is about the size of Barnes's *parvus*. It is however entirely distinct from it. It is much heavier, more ovate, and radiated; has no concentric undulations at the beaks like the *parvus*, which character Mr

PL. XII vol 3



Barnes does not mention, and is yellowish, not brownish. This and the *donaciformis* are all I know which possess the zig-zag markings, and they most resemble each other.

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12. Unio Patulus. Plate XII. fig. 20.

Testâ ovatâ, compressâ, cuneiformi, inæquilaterali, obliquâ, transversâ; umbonibus compressis; valvulis sub-crassis; natibus sub-terminalibus; dente cardinali parvo; laterali longo et sub-curvato; margaritâ albâ.

Shell ovate, compressed, wedge-shaped, inequilateral, oblique, transverse, compressed on the umbones; valves rather thick; beaks nearly terminal; cardinal tooth small; lateral tooth long and slightly curved; nacre pearly white.

Hab. Ohio. T. G. Lea.
My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.

Diam. ·8, Length 1·4, Breadth 2·3 inches.

Shell compressed, wedge-shaped, ovate, broad and flat; substance of the shell thick anteriorly and thin posteriorly, showing the rays through it; beaks nearly terminal, slightly prominent, approaching, and when perfect possessing slight concentric undulations, generally decorticated; ligament not large, passing from the point of the beaks; epidermis yellowish brown, transversely wrinkled, marked with more or less broad interrupted rays, apparently formed of fasciculi of hair-like lines; cardinal tooth short, and but slightly elevated, in the left valve double and deeply cleft, in the right valve emerging from a pit; lateral tooth long and slightly curved; posterior cicatrices as well as anterior cicatrices distinct; the smaller posterior cicatrix situated against the lateral tooth at its termination; dorsal cicatrices on the under part of the cardinal tooth; cavity of the beaks not deep but rounded; nacre thick and milk white anteriorly, thin and iridescent posteriorly.

Remarks.—This species approaches closely to the *scalenia* of Rafinesque; its rays are of the same description, and the general form is the same. It is, however, more flattened, has much less elevated beaks, and its diameter is always much less. Its beaks are generally but little decorticated, and not recurved; the *scalenia* is generally much recurved and decorticated.

GENUS SYMPHYNOTA.

Testâ fluviatili, bivalvi; valvulis superné connatis.

Shell fluviatile, bivalve; valves connate at the dorsal margin.

Animal same as that of Unio.

Remarks.—Objections will most likely be made to the introduction of a new genus into a family acknowledged already to be in great confusion, and presenting many and various difficulties. The formation of the genus *Symphynota*, it is hoped, will rather be conducive to a diminution of that difficulty, by a division which all must acknowledge to be as natural as any of those of the family. The distinctive characteristic of this genus is the testaceous connection of the two valves of the shell above the hinge. I therefore remove from the existing genera all the connate shells without regard to the forms of their teeth, believing, that should this family be hereafter remodelled, it will present only two natural genera; one having a testaceous connection of the valves, the other dispossessed of it. The difficulties attending the adopted genera of the *Naïades*, viz. *Unio* of Bruguière, *Hyria*, *Anadonta*, *Iridina*, *Castalia** of Lamarck, *Dipsas* of Leach, and

* This genus was placed by Lamarck in the family *Trigonæa*, certainly with no propriety. It has been placed by Sowerby and Latreille among the *Naïades*,

Alasmodonta of Say, have been mentioned by two eminent English conchologists, W. Swainson and G. B. Sowerby, as well as in America by P. H. Nicklin. Mr Sowerby (Zool. Journ. Vol. I. p. 55.) has reunited them under the name of *Unio*, of which he makes two great divisions: 1. Without teeth. 2. With teeth; and these are each subdivided into "winged" and "not winged;" which are again divided into the various forms of teeth, or the "hinge line." The evident objection to this arrangement is the difficulty of deciding upon the passage from the "not winged" to the "winged." Thus we do not find the *Anodonta trapezialis* and *Anodonta glauca*, which Lamarck describes as "*compresso-alatâ*," mentioned among the "winged," while we have "*Anodon alatus* of Swainson and Lamarck," which is not described in the "Hist. Nat. des Animaux sans Vertebres*."

It is evident that the apparatus for depositing the calcareous and epidermal matter on the elevated and connected wing must be different from that of the inhabitant of free valves, to which it has been denied by nature.

Lamarck and Barnes both mention in their description of the *U. alatus* of Say, that M. Le Sueur thought this shell should constitute a new genus. Since that time so many connate shells have come to my notice, that I feel satisfied the science of conchology will be subserved by the institution of this natural genus, which will embrace, in all probability, several others, viz. *Hyria* of Lamarck, *Dipsas* of Leach, and *Cristaria*, *Prisodon*, and *Paxyodon* of Schumacher, all of which, when they shall be found perfect, will most probably turn out to be connate shells. Lamarck suspected his *Hyria* to be connate, like the *U. alatus;* for when describing that species, he says, "Nos *Hyries* auraient-elles une pareille réunion

and here must be considered as a species of Unio, and not a genus. The observant M. De Blainville has placed *Castalia* and *Hyria* among the *Uniones*, and *Iridina* and *Dipsas* among the *Anadontæ*. *Castalia ambigua* is undoubtedly a fluviatile shell, and approaches most closely to the *U. triangularis*. The teeth are those of the Unio, and it differs only in its longitudinal furrows from the general characters of the Unio.

* Say describes his *An. gibbosa* as being alated.

à la carène de leur corselet?" Indeed the fact can scarcely be doubted.

SPECIES.

1. Symphynota Lævissima. Plate XIII. fig. 23.

Testâ ovato-triangulari, inæquilaterali, transversim rugosâ, sub-ventricosâ; valvulis tenuissimis, superne bi-alatis, ante et post nates connatisque; dentibus cardinalibus et lateralibus lineam curvatam facientibus; natibus prominulis; ligamento celato; margaritâ purpureâ et iridescente.

Shell triangular-ovate, inequilateral, transversely wrinkled, sub-ventricose; valves very thin, elevated into two wings, connate anteriorly and posteriorly to the beaks; cardinal and lateral teeth form a curve line; beaks scarcely prominent; ligament concealed; nacre purple and iridescent.

Hab. Ohio. T. G. Lea.

My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.
Cabinet of P. H. Nicklin.

Diam. 1·4 inch. Length from beaks to base, 2·4 inches.
Breadth 4·5 inches.
Length from the top of the wing to base, 3·1 inches.

Shell sub-triangular-ovate, inequilateral, sub-ventricose, transversely and very finely wrinkled, shining; substance of the shell thin, but compact; valves elevated into two wings, neither of them very high, the posterior one larger than the anterior, both connate; beaks scarcely prominent, termination pointed, and when not decorticated exhibit two or three very minute elevations, almost requiring a microscope to discover them; the purple nacre shows through the epidermis here, and gives the tips that colour; ligament concealed in the wing; sinus subquadrate; epidermis thin and purple brown; young specimens sometimes possess obscure brown rays; cardinal tooth lamelliform, *single in the left valve and disposed to*

Symphynota lævissima

be double in the right; lateral tooth lamelliform and double in the left valve only, the two teeth form one continuous curve line, somewhat abrupt at both terminations, more so at the anterior one; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices very perceptible. Cavity of the beaks wide and very shallow; nacre purple and iridescent.

Remarks.—This beautiful shell most resembles the *Symphynota alata* in its general form, but its posterior wing is less elevated. The colour of its nacre is the same. It differs entirely, however, in the cardinal tooth, and in possessing the anterior connate wing. A metallic sound is produced by dropping one valve into the other, which is very remarkable, and is caused by the density of the calcareous matter of the nacre, which is very thin. The epidermis is exceedingly smooth and glossy.

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2. Symphynota Bi-alata. Plate XIV. fig. 24.

Testâ ovato-triangulari, inæquilaterali, transversim rugosâ, sub-ventricosâ; margine dorsali bi-alatâ; valvulis tenuibus, ante et post nates connatis; natibus et alæ posterioris basi apiceque undulatis; natibus haud prominentibus; dente lamelliformi unico in valvulâ utrâque; ligamento celato; margaritâ tenui et iridescente.

Shell triangular-ovate, inequilateral, transversely wrinkled, sub-ventricose; dorsal margin raised into two wings; valves thin, connate before and behind the beaks; beaks and the base and summit of the posterior wing undulated; beaks not prominent; one lamelliform curved tooth in each valve; ligament concealed; nacre thin, pearly, and iridescent.

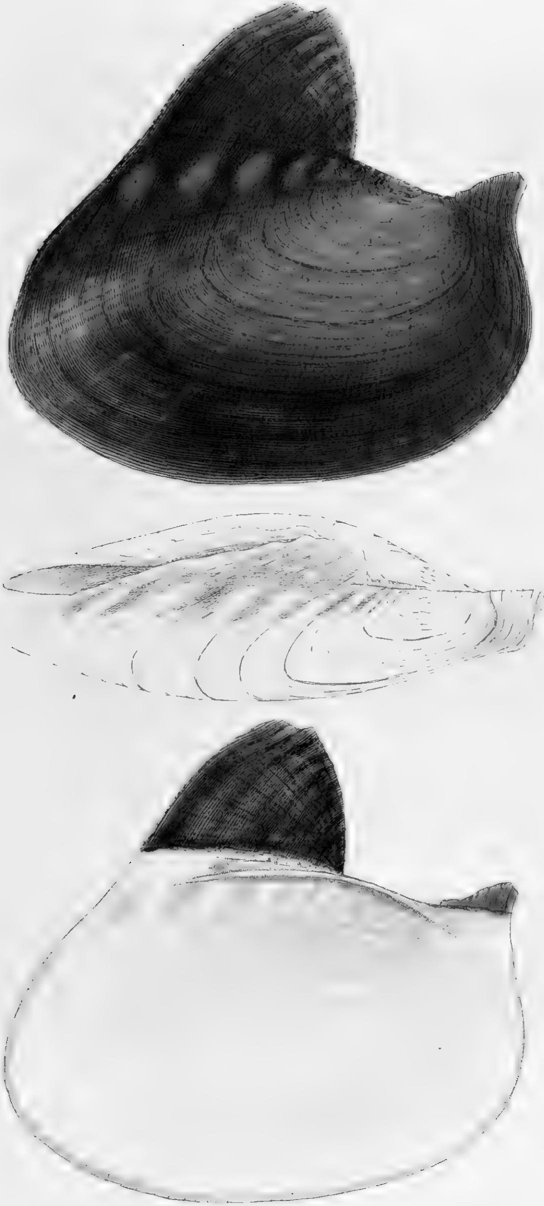
Hab. . . . . fresh waters of the south of Asia? Brought from Canton by Captain Barr.

My Cabinet.
Cabinet of Mr Pierpoint.
Cabinet of Mr Hyde.
Cabinet of Mr Phillips.

Diam. 1 inch. Length from the beaks to the base, 2 inches.
Breadth 3·6 inches.
Length from the top of wing to base, 3·4 inches.

Shell triangular-ovate, inequilateral, subventricose, transversely and finely wrinkled, shining; substance of the shell thin, showing the rays through it; valves elevated into a broad high wing posterior, and a small one, anterior to the beaks, and connate in both; beautifully undulated at the base and top of the posterior wing; undulations of the base commencing at the point of the beaks, pass on the outside of the tooth to the margin in a slightly curved line, each successive wave increasing in size and cutting the wrinkles of the epidermis obliquely; those of the top of the wing, when it is perfect, are about the same in number, but less elevated, and closer together; they cut the wrinkles at about the same angle; beaks not prominent, crowned with about six elliptical concentric undulations; ligament concealed in the wing; sinus formed by the end of the ligament, sub-quadrate; epidermis yellow and purple brown, with green oblique rays, finely wrinkled, smooth and shining; the wrinkles of the anterior wing, as they ascend the wing, are curved anteriorly and continuous over both wings; each valve furnished with a long, curved, lamelliform tooth, very small anteriorly to the beaks, larger and longer posteriorly, pointed at both ends; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices situated in the cavity of the beaks, very perceptible; cavity of the beaks wide and very shallow; nacre thin, pearly, and iridescent, with tints of salmon, white and purple; the undulations very perceptible from the centre of the beaks along the base of the tooth to the posterior dorsal margin.

Remarks.—All the specimens which I have seen of this remarkable species were brought from Canton. The first was received by Mr Hyde about two years since, and then excited much interest with our conchologists. Several specimens more perfect were brought last summer in the "Caledonia;" and from these specimens the description has been



Symphynota bi-alata.

made. That of Mr Hyde is a large, old, and valuable specimen, but has lost some of its important characters. Both wings are destroyed, the beaks much eroded, and the epidermis black and much wrinkled, and the rays obsolete. The remarkable waves at the base of the posterior wing are almost obsolete, and the beauty of the nacre nearly destroyed by being thick and opake; cicatrices very perceptible. In this specimen, and I believe it will occur in all adult individuals, the only remains of the lamelliform tooth are in the termination of it under the ligament, about an inch long; the rest of it is lost in the callus of the dorsal margin. Its dimensions are

Diam. 2·1, Length 5·5, Breadth 7·1 inches.

In general form and character this species exteriorly resembles most the *Symphynota alata;* interiorly, except in colour, the *Symphynota lævissima*, herein described; the shape of the lamelliform tooth of which assimilates to it, with the exception of its being double. The teeth in both these species describe nearly the same arc and take the same position. Both species are alated anteriorly and posteriorly to the beaks. The *lævissima* differs in having no undulations, and possessing obsolete rays, double teeth, and purple nacre.

The *Dipsas plicatus* of Leach bears a strong resemblance to this shell. It differs, however, in the wings of the *D. plicatus* not being elevated, almost forming a line with the beaks, in the latter not being connate, and in not being crowned with undulations at the beaks. His description, however, is so short and defective, and the drawing evidently so badly executed, that I cannot determine in what other points it may differ.

Schumacher's *Cristaria tuberculata* bears a strong affinity to this species also, as well in his description as his plate. He describes and figures it, however, as being alated posteriorly, and not anteriorly, and does not mention its being connate. The fact of its possessing a divided lateral tooth, "callus parallelus bifidus," proves that it is not our species.

3. Symphynota Alata.

Testâ ovato-triangulari, transversim rugosâ, sub-compressâ ; valvulis crassiusculis, earum marginibus dorsalibus alatis, et super ligamento connatis ; dente cardinali in valvulis ambabus duplici, laterali in sinistrâ tantum duplici, subcurvato; ligamento sub alâ celato; natibus prominulis ; margaritâ purpureâ.

Shell triangular-ovate, transversely wrinkled, rather compressed; valves moderately thick, elevated into a high wing, and connate over the ligament; beaks scarcely prominent; cardinal tooth double in both valves; lateral tooth double in the left valve only, and slightly curved; ligament concealed; nacre purple.

Hab. our western waters.

Unio alatus. Say. Nicholson's Encyclopædia (Am. Ed.) Art. Am. Conch. pl. 4, fig. 2.*

Unio alata. Lamarck.

Unio alatus. Barnes. Silliman's Am. Journ. Vol. VI.

Unio alata. Swainson.

Diam. 2, Length 4·7, Breadth, 6·9 inches.†

Remarks.—In young specimens it appears disposed to be connate anteriorly to the beaks also. The dorsal cicatrices form quite a row across the cavity.

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4. Symphynota Complanata.

Testâ ovato-triangulari, inæquilaterali, transversim rugosâ, compressâ ; valvulis crassis; margine posteriori dorsali alatâ connatâque ; dente unico cardinali in valvulâ utrâque ; plano irregulari calloso sub ligamento ; natibus compressis, sub-prominulis ; ligamento celato ; margaritâ albâ, iridescenti.

Shell triangular-ovate,‡ inequilateral, transversely wrinkled, com-

* This figure was made from an imperfect specimen, the wing being mutilated.

† See Barnes's description.

‡ Mr Barnes says "ovately quadrangular ;" but the shell is evidently more triangular, as his figure displays it. *See Silliman's Am. Journ. Vol. VI. p.* 278.

pressed; valves thick; posterior dorsal margin winged and connate; a large cardinal tooth in each valve; an irregular callous plane under the ligament; beaks compressed and scarcely projecting; ligament concealed; nacre white and iridescent.

Hab. { Fox River. Mr Schoolcraft.
Wisconsan. Captain Douglass.
Ohio. W. Cooper. }

My Cabinet.
Cabinet of Mr Barnes.
Cabinet of Prof. Vanuxem.
Cabinet of the New York Lyceum.
Cabinet of Dr Mitchill.
Cabinet of the Academy of Natural Sciences.

Alasmodonta complanata. Barnes.

Diam. ·9—1·4 inches. Length from beaks to base, 3 inches. Breadth 5 inches.
Length from the top of the wing, 4·3—4·5 inches.*

Shell triangular-ovate, inequilateral, transversely wrinkled, compressed, the largest diameter being nearly 2-3ds of the distance from the beaks to the base; substance of the shell thick; valves elevated into a moderately sized wing over the ligament, and connate; this wing is traversed at right angles to the wrinkles, by obscure undulations reaching to the beaks; beaks much compressed and scarcely projecting, crowned by several double concentric undulations, which terminate in a point; ligament concealed in the wing; sinus subquadrate; epidermis dark brown and irregularly wrinkled; cardinal tooth thick, elevated, sulcated, and diverging from the beaks; a wide, irregular callous plane extends under the ligament; cicatrices in the anterior margin three, and irregular; in the posterior margin two, confluent and scarcely perceptible; dorsal cicatrices very perceptible; cavity of the beaks and disk small; nacre white and iridescent.

Remarks.—This shell, first described by Barnes, is a rare

* See Barnes's description; my specimen is rather more ventricose.

and beautiful species. It is peculiar in its very much compressed beaks, and in its greatest diameter being but a short distance above the basal margin.

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5. Symphynota Compressa. Plate XII. fig. 22.

Testâ transversim elongatâ, inæquilaterali, valde compressâ, ellipticâ; valvulis tenuibus; natibus sub-prominulis, undulatis; dente cardinali prominente; laterali parvo.

Shell transversely elongated, inequilateral, compressed, elliptical; valves thin; beaks scarcely prominent, undulated; cardinal tooth prominent; lateral tooth small.

Hab. { Ohio. T. G. Lea.
Norman's Kill, near Albany. Dr Eights. }

My Cabinet.
Cabinet of Prof. Vanuxem.
Cabinet of Dr Eights.
Cabinet of P. H. Nicklin.
Cabinet of the Academy of Natural Sciences.
Cabinet of the New York Lyceum.

Diam. ·8, Length 1·7, Breadth 2·8 inches.

Shell transverse, much compressed, elliptical; substance of the shell rather thin; beaks slightly elevated, not decorticated, beautifully crowned with small double concentric undulations, points of the beaks almost white; ligament concealed within the valves; dorsal margin rather elevated posteriorly to the beaks; posterior margin sub-angular; posterior basal and basal margins curved; anterior and anterior dorsal and basal margins rounded; epidermis olive-green, slightly wrinkled and glabrous; radiations over the whole disk; cardinal tooth prominent and curved, in the left valve with three protuberances, the posterior the highest, sloping to the end of the lateral tooth, the anterior the lowest; in the right valve one rather large, which closes between the first and second of the left; lateral tooth short and nearly straight, passing from the very point of the beaks, in the right valve lamellar near the termination, and abrupt; in the left acicular, the channel being only large enough to admit of the edge of a penknife; in the right valve the cardinal and lateral teeth are entirely separated by a cavity formed by the tooth of the other valve, this cavity is at the very point of the beak, and therefore the valve has little or no cavity; in the left valve the large recurved tooth forms a beautiful angular cavity; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices situated at the point of the cavity of the beaks; cavity of the shell very shallow; nacre delicate salmon colour towards the beaks, bluish towards the margin.

Remarks.—This is a singular and beautiful shell. Its cardinal and lateral teeth are very remarkable. The first being high in the left valve over the cavity of the beak, while in the right it is there depressed; the latter is short and lamelliform at termination. The beaks are equally remarkable, being finely undulated; the epidermis is so thin and delicate as to give them almost a white appearance. The rays are broader and more full than in any shell I have seen; they diverge in all directions from the point of the beaks to the margin.

The specimen belonging to the cabinet of the New York Lyceum, was kindly sent for my inspection by W. Cooper, a member of that valuable institution. It was given by Dr Eights to Mr Barnes, and by the latter labelled "*U. alasmodontina.*" My description was written some years since, but remained unpublished until I should have an opportunity of examining other specimens.

6. Symphynota Gracilis.

Testâ sub-triangulari-ovatâ, inæquilaterali, transversim rugosâ, sub-compressâ; valvulis tenuibus fragilibusque; margine posteriori dorsali sub-alatâ, connatâque; dente cardinali in valvulâ dextrâ elevato, recurvo; natibus sub-prominulis; ligamento celato; margaritâ violaceo-purpureâ et iridescente.

Shell sub-triangular-ovate, inequilateral, transversely wrinkled, rather compressed; valves thin and fragile; posterior dorsal margin connate, wing but little elevated; cardinal tooth of right valve elevated, recurved; beaks scarcely prominent; ligament concealed; nacre pearly, violet-purple, and iridescent.

Hab. { Ohio. T. G. Lea.
Wisconsan. Mr Schoolcraft. }

My Cabinet.
Cabinet of Mr Barnes.
Cabinet of Prof. Vanuxem.
Cabinet of P. H. Nicklin.
Cabinet of Mr Swainson.
Cabinet of the New York Lyceum.
Cabinet of the Academy of Natural Sciences.

Unio gracilis. Barnes. Silliman's Amer. Journ. Vol. VI. p. 174.
Unio fragilis. Swainson*.
Unio planus. Barnes.

Diam. 1—1·2, Length 2·2—2·5 inches.
Breadth 3·1—4·1 inches†.

Shell sub-triangular-ovate, inequilateral, transversely wrinkled, rather compressed; substance of the shell thin; valves elevated into a small wing over the ligament and connate; beaks slightly prominent, pointed, having two or three minute elevations; ligament concealed in the wing; epidermis yellow-

* I have retained the specific name of Mr Barnes in preference to that of Mr Swainson in the right of priority. Mr B. published in January 1823. Mr S.'s dedication of 3d vol. of his Zool. Illus., in which the *fragilis* is described, is dated Oct. 1823.

† See Barnes's description.

green, finely wrinkled, obscurely radiated and glabrous; marks of growth very perceptible; cardinal tooth of right valve crest-like, recurved, and clasping the side of the opposite one; lateral teeth lamelliform and curved; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices form a line across the cavity of the beaks, and are very perceptible; cavity of the beaks very wide and shallow; nacre pearly, bluish-white, violet-purple and iridescent.

Remarks.—Mr Barnes noticed this as a connate shell. His description of the cardinal tooth does not agree with my specimens, except in the younger ones, in which this tooth is more lamellar. The recurved tooth hooking or clasping the other, when the valves are closed, is very remarkable.

In some specimens the lateral and cardinal teeth form an uninterrupted curve line, when the cardinal tooth is quite lamelliform; in others the latter is small and lobed, age producing much effect on it in this respect.

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7. Symphynota Tenuissima. Plate XI. fig. 21.

Testâ angusto-ellipticâ, inæquilaterali, transversim rugosâ, compressâ; valvulis tenuissimis fragillimisque; margine dorsali connatâ; dente cardinali prominentiâ exiguâ, laterali unico et aciculari in valvulâ utrâque; natibus depressis; ligamento celato; margaritâ cæruleo-albâ et purpureâ, iridescente.

Shell narrow-elliptical, inequilateral, transversely wrinkled, compressed; valves very thin and very fragile; dorsal margin connate; cardinal tooth a small lobe; lateral tooth acicular and single in both valves; beaks depressed; ligament concealed; nacre bluish-white and purple, iridescent.

Hab. Ohio. T. G. Lea.

My Cabinet.
Cabinet of T. G. Lea.
Cabinet of Prof. Vanuxem.
Cabinet of P. H. Nicklin.

Diam. ·6, Length 2·2, Breadth 2·5 inches.

Shell narrow-elliptical, inequilateral, transversely wrinkled, much compressed; substance of the shell very thin; valves connate over the ligament, and not elevated into a wing; beaks scarcely prominent, pointed, nearly terminal; epidermis wrinkled, yellow, with very oblique green rays, which, when apparent, give a greenish hue to the shell; rays more numerous and perceptible along the umbonial slope; marks of growth very perceptible; greatest diameter along the umbonial slope; cardinal tooth of right valve a small lobe closing into a depression of the margin of the left valve; lateral teeth acicular, single in both valves, and nearly or quite direct; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices form a line across the cavity of the beaks, and are very perceptible; cavity of the beaks scarcely apparent; nacre bluish-white, purple about the region of the teeth and the cavity of the beaks.

Remarks.—This interesting species is the most fragile and thin of all the family of the *Naïades* which I have seen. The epidermis seems in some specimens to prevail over the substance of the shell, which is so extremely brittle as almost to be destroyed in our cabinets by its contraction from the effect of the atmosphere. The beaks are so nearly terminal that it somewhat resembles the *modiola* in this respect. It is the nearest approach to the *Anodonta*, having but the rudiments of teeth; and I am much disposed to believe that the "*Anodon purpurascens*" of Swainson is analogous to this shell. He had seen but one perfect specimen sent him by Mr Rafinesque from the "back settlements." I have seen many specimens of the *tenuissima*, all of which have the rudiments of the cardinal and lateral teeth. This shell exhibits to us the necessity of resorting to a more natural definite division of *Naïades* than that of the teeth. The *tenuissima* resembles most the *gracilis*. They differ, however, in the latter being much larger, more ovate, heavier, more ventricose, and not radiate. The teeth of the *gracilis* are well defined, which is not the case with this.

8. Symphynota Ochracea.

Testâ sub-ovatâ, inæquilaterali, transversim rugosâ, inflatâ; valvulis post ligamentum connatis, tenuibus, fragilibus, et sine alâ; dentibus cardinalibus et lateralibus curvam lineam facientibus; natibus prominentibus; ligamento conspicuo; margaritâ cæruleo-albâ et ochraceâ.

Shell sub-ovate, inequilateral, transversely wrinkled, inflated; valves thin and fragile, connate *behind* the ligament, not winged; cardinal and lateral teeth forming a curve line; beaks prominent; ligament visible; nacre bluish-white and ochraceous.

Hab. Schuylkill and Delaware.

My Cabinet.
Cabinet of Mr Say.
Cabinet of Prof. Vanuxem.
Cabinet of Mr Hyde.
Cabinet of the Academy of Natural Sciences.
Cabinet of Dr Griffith.
Cabinet of P. H. Nicklin.
Peale's Museum.

Unio ochraceus. Say. Nicholson's Encyclopædia, Art. Am. Conchol. pl. 2, fig. 8.

Diam. 1·3, Length 1·9, Breadth 2·9 inches.

Shell sub-ovate, inequilateral, transversely wrinkled, inflated; dorsal margin rectilinear; valves thin and fragile, connate *behind* the ligament, not winged; beaks full and prominent, with several concentric undulations; *ligament not concealed;* epidermis glossy, varying from yellow ochre to brown ochre, marked with oblique rays, most abundant behind; cardinal and lateral teeth lamelliform, forming a curve line, in the *right* valve the cardinal tooth is double, in the *left* single; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices form a row across the cavity of the beaks, very perceptible; cavity of the beaks large; nacre bluish-white and ochraceous; along the anterior basal margin thicker and tinged with red; posterior margin iridescent.

Remarks.—This is a beautiful shell. It is remarkable in being connate behind the ligament; this connection, however, is very small, and only perceptible in perfect specimens; in the old ones it is separated. Fine specimens have been in our cabinets for years without our observing they were connate. The cardinal tooth being double in the right valve seems to have escaped the attention of the observant Mr Say.

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9. Symphynota Cygnea.

Testâ ovatâ, antice latâ et rotundatâ, irregulariter transversim rugosâ; natibus retusis; valvulis tenuibus et post ligamentum connatis.

Shell ovate, wide before and round, with irregular transverse wrinkles; beaks not prominent; valves thin and connate behind the ligament.

Hab. rivers and lakes of Europe.

My Cabinet.

Mytilus cygneus. Lin. Gmel. p. 3555.

Anodonta cygnea. Lam.

Remarks.—It is a matter of surprize to me that this shell, so long known and so often described by European conchologists, should not have been before observed to be connate. It has not to my knowledge been thus described. Among about a dozen specimens received from various parts of Europe, I have two which are decidedly and undoubtedly connate. One was sent to me by Count de Yoldi of Copenhagen, the other by W. Swainson, Esq. of London. These are the only specimens I have seen with the dorsal margin unfractured, and it may be that even in their native beds they rarely exist in a perfect state with regard to this part. Young specimens would be more likely to be found perfect, if taken from pools or lakes where they remain undisturbed by the attrition of sand, &c. carried over them by the action of the water.

In closing this paper, I take the opportunity of returning my thanks to those friends who have kindly loaned me their specimens for examination and comparison, and by whose advice I have frequently profited. To P. H. Nicklin, Esq. I feel under peculiar obligations for frequent consultations and assistance; and to W. Cooper, Esq. I am greatly indebted for the opportunity, through his means, of having in my possession for some weeks the identical specimens appertaining to various valuable cabinets in New York, from which Mr Barnes made his descriptions.

No. XIV.

Remarks on the use of the Maxillæ in Coleopterous Insects, with an Account of two Species of the Family Telephoridæ, and of three of the Family Mordellidæ, which ought to be the Type of two distinct Genera. By N. M. Hentz.

THE maxillæ in most coleopterous insects may not have as much influence in the masticating of the food as has been supposed. Latreille long ago has shown that Fabricius's characters of his *Eleutherata* and *Synistata* were erroneous, since in all the *grinding* insects the maxillæ are attached to or connected with the tongue. After mature consideration, I have even come to the conclusion that the maxillæ, in many cases, must be considered only as appendages to the tongue, and that their use, then, is similar to that of this last organ; that is, to assist in the deglutition of food, while they seldom serve to grind or lacerate, excepting in the *Melolonthidæ*, *Rutelidæ*, and a few more, where there seems to be a departure from their primary use. De Geer, quoted by Kirby and Spence, long ago observed in *Leptura quadrifasciata* that the maxillæ were terminated by soft appendages, fringed with hair. There the chief use of the maxillæ could not be mistaken; they are evidently employed to penetrate into the corolla of flowers, somewhat in the same manner as the antlia of Lepidopterous insects. We are already acquainted with the genus *Nemognatha*, established by Illiger, where the maxillæ can hardly have any power in masticating or lacerating the food. I have been fortunate enough to discover a considerable number of insects, in which the configuration of that part of the mouth is such as to corroborate the idea expressed in the sentence heading these remarks.

The first to be mentioned seems to be the *Cantharis marginata* of Fabricius, though the marking of the elytra differs in most varieties from the descriptions of that species. In this insect, the maxillæ, if examined after desiccation, offer only one lobe, which is cleft or bifid. See Fig. I. *b.* But before it is dried, if the abdomen be pressed gradually, and then the thorax, there issues from the cleft of the lobe of the maxilla a soft, elastic, subconic body, of more than half its whole length, and extending beyond the palpi. Another body of the same nature issues nearly at a right angle from the base of the first, which is directed forward. This projection is about half the length of the first, and would seem to issue from, or possibly to constitute the lower lobe. Both are covered with short hairs. See Fig. I. *e.* These bodies, which the insect can protrude at will, can extend into the corollæ of umbelliferous and other small flowers, and are used to collect nourishment. The next insect is the *Cantharis bimaculata*, F. The anomalous characteristics of the preceding exist in this in a more conspicuous degree. When the abdomen and thorax, still in a recent state, are pressed, there issues from each maxilla a soft tapering body covered with fine hairs. It is capable of great extension, as it may reach farther than the middle of the antennæ, being then more than twice as long as the maxilla itself. See Fig. II. *b. c.* These two insects are evidently congeneric and even bear great affinity to each other. A superficial observer might take one for the other. They would rather belong to *Malthinus* than to *Telephorus*, on account of the brevity of the elytra in relation to the abdomen, but I have been induced by several reasons to propose that these should constitute a new genus, which I will thus define:—

FAMILY LAMPYRIDES.

Genus Chauliognathus.

Cantharis, Linn. *Telephorus*, Oliv. *Malthinus*, Lat.

Antennæ nearly as long as the elytra; mandibles arcuated, entire, apex acute; maxillæ with the upper lobe, at least, extensible during life; palpi with their last joint larger, subsecuriform; body soft; elytra shorter than the abdomen; head generally attenuated behind.

I. *Chauliognathus marginatus.*

Testaceous; antennæ and a bifurcated band on the vertex black; a longitudinal band on the thorax, and an abbreviated one near the apex of the elytra black.

Length (in a dried state) from 2-5ths to nearly half an inch.

Inhabits North Carolina from May till the end of July.

Description.—Head testaceous; a line on the vertex which bifurcates towards the eyes black; mandibles piceous at tip; palpi piceous; antennæ black, first three joints rufous underneath; thorax testaceous, subquadrate, not transverse, margined with a longitudinal band black; elytra testaceous, narrowed at tip, with an abbreviated band near the apex black; a slightly elevated line near the suture diverging beyond the middle towards the humerus, where it is obsolete; beneath testaceous; postpectus darker; venter testaceous, segments black at base; thighs pale ferruginous, black at tip; tibiæ piceous, slightly ferruginous at base; tarsi piceous.

Var. α. Elytral band nearly reaching the base, where it bifurcates, inner bifurcation longest; band of the thorax interrupted in two places.

Var. β. Elytra black; suture, margin and humerus testaceous. This is possibly the *Cantharis marginata.* Fab. Eleut. I. p. 298.

Var. γ. Elytra testaceous, immaculate.

Observations. This insect very much resembles the following, but may be distinguished by its narrow thorax, the marking of the head and feet, its size, the time when it appears, and, above all, by the difference in the form of its maxillary appendages. Another great peculiarity, not mentioned in the description, is the existence of two bags, analogous to the caruncles of the prothorax of *Malachius.* These bags issue from the sides of the second segment of the abdomen, within the *pulmonaria* and under the *spiracula dorsalia;* and being capable of considerable distention, they seem to be composed of one lobe only. During life the abdomen is much longer than the elytra, but it contracts much in drying. Neither this nor the next species live upon prey. They are both always found feeding on flowers, live long, and many, when about to die, grasp with their mandibles the petal of a flower, and may be found dried up in that state.

II. *Chauliognathus bimaculatus.*

Black; thorax testaceous, with a spot black; elytra testaceous, with an elongated spot near the apex black.

Length (in a dried state) from 9-20ths to 11-20ths of an inch.

Inhabits Pennsylvania and North Carolina, where it appears in September and lives throughout October.

Cantharis bimaculata. Fab. Eleut. I. 298.

Description.—Head black; antennæ black; palpi black; mandibles ferruginous, piceous at tip; labium ferruginous; thorax testaceous, margined, subtransverse, slightly broader at base with a central spot black; elytra testaceous, slightly narrower at tip, with a spot or band covering about one half of each elytron, beginning near the apex black, a subobsolete elevated line near the suture, and diverging towards the humerus; beneath piceous, edge of segments of the abdomen testaceous; feet blackish; tibiæ of the anterior pair of legs piceous, covered with rufous hairs, those of the second and third pair with shorter and thinner hairs of the same colour.

Observations.—This insect is one of the last to appear, and that in profusion, about the same time with *Lytta atrata*, till repeated frosts deprive it of food. The black spot on the thorax varies much; it is usually subquadrate, but is sometimes transverse, and sometimes longitudinal, but most commonly indented at base as represented in Fig. II. I observed this insect about ten years ago in the month of August; it was found on the blossom of thistles, where I had an opportunity to see it protrude its maxillary appendage as the antliæ of Lepidopterous insects. In this insect, as well as in the preceding, the abdomen extends at least three segments beyond the elytra, during life.

The next insects in which I have observed a peculiar formation of the maxillæ, all belong to the family *Mordellonæ*, namely *Rhipiphorus dimidiatus*, *R. limbatus*, and *R. tristis*. The remarkable elongation of the upper lobe of the maxillæ, which is greater than at least in one species of *Nemognatha*, and other considerations have induced me to propose the establishment of the following genus, taking *R. dimidiatus* for its type, and adding to it the two other species just mentioned.

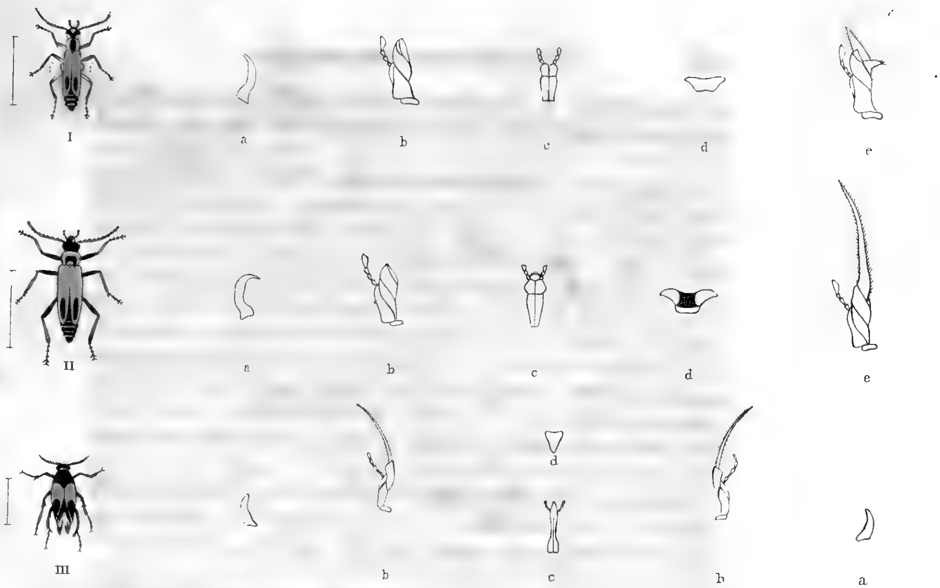
FAMILY MORDELLONÆ.

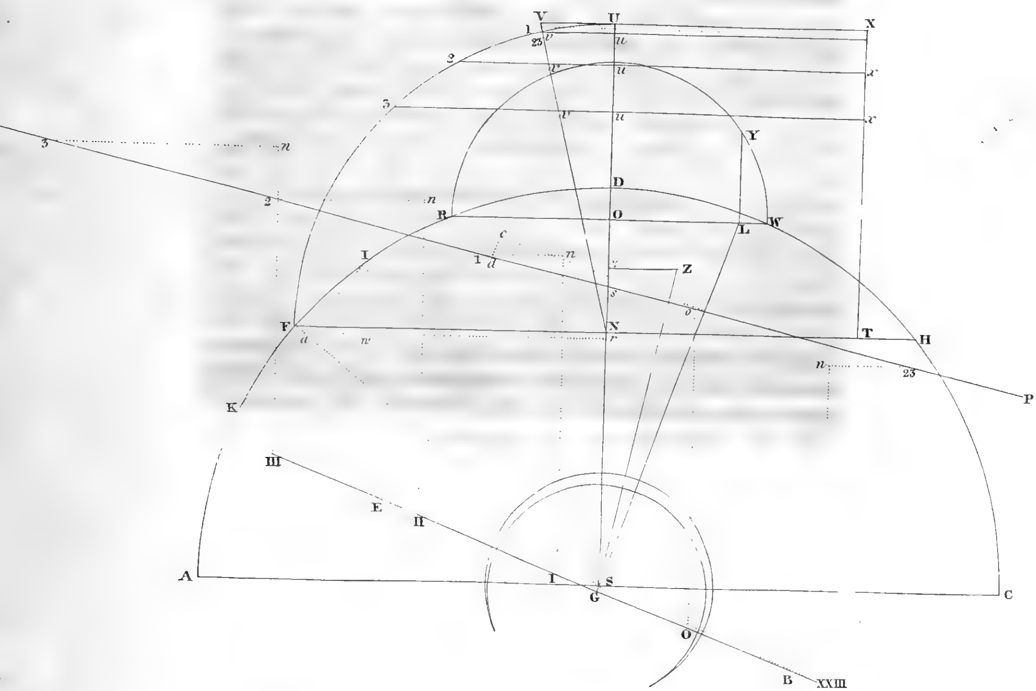
Genus Macrosiagon.

Rhipiphorus, Bosc. Fab. &c.

Tarsi with all their joints simple; palpi subfiliform; antennæ pectinated; maxillæ with the upper lobe filiform, longer than the palpi; scutellum not apparent; abdomen abruptly truncated; elytra dehiscent, longer than the abdomen. See Fig. III. *a*, *b*, *c*, *d*.

PL. XV.





J Drayton Sc.

Observations.—It is strange that a peculiarity belonging to three species, all known to Fabricius, should have escaped his notice. As the genus *Rhipiphorus* is now large, I think it is well to make a division, which is so natural and easily observed. All these insects live on flowers, and are very quick in their motions.

Explanation of the Plate.

Fig. I. Chauliognathus marginatus (Cantharis marginata? F.).
a. mandible.
b. maxilla in a dried state.
c. labium and lingua.
d. labrum.
e. maxilla in a recent state, with its protruding appendage.
f. caruncles, or ventral bags.

Fig. II. Chauliognathus bimaculatus (Cantharis bimaculata, F.).
a. mandible.
b. maxilla when dried.
c. labium and lingua.
d. labrum.
e. maxilla in a recent state, with its protruding appendage.

Fig. III. Macrosiagon dimidiatum (Rhipiphorus dimidiatus, F.).
a. b. c. d. trophi.*

* This paper was read before the Society September 19th, 1828.

No. XV.

Description of a New Species of the Genus Astacus. By R. Harlan, M.D. &c. Read April 3d, 1829.

A. Blandingii.

Rostrum mucronate, canaliculate, slightly notched at the extremity: a spine behind each eye; arms tuberculated; fingers unequal.

Inhabits the southern states, where it is common in the marshes and rivulets.

Cabinet of the Academy of Natural Sciences. Presented by Dr W. Blanding, Camden, S. C.

Description.—The hands and arms, and sides of the body tuberculated; conspicuously large on the hands: thorax with a small spine on the side, behind the transverse arcuated band; first and second joints of the peduncles of the exterior antennæ furnished with each a single spine: rostrum elongated, angular, attenuated anteriorly, and obsoletely notched near the extremity, extending nearly to the tip of the third joint of the peduncle of the exterior antenna, carinated on each side of the base, and terminating in a post-ocular spine: anterior feet, third joint very long, with a double longitudinal series of spines beneath: carpus four-spined; spines irregularly distributed about the anterior margin: hands long, tuberculated throughout; fingers elongated, slightly curved inwards, the innermost the longest, terminating in a small spine opposed to the thumb: caudal lamellæ ciliated, lateral segments with an elevated longitudinal spine; the penultimate and antipenultimate legs of the male furnished with an obtuse apophysis at the base of the second joint.

Dimensions.—Length from the tip of the rostrum to the tip of the tail, three inches eight-tenths; breadth of the thorax one inch; length of the anterior feet nearly four inches; length of the hand and finger nearly equal.

The present species, in size and markings, is most nearly allied to the *A. affinis* of Say; but differs in the form of the rostrum, in the proportional length of the arms; in being furnished in the male with an apophysis on the third joint of both the penultimate and antepenultimate legs; in the disposition of the spines; and in being tuberculated. The present species will bear no comparison with the *A. Bartonii*, with which, nevertheless, Mr Say appears to have confounded it, when he assures us that the last mentioned species are "extremely common in the pine barren marshes of the southern states, and particularly in those of Georgia and Florida." (Vid. Journal of the Acad. Nat. Sci. Phila. Vol. I. p. 443.)

All the crawfish, which I have seen from the southern states, (and I have received specimens from New Orleans and South Carolina) are of the same species with that now described.

No. XVI.

Notice of an Anatomical Peculiarity observed in the Structure of the Condor of the Andes; (Vultur gryphus, Linn.) By R. Harlan, M.D. Read April 3d, 1829.

DURING the past year, two fine specimens, male and female, of the Condor from Peru, died in this city. I caused their skins to be prepared, and they now constitute a valuable addition to the cabinet of the Academy of Natural Sciences of Philadelphia.

On dissection the stomach presented a peculiarity of organization, which appears to be characteristic of this species.

The crop or ingluvies is very large, and was in this instance filled with macerated raw meat. The stomach, which was nearly empty (with the exception of some thick pieces of glass, stone coal, gravel, &c.) is oblong in form; the cardiac portion being marked with longitudinal folds: the middle portion displays two oval protuberances composed of gastric glands, which is again succeeded by a membranous or saccular portion, on the interior surface of which are numerous and nearly contiguous, longitudinal bands or ridges, of a cartilaginous structure, serrated or spiny on the surface towards the stomach, covering the pyloric or lowermost two-thirds of the stomach. This cartilaginous production, like the inner lining of the gizzard of the fowl, is easily detached. It must have considerable effect in facilitating the process of digestion, by tearing and separating the fibres of the meat with which these birds habitually gorge themselves, so as to be disabled, for a time, for flight. The liver is very large; the gall bladder was much distended with bile.

No. XVII.

On the Construction of Eclipses of the Sun. By John Gummere. Read March 20, 1829.

WE may, without diminishing the accuracy of the results, dispense with the description and division of an ellipse, which are necessary in the usual method of projecting eclipses of the sun, and which render it so troublesome. This is most conveniently done, by supposing the sun's centre to remain fixed in the centre of the circle of projection, and giving to the moon a parallax in right ascension, equal in magnitude, but opposite in direction, to the distance of the projection of the sun's centre from the universal meridian, at the time; and a parallax, parallel to the universal meridian, or parallax in declination*, equal in magnitude, but opposite in direction, to the distance of the sun's centre from a plane passing through the centres of the sun and earth, perpendicular to the universal meridian. The figure to which I shall refer, is the construction of an eclipse of the sun, that will occur on the 12th of February 1831. It is adapted to the meridian and latitude of Philadelphia.

The semicircle ACD represents the northern half of the circle of projection. AC is a parallel to the equator; SU is the universal meridian; SL a circle of latitude; PQ the

* These quantities are not, rigorously speaking, the moon's parallax in right ascension and declination, but it is convenient to call them so.

moon's relative orbit; the points 23, 0, 1, 2, and 3, on the line PQ, are the moon's places at the hours denoted by the numbers; the sun's place being supposed to be at S. All these are obtained as in the usual method.

Make the arcs AF and CH, each equal to the reduced latitude of the place, and join FH. With the centre N and radius NF, describe the quadrantal arc FU. Make FI and FK, each equal to the sun's declination, and join KI and FS. Draw *ar* and I*w*, parallel to FN and SD respectively. On NH, make NT equal to S*r*, and complete the rectangle NTXU. On XU, produced if necessary, take UV, equal to I*w*, taking it to the right of SU, when the sun's declination is north, but to the left, when the declination is south, and join VN. Take the hour angles from noon, corresponding to the hours marked on the relative orbit; and on the arc UF, produced if necessary, set off from U, arcs equal to these angles, marking their extremities with the numbers of the hours to which the arcs correspond. From the extremities of the arcs, draw lines parallel to UX or FH, as the lines 1, *x*; 2, *x*; &c. meeting NU in the points *u*, and NV in the points *v*. Then will the distances 1, *w*; 2, *w*; &c. be the moon's parallax in right ascension at the 23d, 1st, 2d, &c. hours; and the corresponding distances *vx*, will be the parallax in declination.

From the hour points on the moon's relative orbit, draw lines as 23, *n*; 1, *n*; &c. parallel to FH or AC; drawing them to the left hand, when the time is in the forenoon, but to the right hand, when the time is in the afternoon, and make them respectively equal to the parallax in right ascension at these hours. From the points *n*, draw the lines *n*, xxiii; *n*, O; &c. parallel to SU, drawing them below the point, *n*, and make them respectively equal to the moon's parallax in declination at the corresponding hours. Join xxiii, O; O, 1; &c. Then will the broken line thus formed be a near representation of the moon's apparent relative orbit; and the points xxiii, O, 1, &c. will be the moon's places in the apparent orbit at those times.

With the centre S, and sum of the semidiameters of the sun and moon, as a radius, describe arcs, cutting the apparent orbit in B and E, which will be the moon's apparent places at the times of beginning and end. From S, draw SG perpendicular to a straight line joining B and E; then G will be the moon's place at the time of greatest obscuration. And the point in which LS, produced if necessary, cuts the apparent orbit, is the moon's place at the time of apparent ecliptic conjunction. Take the distance between the hour point next preceding the point B, and that next following it; and applying it to the scale, obtain its measure. Do the same with the distance between B and the hour point next preceding. Then, as the 1st distance : 2d distance : : 60 minutes : the time past the preceding hour at which the eclipse begins. The other times are found in the same manner; and the quantity of the eclipse is found in the usual manner.

Find the moon's parallax in right ascension and declination for the time of beginning, and make S*z* equal to the parallax in declination. From *z*, draw *z*Z, parallel to FH, drawing it to the right hand when the time is in the forenoon, but to the left when it is in the afternoon, and make it equal to the parallax in right ascension. Join SZ, which will represent a vertical circle passing through the sun's centre; and the angle BSZ will be the angular distance from the sun's vertex, of the point at which the eclipse commences.

The slight changes necessary in the construction, for places near the equator or in the southern hemisphere, are so obvious as not to require notice.

In finding the times of beginning, &c. the moon's motion in the apparent orbit is assumed to be uniform during the hour, which is not strictly true. The greatest error, however, that can arise from the assumption, is only about a minute, when the latitude of the place is 40°. For higher latitudes it will be less; and for places nearer the equator it will be rather more. The error that may arise from assuming the part of the apparent orbit, between two consecutive hour points, to be a straight line, will seldom be as great as that which is sometimes produced by omitting to diminish the sun's semidiameter; and this is usually omitted in the common method of projection. If the construction is made for each half hour, instead of each hour, which may be done with but little additional trouble, the error arising from the assumptions which have been mentioned will always fall within the unavoidable error of construction.

This method of construction is equally applicable to occultations of a star or planet.

No. XVIII.

Description of a Fragment of the Head of a New Fossil Animal, discovered in a Marl Pit, near Moorestown, New Jersey. By Isaac Hays, M.D.

I am indebted for the opportunity of describing this specimen to my friend Mr Isaac Lea, whose zeal in the cause of science is too well known to require any eulogium from me. It was found by Mr Joseph Brick in Inskeep's marl pit, on Pensauken creek, 5 miles south east of Moorestown, New Jersey; and was presented by J. J. Spencer, M.D. of Moorestown to Mr Lea, in whose valuable cabinet it is at present. The marl in which it was found is of that description called fine green marl: the stratum is about ten feet thick, and commences about two feet from the surface. In this stratum are found marine shells, (principally terebratulæ) shark's teeth, &c.

The only part of this animal yet discovered is the fragment in the possession of Mr Lea, consisting of a portion of the head and lower jaw. Some of the bones are in a tolerable state of preservation; others are covered with marl which has become too hard to be removed, or are so mutilated that they cannot be satisfactorily made out.

About three inches and four-tenths of the anterior portion of the lower jaw are preserved; the two sides are nearly parallel; anteriorly they are slightly mutilated—appear to have been very little rounded, and in contact; inferiorly, through the whole extent of the fragment, they are in contact, and appear to be united by suture; posteriorly on each there is a smooth, shallow cavity, represented in Pl. XVI. Fig. 3, *d. d.* Near the posterior extremity there is an appearance of suture, which is most distinct on the left side, and which in all probability marks the union of the dental with the coronoid bone. The angular bones cannot be very distinctly made out; there is, however, on the left side near the base, and along the whole extent of the specimen, an indication of suture, which I have no doubt is the union of the angular and dental bones.

The dental bone contains a single row of distinct alveoli, continued in front, for the teeth; just below the alveolar border there is a series of foramina, one foramen to each alveolus, for the transmission of the inferior maxillary nerve and the blood vessels to the teeth. The teeth of the lower jaw (and in the present specimen part of the dental bone, owing perhaps to its being crushed) close within the upper.

Just within the dental bone, on the left side, there projects a rectangular portion of bone, Fig. 2, and 4, *s.* belonging to the upper jaw: its character and analogies are not very evident; it is deficient on the right side.

The intermaxillary bones are very distinct, and are seen in Fig. 1, 2, and 4, *b.;* they are united posteriorly by squamous suture to the upper maxillary, and a bone which appears to be the lachrymal. Anteriorly the intermaxillaries are rounded, and separated about one-tenth of an inch; the anterior inferior portion of each is mutilated, but the alveoli for the teeth are conspicuous, and from their direction we are led to infer that the upper front teeth project beyond the lower; the posterior inferior portions of this bone, each side, contain four or five teeth.

Between the intermaxillary and upper maxillary bones on each side, and covered principally by the former, is a bone, Figs. 1, and 2, *g*, (the lachrymal probably,) in the anterior portion of which is a deep groove, Fig. 2, *f*, passing forwards and downwards, and becoming smaller as it descends; on the upper portion of each of these bones there is a small, smooth, superficial groove, Fig. 2, *h*, and on its inner side, a small, smooth, slightly convex, apparently articulating surface, Fig. 2, *i*.

The general figure of the upper maxillary bone will be better understood by a view of the drawing, Fig. 1, *c*. than by any verbal description; this bone is imperfect posteriorly. Superior and anteriorly, near its junction with the last described bone, the upper maxillary has a smooth, apparently articulating surface, convex antero-posteriorly, and inclining a little inwards, Fig. 2, *g*.; like the dental and intermaxillary bones, this has also distinct alveoli for the teeth; and near its alveolar margin, on the inner surface, there is a regular series of foramina, similar to those in the dental bone, for the transmission of the superior maxillary nerve and vessels to the teeth. The external surface of this bone and also of the intermaxillary, where not broken, presents a shagreened appearance.

The teeth in both jaws are placed close together, in a single row, in distinct alveoli; they are also similar, those in the lower jaw, however, being rather more compressed than those of the upper: the anterior teeth of the lower jaw are smaller than the posterior. The crowns of the teeth are enamelled, smooth, lanciform, slightly inclined inwards; those at the posterior portion of the lower jaw slightly curved forwards. Their roots are hollow, slightly grooved on their external aspect; on their internal aspect there is a very slight groove. See section magnified three times, Fig. 10.

The young teeth grow into the hollow of the old. The mode of dentition is shown in Fig. 5; *l*. is the new tooth, *m*. the old.

There appear to have been nine or ten teeth in each intermaxillary, and about thirty in each upper maxillary bone; we are unable to ascertain satisfactorily the number of teeth in the lower jaw.

This animal, though its head bears some resemblance to, evidently does not belong to the great Saurian family, (*La-*

certa Linn.), since in all that family, except the crocodile and the Saurian of Luneville discovered by Dr Gaillardeau, the teeth are not lodged in alveoli, or even in a continuous furrow; on the contrary the jaw bone presents only a sort of parapet on the outer side—the teeth are fixed to the jaw by a bony mass, occupying the place of their root, and incorporated organically both with the tooth and with the jaw bone—and the new teeth make their first appearance in cells from within this osseous mass, and shoot irregularly through its substance, gradually producing a necrosis in it, thus causing both the mass and the old tooth to fall out.

This animal differs from the crocodile in the composition of its jaw, in the form and position of its teeth, in the mode in which the nerves and blood vessels are transmitted to the teeth, &c. &c. It differs from the Saurian of the environs of Luneville in the form and character of the teeth, which in the latter are conical, strongly striated, and alternately larger and smaller—also in the mode in which the blood vessels are transmitted to the teeth, &c.

It most probably belongs to the order *Enalio Sauri* of Conybeare; an order formed for certain animals which approaching more closely to the Saurian or Lizard family, and especially to the genus Crocodile, than to any other recent type, yet recede from it in many important characters, especially in the form of their paddles, which possess an intermediate structure between the feet of quadrupeds and the fins of fishes*.

It is impossible, however, to place the animal which forms the subject of this communication in any of the hitherto described genera of this order. It is excluded from the genus *Ichthyosaurus* by the composition of its jaw; by the teeth in the latter being placed in a sulcus and not in distinct alveoli, and also by the nerves and blood vessels being transmitted to the teeth of the lower jaw by perforations on the *outside* of the anterior portion of the dental bone, &c.

* See Geological Transactions, Vol. I. N.S. p. 561.

It differs from the *Plesiosaurus* in the form and relative size of the intermaxillary and upper maxillary bones—in the form of the lower jaw—form of the teeth—mode in which they close—and manner in which the lower maxillary nerve is transmitted to the teeth, which, in the Plesiosaurus, is by foramina dispersed irregularly along the outer edge of the lower jaw.

It appears most nearly to approach the *Saurocephalus*, a genus founded on a single dental bone, discovered in a cavern on the river Missouri, near Soldiers' river, by Sergeant Gass, who accompanied Lewis and Clark in their expedition, and presented by the latter gentleman to the Society, and now in their cabinet*. It resembles this animal in the teeth closing like incisors—in the foramina for the transmission of nerves and blood-vessels to the teeth of the lower jaw being in a regular series on the inner side of the dental bone near the alveolar edge—and in the young teeth entering the old directly in the centre and not at the side, as in the other animals of this order, in the Crocodile, &c.

It differs however from the *Saurocephalus* in the teeth being in distinct alveoli, while the teeth in the latter are described as being "fixed in a longitudinal groove" "in close contact throughout," "there being *no* distinct alveoli." Our animal differs also in the groove on the inside of the dental bone for the accommodation of the inferior maxillary nerve (and which is made a generic character) being absent, in the form of the teeth, and no doubt in many other particulars, which a want of opportunity for comparison and more perfect specimens makes it impossible for us to point out.

Under these circumstances we venture to propose for it a new genus, under the name of SAURODON, and will dedi-

* We regret much not having an opportunity of examining this specimen : we are compelled to depend upon the account of it by Richard Harlan, M.D. in the Journal of the Academy of Natural Sciences of Philadelphia, Vol. III. Part II.

cate the species to our friend Mr Lea, by the designation *Leaæ*.

We hesitate attempting to indicate the generic and specific characters with the imperfect knowledge we possess of all the animals of the order to which it belongs; and at all events will postpone doing so till we can collect more complete remains of our animal.

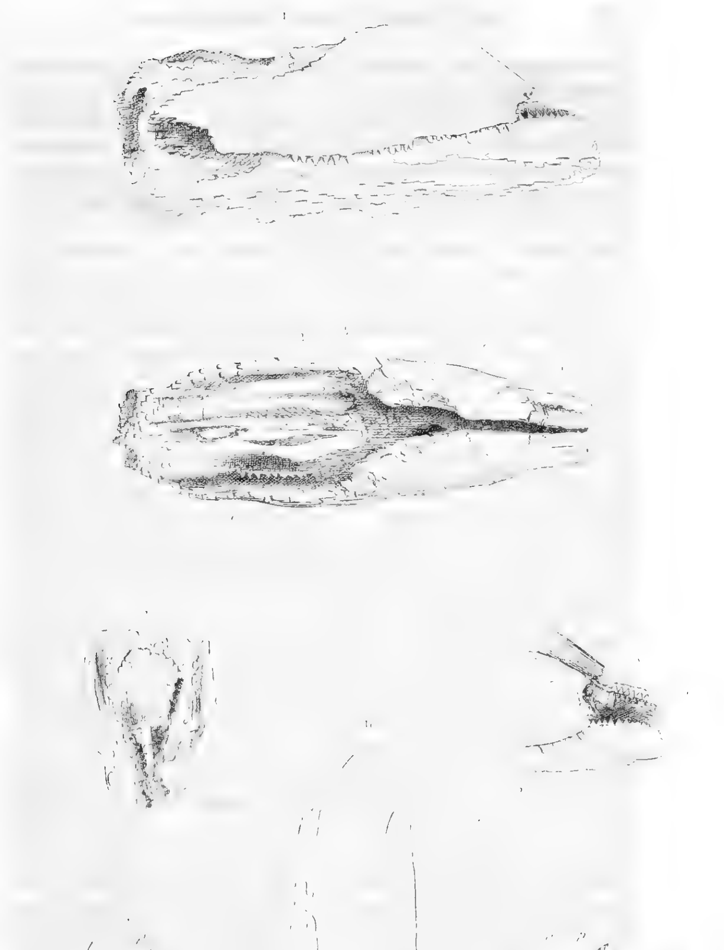
Since I had the honour of laying before the society the description of a portion of the head of a new fossil animal from New Jersey, I have had an opportunity of examining the fossil organic remain in the cabinet of the society, presented by Lewis and Clark. I find that this specimen consists not only of a portion of a dental bone, but also a small part of a coronoid bone; and that the teeth, instead of being "in a longitudinal groove" "in close contact throughout," "there being no distinct, separate alveoli," *are in fact placed in distinct alveoli.*

The most important generic character which was supposed to distinguish this animal from the one we described having thus no existence, it appears proper in the present state of our knowledge to place the two species in the same genus; and, as the genus *Saurocephalus* is founded on erroneous characters, and will not admit our species, it becomes necessary to construct a new genus, which we shall accordingly do, and shall retain for it the name Saurodon.

Genus *Saurodon* (*Hays*). Teeth of the lower jaw closing within those of the upper, like incisors; a regular series of foramina along the inner aspect of the jaws near their alveolar margins, for the passage of nerves and blood-vessels to the teeth.

Species 1. *S. lanciformis*. A groove along the inner

PL. XVI



surface of the dental bone for the accommodation of the inferior maxillary nerve; teeth very obtusely lanciform.

Species 2. *S. Leanus.* Teeth acutely lanciform, much smaller than in the preceding species, slightly curved.

Saurodon Leanus.—Plate XVI.

Fig. 1.—Fragment of head, lateral view. *a.* Dental bone. *b.* Intermaxillary bone. *c.* Upper maxillary bone. *g.* Lachrymal bone.

Fig. 2.—Head seen from above. *b. b.* Intermaxillary bones. *e.* Teeth of under jaw. *f. f.* Nasal grooves. *g. g.* Lachrymal bones. *h.* Small groove. *i.* An articulating surface. *q.* An articulating surface of upper maxillary bone.

Fig. 3.—Posterior view. *d. d.* Glenoid cavities in coronoid bone.

Fig. 4.—Anterior view. *o.* Foramina in dental bone for transmission of nerves and blood-vessels to the teeth.

Fig. 5.—Portion of upper jaw, with the outer lamina of bone removed to show the mode of dentition, magnified three times. *l. l.* New teeth. *m. m.* Old teeth. *p.* Empty alveolus.

Fig. 6.—Portion removed from posterior part of upper jaw, right side—internal aspect, magnified three times. *o.* Foramina for transmission of nerve and blood vessels to teeth. *p.* Empty alveolus.

Fig. 7.—Tooth, removed from alveolus *p.* Fig. 6, inner aspect.

Fig. 8.—Same tooth, external aspect.

Fig. 9. Ditto side view.

Fig. 10. Ditto section of the root.

Fig. 11.—*Saurodon lanciformis.* Portion of dental bone, external lamina removed so as to show the alveoli and form of the teeth, magnified three times.

Read December 4, 1829; *and January* 1, 1830.

No. XIX.

Description of a New Genus and New Species of Extinct Mammiferous Quadruped. By John D. Godman, M.D.

THE subject of the following description was disinterred a short time since by Mr Archibald Crawford, about twelve miles from Newburg, in Orange county, New York; a region deservedly celebrated for its inestimable contribution to natural history in the splendid skeleton of the gigantic Mastodon, which was thence obtained in 1801 by the indefatigable founder of the Philadelphia Museum.

The bones obtained by Mr Crawford are in a good state of preservation, and comprise the following parts of the skeleton:—

The anterior part of the head; consisting of parts of the frontal, intermaxillary, superior maxillary and two-thirds of the lower jaw bones; the tusks and sixteen teeth. Of the posterior part of the head there is but a small fragment, being a piece of the occipital bone, distinguished by the presence of nearly one condyle, and showing a small part of the circle of the foramen magnum.

Of the bones of the trunk and extremities, there are four vertebræ, and one separate spinous process; two ribs, of which one is whole and the other broken and imperfect; a humerus, radius, ulna, and two digital phalanges; a femur, tibia, and five epiphyses or heads of bones, separated from their shafts, which, with other circumstances, show that the animal had not attained its adult age.

The right side of the head is the most perfect, and when the bones are placed in apposition, give a good idea of the general character of this part of the skull, which strongly reminds us of that of an Elephant. [See Plate XVII. Fig. 1.] A line drawn from the highest part of the frontal to the extremity of the intermaxillary bone measures seventeen inches. [Fig. 2.] The fragment of the frontal bone makes up about five inches of this extent, and is united to the superior edge of the maxillary bone by a suture, and forms at its junction therewith the superior anterior border of the orbit of the eye; the posterior part of the frontal is broken and lost.

Of the right upper maxillary bone, the whole is preserved, from the end of its alveolus for the tusk, anteriorly, to as far back as the posterior margin of the second molar or permanent tooth. A line drawn perpendicular to this tooth would mark its extent superiorly where it forms the inferior anterior part of the orbit, of which about one half remains. All posterior to the line mentioned is lost, the bone being broken through its malar process, which still presents a projection about an inch long. The foramen infra-orbitarium is situated at the anterior extremity of the base of this process, and in a line with the inner angle of the orbit. The superior maxillary bone, measured from its highest part united to the os frontis, to the edge of the alveole containing the posterior tooth, is eleven inches high. Inferiorly and internally it is quite imperfect, consisting of only as much of the alveolar process as serves to contain three teeth, a small part of the palatine process, and the inferior part of the socket for the tusk; this part of the socket projects two inches or more beyond the anterior teeth.

The intermaxillary bones are of considerable size; that of the right side being rather more than twelve inches long and three broad, extending from the inferior edge of the frontal bone to the base of the great tusk, the superior part of whose sockets it forms. The entrance to the nasal passage is designated by a semicircular indentation on the internal edge of this bone, which is uninjured at this part; lower down a small piece is fractured from its inner edge. The intermaxillary of the left side is destroyed, except at its inferior part, forming the superior portion of the alveole for the tusk.

The tusks belonging to this jaw are in a tolerable good state of preservation, though not wholly uninjured. The entire length of the right tusk is seventeen inches, five of which are within the socket. The tusks, where they emerge from the socket, are four inches and three-eighths apart, and at this point they are seven inches and a half in circumference. They do not perceptibly decrease until within about four inches of the extremity, whence they taper to the point; this is worn in a peculiar manner on its inferior and external surfaces, as may be better understood by the excellent accompanying drawings from the masterly pencil of my estimable friend Mr Titian R. Peale, whose skill and judgment as a naturalist are so admirably displayed by his numerous contributions to the Philadelphia Museum.

Of the lower jaw [Plate XVIII. Fig. 1.] about two-thirds, in a good state of preservation, have been obtained; with the exception of part of the condyloid, the whole of the coronoid, and a small part of the posterior alveolar processes, the right ramus of the jaw is complete, and its inferior and lateral outline from the angle to the apex is uninjured. Superiorly the coronoid process, as just stated, is destroyed as far as the posterior margin of the second molar tooth; but thence anteriorly the jaw is also perfect. Twelve inches of the left ramus are preserved, the condyloid, coronoid, and part of the alveolar processes being broken off, a little posterior to the first permanent tooth. The mental foramen for the exit of the labial branch of the lower maxillary nerve is situated on a line with the root of the second deciduous tooth. Between two and three inches in front of this foramen, which is half an inch in diameter, there are three others of smaller size for the passage of vessels, nerves, &c. to the lip and parts adjacent to the insertion of the inferior tusks.

The great peculiarity of this jaw, and that which separates this animal from every genus hitherto established, is its elongated or rostrated extremity, containing the alveolar processes or sockets for two very remarkable tusks. The superior border of the jaw, from the situation of the anterior teeth, declines immediately, tapering towards the level of these sockets. Inferiorly the outline of the jaw does not so immediately change, until opposite the anterior mental foramina, whence it suddenly diminishes to the end. The rostrated portion of the jaw, anterior to the front teeth, is three inches and three-fourths long, and superiorly is regularly hollowed or grooved as for the reception of the tongue; this hollow is two inches wide, quite smooth, and bounded on each side by thin raised edges.

The alveolar processes for the tusks are contained within the rostrated part of this jaw, and are nearly an inch in diameter at their outlet; the right one being three, and the left two inches in depth, gradually diverging from the centre, and decreasing in width as they penetrate the bone. The tusks belonging to these sockets are of a very striking appearance, and that of the right side, which is entire and well preserved, is four inches in length, three inches of which are within the socket. The projecting external part is covered by a shining, hard, black enamel, and is smooth and round at its point; the other part appears to be a dark, grayish, bony matter, dry on the surface, yielding to the pressure of the nail. The part of this tusk within the socket is exactly accommodated thereto, tapering to a small point. The external projecting part has a peculiar spiral twist for about an inch and a half from its anterior extremity, as will be readily understood by referring to the plate. [Plate XVIII. Fig. 2.]

In relation to the dentition of the animal, we find it possessed of sixteen teeth, eight of which (the two anterior teeth on each side of both jaws) are deciduous or milk teeth; on the right side one of these has fallen out, while all the remaining deciduous teeth are considerably worn, so as to show that the enamel merely covers the external surface of their crowns, as in the Mastodon, and does not penetrate their substance as in the Elephant, &c. The permanent teeth, which are four in number in each jaw, are acutely mamillated, forming three transverse ranges of wedge-shaped tubercles. The first is three inches in length; the second or last tooth three and a half; the deciduous teeth are much smaller, the first measuring but half an inch, the second two inches. The roots of all the teeth are short, as the greatest depth of the lower jaw is but four inches.

Of the other bones the vertebræ are about an inch and a half long, and three inches in diameter; the separate spinous process is seven and a half inches; the entire rib is twenty inches long, and its curvature four inches; the greatest diameter of the broken rib is an inch and a half. The humerus is seventeen inches long, and three in diameter; radius thirteen inches in length, one and a half in diameter; the ulna fourteen inches long, two and a half in diameter. The digital phalanx is three inches long, and three in diameter; the tibia is fourteen and a half inches long, and three in diameter.

While engaged in the examination of the New York specimen, my friend, Mr Franklin Peale, manager of the Philadelphia Museum, informed me that he had seen a jaw bone in the cabinet of the University of Virginia which must have belonged to the same species. In consequence I immediately addressed a note to the Professor of Anatomy in that institution, R. Dunglison, M.D. requesting an accurate description of this bone. This gentleman, who is equally distinguished for zealous devotion to the cause of science and polished urbanity of manners, favoured me with an immediate and satisfactory answer, from which the following particulars are derived.

In the collection examined by Professor Dunglison there are two parts of lower jaws, most probably belonging to the same species, though to individuals of different ages. These have been clumsily joined, as if they had formed a single jaw. The right side of the jaw is complete from the angle to the apex of the chin, which is perfect, having about three inches of the left side preserved. The lower jaw is elongated at its anterior part, and hollowed out superiorly, while on each side of the symphisis menti there is a canal extending obliquely upwards through the bone, the right one contains the root of a tusk, which occupies the whole socket, and projects slightly on the inner side, being 1.25 in diameter. This right portion of the lower jaw is two feet four inches long, measured along its base, and weighs forty pounds*.

Every view taken of this animal strongly reminds us of its resemblance to the gigantic Mastodon; and but for the singular difference of organization presented by the lower jaw and its tusks, we could not avoid concluding we had obtained a young animal of that species. We have made diligent examination of the different perfect lower jaws of the Mastodon preserved in the cabinets of the Philadelphia and Baltimore Museums, the cabinet of the New York Lyceum, &c. to discover whether any trace of this structure could be found, or had possibly been overlooked by previous observers.

These researches ended in a conviction that nothing like this construction pertained to the Mastodon, whose lower jaw ends in a distinctly decurved extremity, simply suited to give attachment to the muscles of a lip; as is evident on referring to a specimen or to any authentic engraving. We are therefore under the necessity of regarding it as a *new*, but closely allied *genus* to the Mastodon; and propose for it the following name and characters:—

* The lower jaw bone of the Mastodon is two feet ten inches long, and weighs sixty pounds; hence our animal, in the adult state, was of about the same size.

Order BELLUÆ L. (Pachydermata, C.)

Family Proboscidia.

*Genus Tetracaulodon.** (Godman.)

Dental Formula: Incisive $\frac{2}{2}$, Canine $\frac{0\,0}{0\,0}$, Molar $\frac{2\,2}{2\,2}$, = 12.

Character: having four tusks; of which two, large and strong, similar to those of the Mastodon, belong to the upper jaw, and two, small, short and spiral, project from sockets on each side of the chin. The lower jaw produced or elongated at the symphisis; having on its superior surface a smooth hollow groove for the tongue, and terminating in a narrow apex containing sockets for the inferior tusks.

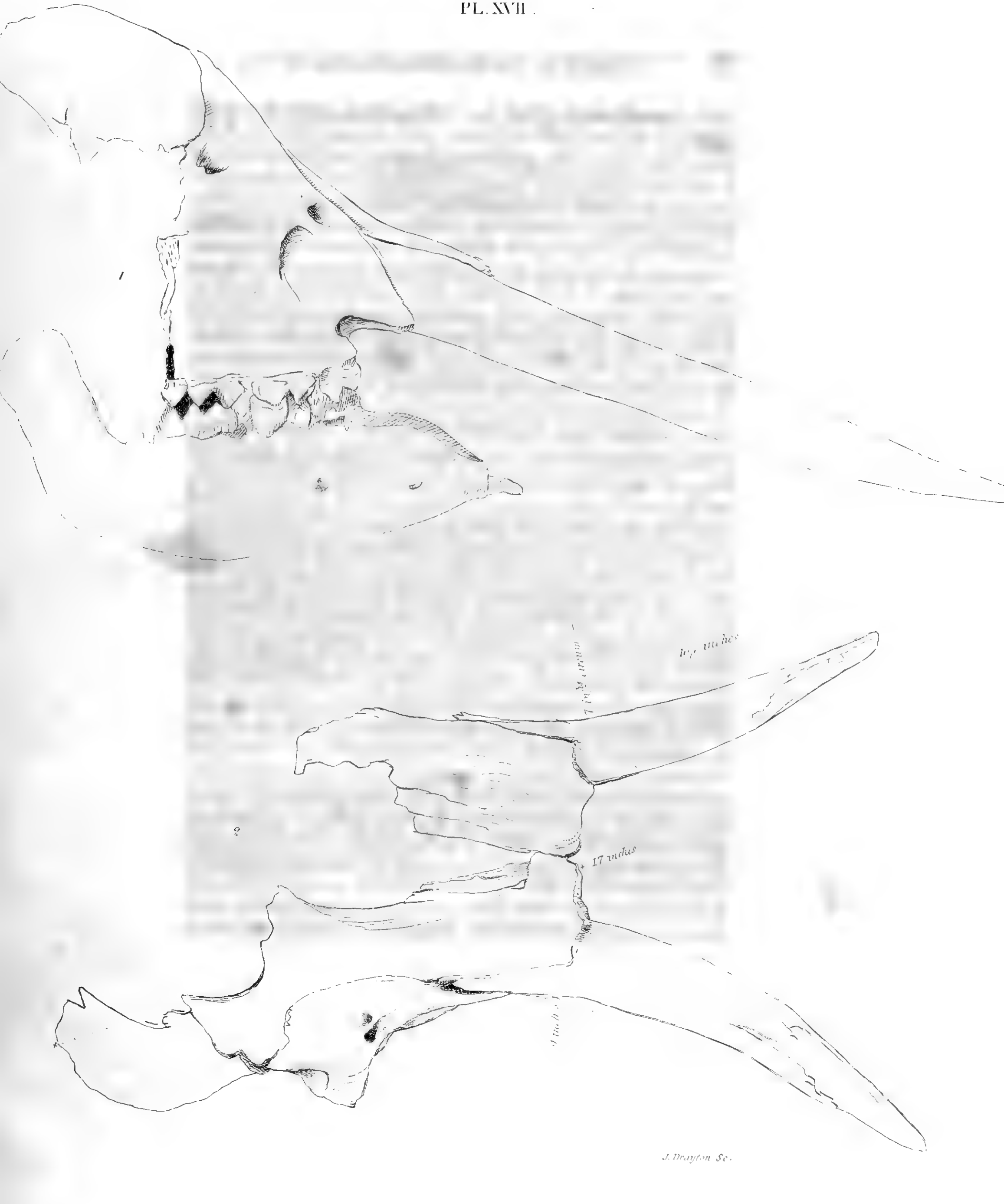
Species 1. *T. Mastodontoideum.* Godm.

In addition to the preceding details, the species will be sufficiently characterized by observing, that in the lower jaw of the adult its outlines are peculiarly straight or rectangular, exhibiting none of those bold curvatures and projections so conspicuous in the allied genus Mastodon, about the angles and base of the jaw. The condyloid process is thrown farther backward, and the coronoid process is not separated from it by a deep semilunar notch, as in the other genus, the bone gently ascending from the tip of the coronoid until it terminates in the condyle. These peculiarities clearly indicate a very marked difference in the arrangement and power of the muscular apparatus, as well as suggest thoughts of differences in mode of life and regimen, between the two genera during their existence.

Of this highly interesting species, we are now aware of the preservation of fragments of *three* well authenticated individuals. Two adult jaw bones (one of which is nearly two-thirds entire) in the Museum of the University of Virginia; the young specimen, the immediate subject of this descrip-

* From τετρα, four; and χαυλιοδοντα, tusks.

PL. XVII.



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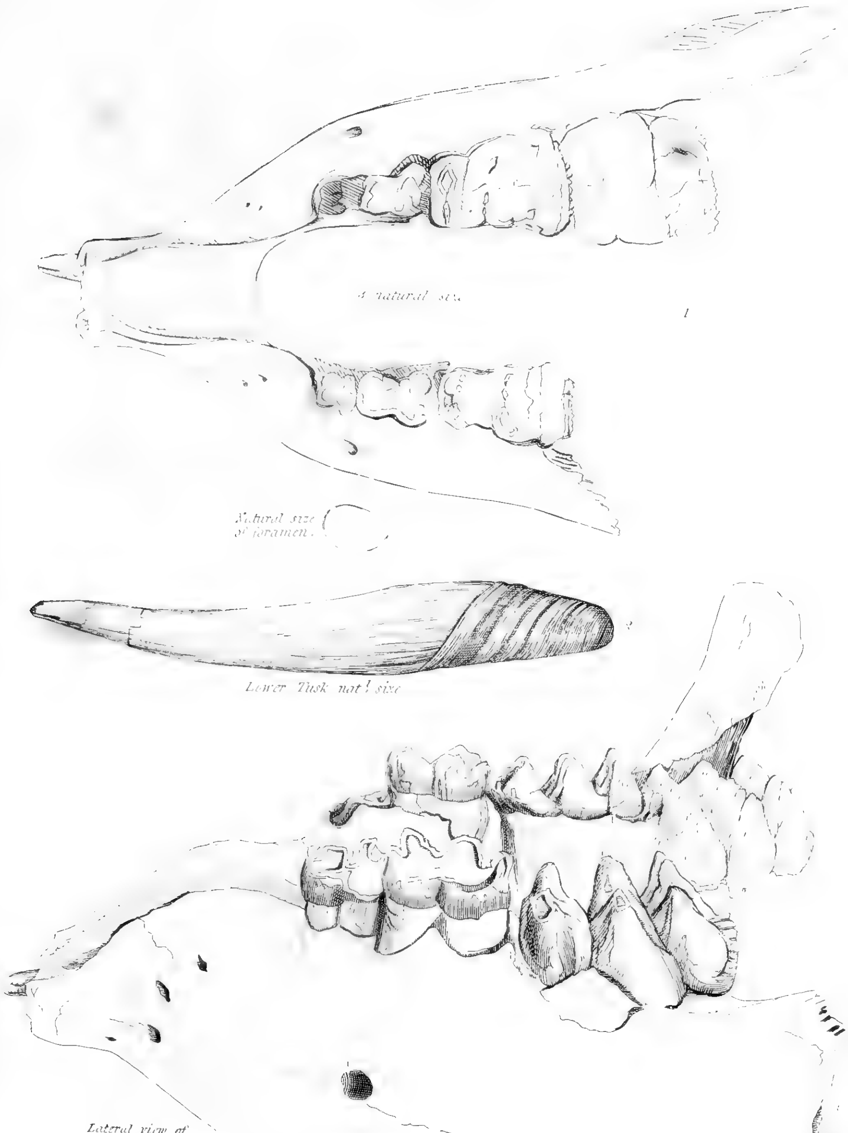
PL. XVIII.



J. Drayton Sc

tion, belonging to the beautiful Museum of R. Peale of New York; of a fourth we have heard, as being in possession of a distinguished scientific gentleman of that city, though of this we can affirm nothing positively. It is highly probable that other specimens have been raised by those engaged in canalling, &c. that have been laid aside as Mastodon bones, which they so closely resemble.*

In regard to the relative position of the animal in the class Mammalia, we are led by the form of the lower jaw and tusks to believe that it should stand between the genera Mastodon and Hippopotamus; being allied to the former by the general character of the teeth and skeleton, and to the latter especially, by the inferior tusks, as well as the form of the molar teeth. The same circumstances would cause us to conclude that the regimen of our animal might have been of a mixed character, or that like the Hippopotamus this genus was somewhat aquatic and fed upon the productions found in rivers, lakes, or marshes. However this may be decided, the proofs of the former existence of the genus are unequivocal, and will no doubt be multiplied if proper attention be paid to the explorations making throughout our own country.

In concluding this paper the writer would feel culpable of neglect did he not return his warmest thanks to the intelligent discoverer of these bones for the opportunity afforded of examining and describing them, as well as to his friends Dr Boyd of New York, and Messrs Rubens and Titian R. Peale for their much valued assistance.

[Read, *Friday, January* 1*st*, 1830.]

* Since this paper was in type we have learned with much pleasure that a second exploration made by Mr Crawford has been very productive, and there is reason to hope that Mr Rubens Peale will be enabled thereby to mount an entire skeleton of the Tetracaulodon Mastodontoideum.

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Mr Poinsett and Mr Keating having requested that Mr Franck (an artist who had been two years in Mexico making drawings from Mexican Antiquities) might be allowed to make copies of some of those in the Cabinet of the Society; permission was given him accordingly, of which Mr Franck has availed himself with much fidelity and talent.

THE END.

ERRATA.

Plate II.—The numbers on this Plate after No. 3 are placed wrong. 11 should be 4; 9 should be 5; 10 should be 6; for 4 put 7; for 5 put 8; for 6 put 9; for 7 put 10; for 8 put 11.

Page 275, line 12 from the bottom, after the word "parts" for comma *put* semi-colon.

Page 283, 1st line, for "position" *read* portion.

406,	line	4 from the bottom,	for	peruvianus	*read*	plicatus
407,	line	3 do.	for	form	*read*	forms
417,	line	4 do.	for	peruvianus	*read*	plicatus
"	line	5 do.	for	peruvianus	*read*	plicatus
418,	line	4 do.	for	peruvianus	*read*	plicatus
424,	line	4 do.	for	made the type of	*read*	placed in

473, line 10, for Fig. 2, g *read* Fig. 2, q

476, line 2, for Leaæ *read* Leanus